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Editorial

Editorial Office Address
Commission of Motorization and Energetics in Agriculture
Wielkopolska Str. 62, 20-725 Lublin, Poland
e-mail: eugeniusz.krasowski@up.lublin.pl

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Method of choosing vectors for investment strategies implementation

N. Baydala, S. Kniaz, O. Pauk

Lviv Polytechnic National University; e-mail: lucky1@ua.fm

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Abstract. Statement of the problem. In market conditions, the investment activity of enterprises requires diversification of objects and methods of investment. This helps to minimize investment risks, stabilize cash flows in space and time, as well as to increase the guarantee of successful implementation of investment to the entities, which take indirect participation in investment processes. The problem consists in the absence of scientifically grounded methodological regulations regarding the selection of methods of the investment strategies implementation. Consequently, most of the investment decisions are based on an intuitive approach which reduces the possibility of opportuneness and completion in the implementation of purposes established by investors'.

Key words: strategies, investment strategies.

SOURCE MATERIALS AND METHODS

Implementation of a specific investment strategy by an industrial enterprise requires a critical analysis of alternative investment projects as for their compliance with the chosen strategy. In scientific literature there are quite a few works devoted to project analysis [1, 2, 4, 6, 7, 8]. Almost in all of them, however, methods of identifying comparative advantages of some projects are described in comparison to others. The existing methodological recommendations are not sufficiently informative for a scientifically-grounded choice of implementing investment strategies selected by a particular enterprise. Formation of the list of investment projects which a company may implement, is the result of accumulating the information about the possibility of obtaining economic benefits, certain competitive advantages in comparison with other enterprises, as a result of investing. In transfer networks the information about numerous investment projects is public. All these projects are supplied with technical-economic substantiation of their implementation effectiveness; still, many projects do not find their investors. The reason is that the goals of these projects are not always compatible with the characteristics of the investing strategies selected by industrial enterprises. In this case, by characteristics of investment strategies we mean long-term investment goals and criteria of their realization. Hence, analysing alternative investment projects while choosing implementation vectors of selected investment strategy requires ivestigation of compatibility of investment projects purposes with the characteristics of the investment strategy chosen by an enterprise. Fig. 1 shows the stages of analysing alternative investment projects in the process of choosing implementation vectors of a selected investment strategy. \

Studies have shown that this task can be carried out through analysis of the period of investment projects implementation, the sphere of their performance, the economy sector, the number of subjects involved in the implementation of projects, etc. When a set of projects matching the characteristics of the selected investment strategy is formed the next step of analysis (see Fig. 1) comes – verification of investment projects for their profitability and risk. Verification of the investment projects optimality in the context of these indicators can be performed according to the criterion of Wald (the best of alternatives is the one with the highest pessimistic evaluation), the maximum optimistic criterion (the best alternative is the one with the highest optimistic evaluation), the Hurwitz criterion (the best alternative is the one in the middle between the optimistic and pessimistic estimates), the criterion of Laplace (the best alternative is the one characterized by the highest arithmetic mean evaluation), the Baiyes-Laplace criterion (the best alternative is the alternative with the highest averagely evaluated arithmetic evaluation), the criterion of the Hodges-Lehmann (optimal alternative is the one that satisfies the maximum optimistic criterion, as well as the Baiyes-Laplace criterion).

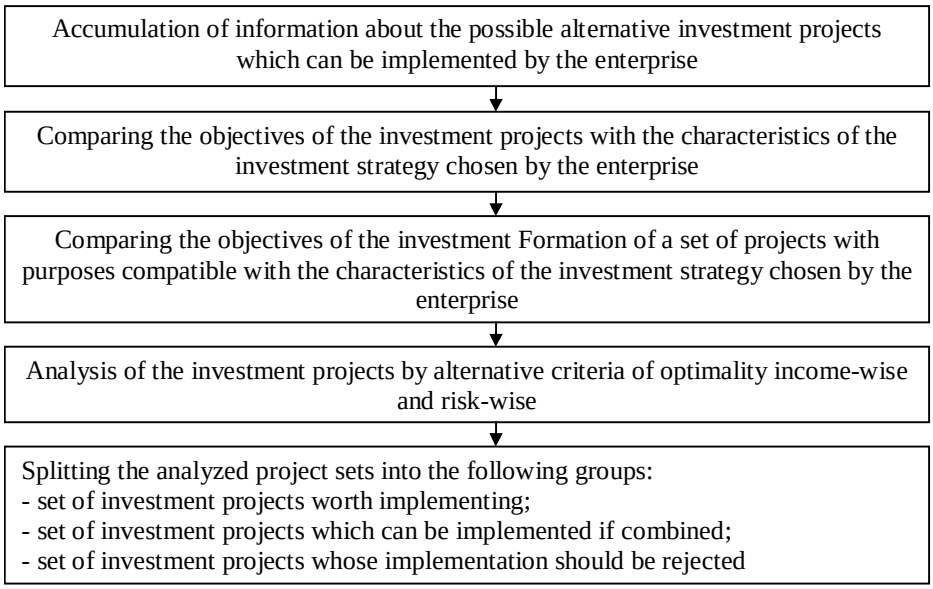

Fig. 1. Stages of analyzing alternative investment projects during the selection of vectors for implementation of a selected investment strategy
Notes: elaborated by the authors

As a result of investment projects analysis by alternative criteria of their income and risk optimality, they can be split into three groups – with low, average and high risk levels, as well as into three other groups –with low, average and high levels of profitability. Since the general number of criteria is 6 the high level of optimality takes place when a project meets from 4 to 6 criteria. If an investment project meets from 0 to 2 criteria, this indicates the low level of optimality. In other cases the investment project is characterized by the average level of optimality. Fig. 2 and 3 show the chart of possible investment projects allocation into these groups.

As can be seen from Fig. 2 and 3, the project I1 is acceptable for implementation since $I_a \in f(R_1;P_2)$. The Project $I_d \in f(R_3;P_1)$ is expedient for rejection. The decision on the implementation of other investment projects $I_b \in f(R_2;P_2)$ and $I_c \in f(R_2;P_3)$ can be made only if we merge these projects into one and thus provide the required level of profitability and risk.

Notation conventions: Ii - investment projects; Ri - level of risk of i-investment project; R1 - low level of risk of the investment project; R2 – average level of risk of i-investment project; R3 - high level of risk of i-investment project.

As a result of comparing investment projects by their levels of income and risk, three groups of sets have been formed. The first of them is the consequence of applying a selection scheme:

$$\forall \mathbf{U} I_n \exists \mathbf{U} I_i \forall I_d \left(I_d \in \mathbf{U} I_i \Leftrightarrow I_d \in \mathbf{U} I_n \wedge F\left(I_d\right) \right),$$

$$\mathbf{U} I_n = I_a \cup I_b \cup I_c,$$

where: $\mathbf{U} I_n$ is the merging of the sets of investment projects which are acceptable for implementation, under certain conditions; $F\left(I_d\right)$ set-singleton which represents an investment project which, due to the criteria of risk and profitability, should be rejected.

Merging of the sets of investment projects:

$$\mathbf{U} I_n \supset \begin{cases} I_a \in f(R_1;P_2), \\ I_b \in f(R_2;P_2), \\ I_c \in f(R_2;P_3). \end{cases}$$

Includes the project I_a, which, under the minimum level risk, can provide an average level of profitability of investments; and the projects $I_b \wedge I_c$, which are acceptable only by one of the two criteria.

The studies suggest that in case if an enterprise implements its investment strategy only in the financial sector, i.e. investment projects mean investing only into corporate, debt and derivative securities, and into currency and banking metals, the most widely spread solution is to form investment portfolios of the balanced type. Such portfolios embrace investing into investment objects that have different, often opposite assessments of profitability and risk. The purpose of their formation is levelling the influence of subjective, economically unsound investment decisions on the state of the investment portfolio of an enterprise in general.

The empirical data indicate that in case of the formation of investment portfolio of the projects for investing into objects of the real sector of economy, the decision to merge two or more projects into one are less common. Such decisions require flexibility of investors, recipients and participants of investment activity. First of all, we are talking about the complexity of distributing property rights for the object of investment. Study of the materials of industrial enterprises which have experience in realization of joint investment projects indicates that the subjects of investment often have different visions on the content and the amount of work to be done to ensure

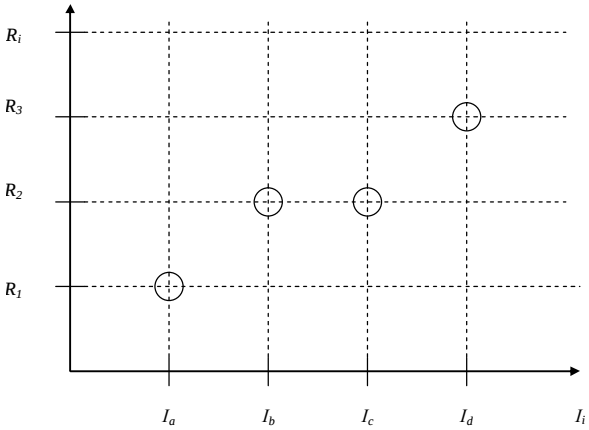

Fig. 2. Chart of the investment project risk
Notes: elaborated by the authors

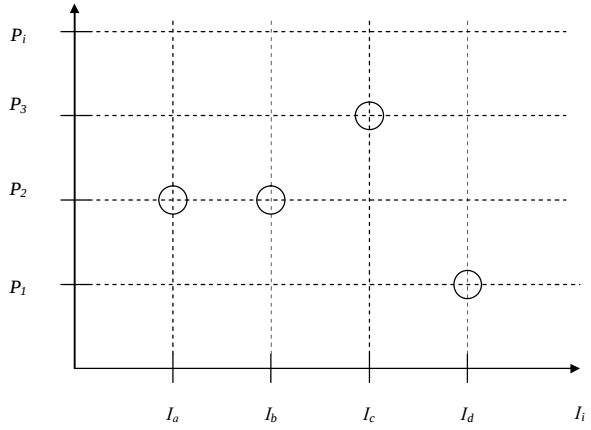

Fig. 3. Chart of the profitability of investment projects
Notes: elaborated by the authors
Notation conventions: Ii - investment projects; Pi – the level of profitability of the i - investment project; P1 - low level of profitability of the investment project; P2 – average level of profitability of the investment project; P3 - high level of profitability of the investment project.

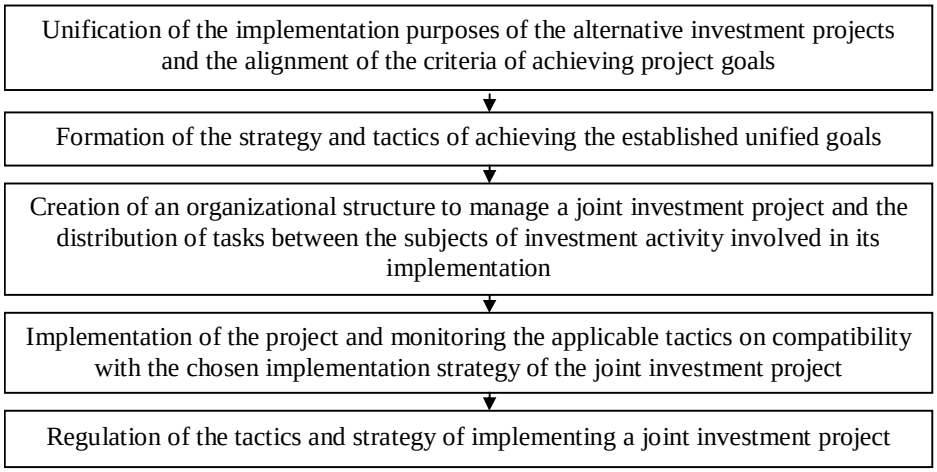

Fig. 4. The sequence of stages of merging two or more investment projects into one
Notes: elaborated by the authors

success of an investment project. They assess the scope of required investments and their payback periods differently. One of the technologies of merging two or more investment projects into one is via gaining membership in a social association of mutual investment and joint implementation of investment projects – GIG MS Corporation. Due to the construction of the «Bank of ideas», the participants of the association get an opportunity to accelerate the process of investment project improvement and to facilitate the search of business partners.

Mainly the scheme of merging two or more investment projects into one covers the stages presented in Fig. 4.

From the position of sets' theory the components $\mathbf{U}I_n$ relate to each other in the following way:

$$\mathbf{U}I_n = I_a \cup I_b \cup I_c,$$
$$a \in \mathbf{U}I_n \Leftrightarrow \exists I_a \in \mathbf{U}I_n, a \in I_a,$$
$$b \in \mathbf{U}I_n \Leftrightarrow \exists I_b \in \mathbf{U}I_n, b \in I_b,$$
$$c \in \mathbf{U}I_n \Leftrightarrow \exists I_c \in \mathbf{U}I_n, c \in I_c,$$

where: a – the element of set-singleton I_a; b – the element of set-singleton I_b; c – the element of set-singleton I_c.

Taking into account the fact that the investment project I_a, being characterized by the acceptable values of profitability and risk; might be implemented by a company at once, while investment projects $I_b \wedge I_c$ require further improvement, it is reasonable to distinguish two subsets in the $\mathbf{U}I_n$ structure:

$$\mathbf{U}I_n \supset I_a \cup \mathbf{I}I_k,$$
$$\mathbf{I}I_k = I_b \cap I_c,$$
$$I_b \in \mathbf{U}I_n \Leftrightarrow \exists \mathbf{I}I_k \in \mathbf{U}I_n, I_b \in \mathbf{I}I_k,$$
$$I_c \in \mathbf{U}I_n \Leftrightarrow \exists \mathbf{I}I_k \in \mathbf{U}I_n, I_c \in \mathbf{I}I_k.$$

Intersection of sets indicates that these sets have common elements. That is,

$$I_b \cap I_c = \{x \mid x \in I_b \wedge x \in I_c\},$$

where: x – the common element of sets $I_b \wedge I_c$.

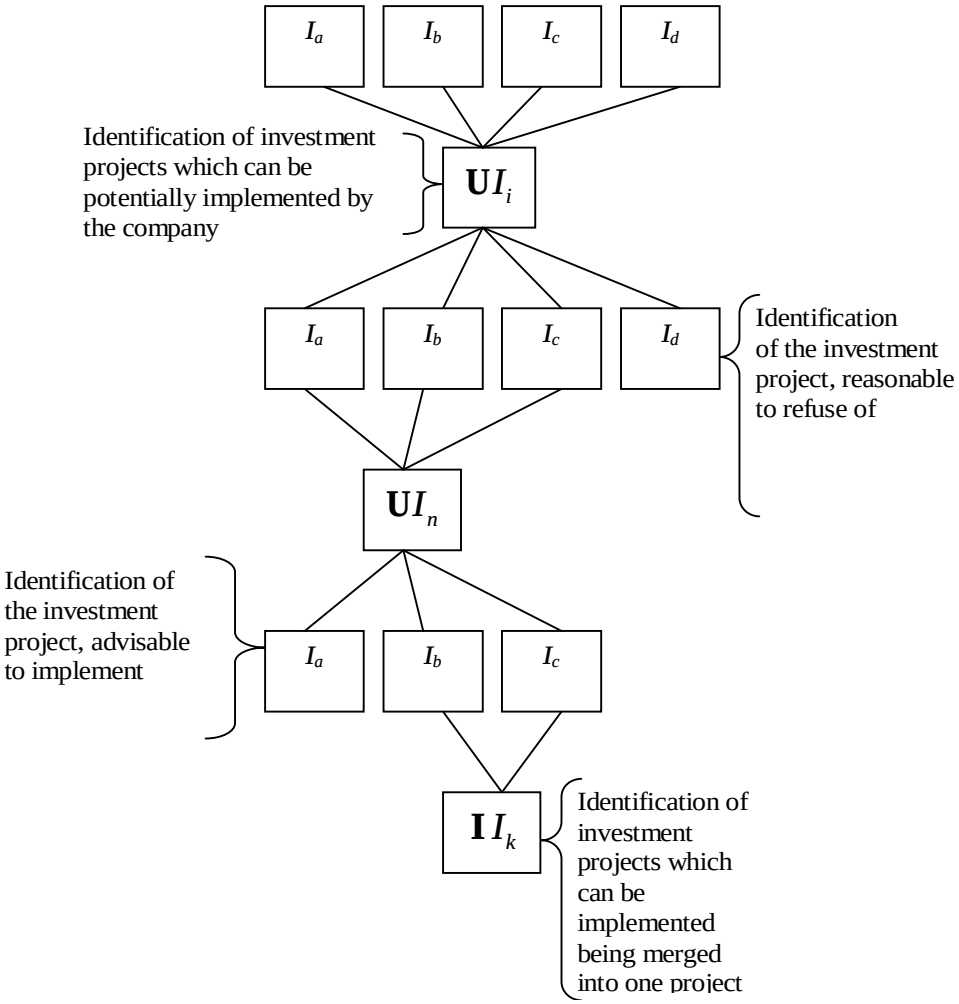

Fig. 5. The results of the analysis of investment projects according to their profitability and risk
Notes: elaborated by the authors

Since we are talking about merging of two investment projects into one, the common elements of these projects may be the objects of investment, subjects of investment activity, expected effects of the implementation of the project, etc.

Fig. 5 shows a graphical representation of the investment project analysis results according to the criteria of profitability and risk.The presented decomposition of investment projects indicates that the unacceptable for implementation investment projects may be immediately rejected if they are not connected with the other alternative projects. The investment projects, whose purpose is compatible with the characteristics of investment strategy chosen by the enterprise, require further investigation on the possibility of obtaining the expected economic effects by various criteria of optimality in the context of identifying their profitability and risk. The process of merging two or more projects into one largely depends on the aptitude of investment activity subjects to risk, their mobility, that is, flexibility in decision making, as well as on objective factors, i.e. technological complexity of the projects' merging, geographical remoteness of investment objects (enterprises-recipients), and the compatibility of the project ideas, etc.

The method of choosing vectors of the investment strategies implementation is designed for industrial enterprises which act as investors. The projects they have started are the expression of the selected investment strategy implementation. Application of the proposed method by the heads of industrial enterprises-investors will help to avoid contradictions between strategic goals of an enterprise and objectives for the implementation of individual investment projects; raise awareness of project analysis; advance arguments for the election of the best investment projects of a number of alternative projects; deepen analysis of the factors influencing the efficiency of realization of the investment strategy; optimize the conditions for implementing those investment projects, which, according to certain criteria, are unacceptable for implementation.

RESULTS AND DISCUSSION

Investment activity, like any other economic activity, is carried out under the influence of individual,

collective or public initiatives. The basis for these initiatives are individual, collective or public needs, namely the achievement of a certain level of material prosperity, security, comfort, etc. Despite the idea that encourages investment activity subjects to invest and the kind of effects expected from the creation or acquisition of certain assets, management investment decisions are deeply subjective. The subjectivism of investment activity is that at each stage of the investment process particular people or groups of people are taking appropriate decisions based on their awareness about the investment conditions, their own experience, level of professional training, interest in the outcome of investment, relations with the recipients etc. Despite a considerable interest of scientists in the problems of investment activity, as for today, there are no software products and automated systems of making management investment decisions based on economic-mathematical apparatus which would not necessitate human participation. It is a natural phenomenon because the factors that determine the feasibility and effectiveness of an investment are largely beyond the objective laws and are based on the emotional and psychological effects. It is well known that the nature of the formation and development of these impacts practically cannot be formalized and explained by the rules of logic.

With this taken into account, the subjectivity of investment activity, in particular formation of investment strategy of the enterprises is one of the most essential features, which, on the one hand, determines their economic efficiency and, on the other hand, appears to be a problem. The subjectivity of forming investment activity strategies is the main source of risks connected with obtaining the expected economic effects by investors. Regarding other problems of investment activity, in particular the problems of ensuring the economic efficiency of any vector of implementing the existing strategies of investment, there are the following ones: adverse investment climate; low level of development of market infrastructure; uncertain priorities of the state in the investment activity; high levels of corruption and weak public control over the official public structures etc. Economic efficiency of the strategies of investing into enterprises, as a criterion for selecting a possible investment strategy, also depends on the low level of market infrastructure development, i.e. communications, systems and organizations that create opportunities for legitimate and safe interaction of investors and recipients. In the market conditions the important infrastructure elements for investors are the presence and the development of financial organizations and organized financial markets; communication systems; transport communications.

In Ukraine the equity of financial institutions, if compared to other countries of Eastern Europe, is very low. This fact to some extent hinders the promotion of entrepreneurial and investment activities and does not allow businesses to rely on the market of credit resources in case of critical phenomena. In addition, the level of competition among the local financial institutions is too low to intensify the efforts of participants of financial markets to introduce some innovations for improving the quality and reducing the cost of customer service.

The undeveloped national stock and currency markets act as ballast for the national economy in the period of global economic-financial crises. Locality of our financial markets, passiveness of the integration of the stock exchange development into the world market, together with the currency restrictions introduced by the NBU, protect the national currency and assets of local enterprises from the world speculative capital. On the other hand, however, national enterprises as subjects of investment activity, compared with foreign companies, have far more limited opportunities for the implementation of investment activity strategies. They are not able to accumulate investment resources on financial markets regularly in large amounts and get capital gains from the growth of their market value.

Concerning the activities of venture investment funds, according to the experts of the Ukrainian Association of investment business, they are relatively new for the Ukrainian investment business and became possible after the adoption of the Law of Ukraine "About the Joint Investment Institutions" [10]. Prior the appearance of the mentioned law there were investment and mutual funds in the country since mid 1990's. They were being created in order to ensure the processes of mass privatization. Among them one can mention Western NIS Enterprise Fund, Sigma Blazer, direct investment Fund «Ukraine». In addition, there functioned such funds and venture investment companies as Black Sea Fund, "Euro ventures Ukraine" company, "Ineko" company, Fund "Dnipro". By 2003 the number of such funds decreased three times from 329 to 129, and those remaining had to be liquidated or reorganised in accordance with the Law. In December 2005, the company Draper Fisher Jurvetson (DFJ), composed of 20 funds with a combined investment capital of over $ 3 billion, opened a technological venture Fund DFJ Nexus in Ukraine. In the next 10 years the Fund plans to raise from 50 up to 100 million dollars for the development of high-tech companies in the former USSR countries. A large number of participants of venture investment companies market in 2005 made market concentration among companies impossible: none of the companies owns more than 10% of the market of venture joint investment institutions [3].

In Ukraine the venture capital market is about $ 400 million (its potential by the data of some companies reaches 800 billion dollars.) and consists of no more than ten working companies. Among them one should mention Western NIS Enterprise Fund (capital of $ 150 million, given by the U.S. government for the development of

food industry, agriculture, production of construction materials, and financial sector of Ukraine), Sigma Blazer (capital of $ 100 million). For comparison, in Russia the scope of venture capital reaches more than $ 5 billion, and in the United States, just several decades ago, venture capital market was more than 70 billion USD. To promote the development of venture capital organizations in Ukraine and empower enterprises for investment strategies implementation on the basis of attracting venture capital, it is necessary, first of all, to develop national legislation, namely, to adopt the Law of Ukraine «About venture capital activity in the innovation sphere». This would be the basis for formation of a number of special legal acts which would describe the procedure of venture capital organizations functioning.

As for the communication and information systems, the level of their development in Ukraine is also one of the barriers to the economically effective implementation of investment strategies since, in comparison with foreign markets, in Ukraine these systems are on the primary stage of development. Under such systems are meant primarily Ukrainian technology transfer network (UTTN); national technology transfer network (NTTN); Alt business education, etc. Their purpose is to provide communication between investors, recipients and other subjects of investment activity in supply and demand for investment resources, final products, raw materials and stuff; possible effects of the implementation of specific investment projects and resources needed for their implementation; level of reliability of investment into specific assets and guarantees of return of the invested money within a particular period of time. Foreign analogues of these systems which have acquired a great applied importance in the market of investment resources accumulation are EBN, IRC, IRE, TII, ASTP, etc.

These and other systems are easily accessible by users and highly integrated into international payment and trading systems, such as Cyber Plat, Cyber Check, Cyber POS, ASSIST, Instant, Pay Cash, Web Money Transfer, EACCESS, e-gold, PayPal, stock exchange model of B2B company, advertising model of B2B company, business models B2C, C2C, C2B, B2A, C2A, B2G, G2G, G2C, etc. The weak side of the national communication and information systems is that they cover the national market fragmentarily, do not ensure integrity of the internal Ukrainian information space. Business companies, educational and scientific institutions are poorly informed about their functions and features of functioning. The level of transport communication development is also important for a good choice and successful investment strategies implementation. It is important for the direct investments realization by foreign investors who make their investments by importing production equipment. Transport communications mean transport routes of appropriate quality, service infrastructure of roads, the equipment of the roads by telephone communications, as well as the availability of appropriate conditions for safe cargo transportation. Unfortunately, today even the international transit highways of Ukraine do not satisfy average European requirements. Representatives of foreign companies, who import the basic means as their share in the statutory funds of enterprises of Ukraine, argue that no matter which way the equipment is imported from the border to the enterprise-recipient, the transportation risk is very high because the conditions of highway transportation from railway stations, airports or sea ports are equally unsatisfactory, no matter how close or far the enterprise-recipient is from regional centres and even the capital of the country. Taking this into account, it is necessary to form a national program for constructing and reconstructing the highways to improve transport communications. Local and foreign companies should be engaged in the development, implementation and financing of this program on tender conditions. Obviously, that this task can be fully performed, with the involvement of foreign investors, only when the foreigners are able to become land owners in Ukraine.

The achievement of economic efficiency in the investment strategies implementation is additionally complicated by a high level of corruption among state officials and weakness of public control over their actions. A group of countries-members of the Council of Europe anti-Corruption Group (GRECO) stated that the level of corruption in Ukraine may become a threat to the principles of democracy in the country. According to GRECO, Ukraine is heavily affected by corruption, and this problem is systematic and widespread. The entire Ukrainian society is disposed to corruption. GRECO recommends Ukraine to establish a special body that would be responsible for implementing anti-corruption strategy in the country. Also GRECO advises to create an action plan consisting of almost thirty points, to take a number of other important measures [11]. According to the human rights organization Transparency International, Ukraine is heading the list of the most corrupt countries in the world [10]. Concerning public control, its level in Ukraine is really low. Its objects, as stated by the public organization «OPORA», should be: «...the activity of state and local self-government institutions and their employees of different positions. Government authorities, as a rule, have a wide interpretation: they are not only those state institutions that have the authority but also any organization, institution or enterprise financed from the state budget, » i.e. under public control one should understand «... public inspection of the state activities from the side of society regarding their compliance with the declared objectives; correction of this activity and its very objectives; relevance of state policy, activities of state bodies and their officials to the interests of society, as well as public monitoring of the activities of state and local self-government bodies, aimed at protecting and

ensuring rights and legitimate interests of a human, his/her fundamental freedoms and respect to them...» [5].

In Ukraine there is no Law «About public control», thus the implementation of effective mechanisms of public protection of rights of investment activity subjects at all stages of formation and realization of investment strategies is made almost impossible. Having such a law adopted would significantly intensify the processes of civil society formation in Ukraine and strengthen public influence on the officials, in particular in the sphere of investment activity regulation.

In general, the problem of ensuring economic efficiency of selection and implementation of investment strategies lies in the subjectivity of investment activity subjects in their formation and management of investment decisions, as well as in the irrationality of the influence of the state, as a subject of investment activity management, on creation of favouring conditions for accumulation of investment resources and their economically effective use.

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Structuring expenses of industrial enterprises in the evaluation process of its production and sales potential

A. Emelyanov, O. Kurylo, A. Vysotskij

Lviv Polytechnic National University; e-mail: laputa@meta.ua

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Abstract. The essence of supply-side potential of industrial enterprises and conceptual bases its evaluation. Determined the importance of structuring the company's expenses in carrying out its assessment of supply possibilities. A method of allocating costs that are not dependent on the range of enterprise, for its species. Filed analytical expressions modified index of relative level of costs and the marginal rate of return products. A method for optimizing the production program of industrial enterprises in the evaluation and implementation of its supply-side potential.

Key words: enterprises costs, structuring, supply-side potential, production program, allocation of costs, product range, marginal revenue, optimization.

STATEMENT OF THE PROBLEM

Nowadays the conditions of functioning domestic enterprises are greatly complicated that is caused by increasing competitive struggle, instability in demand, rising prices of certain productive resources etc. In this regard, increased requirements for the degree of justification industrial programs of economic entities regarding the list and amounts of those products, which is expected to produce. In its turn, the formation of enterprise production program should be based on a careful assessment of its level of supply-side potential, which ultimately determines the optimum nomenclature and volume of production and sales of various types of enterprise.

The need for optimization approach to the formation of industrial programs caused by the fact that to the vast majority of industrial enterprises there is a possibility of simultaneous production of different products, different technical and technological parameters of production, a set of consumer characteristics, quality level etc. Regarding economic indicators of manufacturing various kinds, in addition to the price level important indicators by which they undergo differentiation, are the size and structure of the production costs of a particular type of product. The level and structure of costs in terms of each product that produces or intends to produce enterprise, particularly between direct and indirect costs, directly determine the level of profitability of different products and, therefore, have a significant impact on the supply-side potential capabilities of an economic entity. On the other hand, the optimization of enterprise production program allows, among other things, determine the best cost structure as by product, and also by elements of the operating costs at the level of the whole enterprise.

Thus, analysis and rationalization of the cost structure for manufacturing and marketing of products enterprise is a prerequisite and outcome evaluation of its supply-side potential, as only with proper structuring costs the company may set the following parameters of its assortment policy under which achieved the highest amount of financial results its activities.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

The problem of determining the nature and justification of methods for assessing the economic potential of enterprises, including their production and marketing opportunities at present is the focus of many researchers [1, 6-18; 2, 72-75; 3, 14-19; 15 and others]. At the same time the researchers noted the presence of a number of different types of potential business. Thus, in the work [4, 5-6] the author presents three-level model of the economic potential of the entity, which due to potential interaction of lower level components formed a higher level. Besides constituents enterprise potential third level, with the greatest degree of generality, the

author considers the current production and investment and innovation potential of the entity.

With regard to supply-side potential of the company, the majority of scientists, including the authors of papers [4, 5, 5, 49-52, 6, 9-16] see it as a description of the business opportunities on the manufacturing and marketing of its products a certain amount for a certain period of time. At the same time at present there is no single universally accepted approach to the evaluation of this potential. This is because the size of the economic potential of the company, including its production and marketing capabilities, affects a significant number of different factors that vary over time, while some of these factors are external to the enterprise. In this connection you can accept the views of the author's work [7], which states that potential of industrial enterprise should be regarded as a category "that reflects not only the current state of industrial, economic and financial activity, but also the dynamics and prospects of strategic development of entity management in view of influence changing factors internal and external environment " [7, 84].

In this way, increasing the validity of methods for quantitative evaluation of supply-side potential industry requires more complete account of the influence of factors that determine the size of this potential. Among these factors important place occupied by the size and structure costs. In other words, the size of the potential business of producing and marketing products largely determined by how effective and efficient is management system spending on it. As pointed in a number of scientific works devoted to the question of formation of such a system, in particular, in works [8, 9, 10 and others], reducing the relative level of corporate expenses and compliance management relationship between their types is a prerequisite for growth and competitiveness, respectively, increasing its shares on the markets of manufactured products.

At the same time, the existing methods in the current literature evaluating supply-side potential of the enterprise do not pay sufficient attention to counting of factors, size and cost structure of the enterprise. In this connection there is need to develop methods for assessment of supply-side potential of the entity based on a full consideration of these factors.

FORMULATION OF ARTICLE'S OBJECTIVE

The aim of this work is to develop theoretical and methodological principles structuring costs of industrial enterprise in the process of evaluating its supply-side potential.

THE MAIN MATERIAL

Our study showed that the quantitative evaluation of any kind of economic potential of industrial enterprise, including its supply-side potential can be achieved by such a measure (or group of indicators), which is inherently more generalized than a direct characteristic of this type of economic potential of the entity. For example, if supply-side potential of the enterprise can be described as the ability of the company to manufacture and sell certain optimum output over time, the index evaluation of this type potential can serve the maximum possible size of its operating income for this period of time, or if make an assessment of supply-side potential in relative terms - the ratio of the maximum possible value of operating profit entity to actual or planned size of the profits.

Thus, evaluation of supply-side potential of the enterprise, as well as any other type of its economic potential (investment, innovation, labor, etc.) should be based on the use of the optimization approach. Particularly in the event of evaluating supply-side potential of the entity optimization criterion should be its maximum of operating profit. In this turn, one of the main ways to profit management entity is structuring its operating expenses.

When structuring costs proposed to understand our business direction of management, which involves the division of costs on a group (by type of expenditure, kinds of manufactured products, etc.) and establish the best balance between the size of the cost of the various groups in which maximized certain financial performance of a business entity. In particular, an important technique of structuring costs of the enterprise is the selection of the types of costs, the value of which varies with specific management actions in the context of a specific event management company profits.

Regarding the evaluation of supply-side possibilities of industrial enterprise, in the context of solving this problem all the costs of the company can be divided into two major groups, namely:

- the costs, the total amount of which does not change with the change of the structure of the product range, which makes the company;
- costs that are directly dependent on the structure of the product range.

Costs of the first group include the majority of conventionally fixed costs. However, under certain conditions (which is primarily due to the peculiarities of technological processes in the enterprise) this group costs may include certain types of variable costs, including salaries of key workers and charging for it. The last case is possible when the production capacity is limited by the overall complexity of manufacturing all its types, and pay depends on the amount of time spent by each employee.

As for the second group of costs, it primarily includes material costs.Under these conditions, the evaluation supply-side potential of the enterprise and, consequently, the formation of its production program should be based on the appropriate structuring of corporate expenses for each type of manufactured

products - namely, to establish the relationship between costs that vary and are not dependent on the structure product range. This structuring allows to determine the general direction of changes in the production of different products and, given the appropriate changes in their prices (which appear as a reaction of markets) in an iterative mode, set the optimal production program of the company. In this turn, this will allow for the structuring of the total operating costs of the enterprise in terms of products and components of these costs.

Generally, in conditions of a dynamic market environment ensuring proper level of competitiveness requires from businesses permanent, or at least periodically reviewing the composition and structure of the range of products they produce. In order for such a review was economically justified, the company should have information on what kind of revenue share in the total amount it provides a realization of a particular type of product. Only if this information can establish production which products should expand and which to cut.

Obviously, the determination of profits from sales of each type requires its calculation of the production costs of each type of product. The complexity of this calculation due to the presence of costs that cannot be directly (directly) attributed to each type of product that the company produces. In modern literature, in particular in works [11, 12, 13, 14], a number of different ways proposed for distribution of indirect costs by type of enterprise, however, these methods are often presented without proper theoretical justification.

In our opinion, the basic principle of classification of costs by type of products should consist of the following: assign costs to be considered properly executed if received as a result of cost performance and profit from the production unit of each product can make a reasonable assortment of formation of the business. In other words, the question is not about how "real" is resulting from the charging of the value of unit cost, and whether it allows information of value to accept management decision to change the structure of the range of products the company produces, to achieve maximum possible efficiency of its industrial and economic activity.

As indicators of selecting the best option changing the structure range of enterprise should be used primarily the following two points:

1. The absolute efficiency of production of certain types of products. This rate can be calculated, such as the ratio of profit from the production and sale of units of certain goods, produced venture, the cost per unit or share value of a limiting factor (e.g. labor per unit of output, if the limit on the size of the production program in favor of its overall complexity).

2. Index of marginal efficiency of manufacturing certain types of products. This index can be calculated, such as the ratio of growth of return on production and sale of an additional unit of a particular type of product that the company produces, the cost per unit or share value of a limiting factor.

Under such conditions, to achieve maximum financial results (profits) will be feasible to increase production of those products enterprise for which the values of some indicators to select the best option changes the structure of the product range will be the largest, and the decline in the production of those products for which value is the smallest. It should be noted that the absolute efficiency of production of certain types of products, which does not require the evaluation of the changes in relevant indicators calculated more easily than in the marginal efficiency. At the same time, the use of the absolute efficiency is not always possible to determine the best direction changing the structure range of enterprise (as optimality criterion enterprise production program is the equality of the marginal efficiency of manufacturing all kinds of products).

To carry out further research, we assume that:

- firstly, the production capacity of the enterprise is a constant value (that is considered a short-term planning period);

- secondly, the enterprise has the ability to influence the size of the price of their products, changing the amount of production of one or another of its kind, but with little change in these amounts change in prices is not essential;

- thirdly, the production capacity of the enterprise is used in full and limited for the total labor input of manufacturing of all kinds.

Then the operating profits of the enterprise from the production of all kinds of products can be calculated by the formula:

$$П = \sum_{i=1}^{n} (Ц_i - c_i) \times Q_i - C , \qquad (1)$$

where: the $Ц_i$ - the price-and the kind of enterprise without VAT, UAH; ci - costs that are directly dependent on the structure of the product range, the i-fact type of product as per its unit, UAH; Qi - current natural amounts of production i- -type; n - number of products that enterprise produces; C - the total value expenses of the enterprise that do not depend on the range of products, UAH.

It must be made by the equation:

$$\sum_{i=1}^{n} t_i \times Q_i = T , \qquad (2)$$

where: the t_i - labor input of manufacturing unit i- type, man-hours, T - total labor input of manufacturing all kinds of products, man-hours.

If the enterprise wants to increase the size of their income, slightly changing the structure of the range products that it produces, then as follows from formulas (1) and (2), it is necessary to calculate the ratio $(Ц_i - c_i)/t_i$ for each product. Then it is necessary to increase

production of the type of products for which this ratio is a maximum, and the decrease in production of those products for which this ratio is minimal. The amount of expenses that do not depend on changes in structure of the range as the value was not affected by decisions made.

In order to have information about the full cost of each product, which makes enterprise we should distribute costs that do not depend on the structure of the product range between its kinds so that the information obtained from such distribution, led to the adoption of the same optimal solutions to manufacturing production program of the enterprise that use the criterion:

$$Z = \frac{Ц_i - c_i}{t_i} \to \max . \quad (3)$$

For this purpose, we calculate this figure:

$$a = \frac{C}{\sum_{i=1}^{n} (Ц_i - c_i) \times Q_i}, \quad (4)$$

where: the α - the coefficient of distribution costs that do not depend on the structure of the product range, the share of unit. Using this coefficient will perform a cost sharing between the products in which one could reasonably determine areas of improvement of assortment policy the company.

Then:

$$C = a \times \sum_{i=1}^{n} (Ц_i - c_i) \times Q_i . \quad (5)$$

and, accordingly the formula (1) takes the form:

$$П = \sum_{i=1}^{n} (Ц_i - c_i) \times Q_i - a \times \sum_{i=1}^{n} (Ц_i - c_i) \times Q_i = \sum_{i=1}^{n} (Ц_i - c_i - a \times (Ц_i - c_i)) \times Q_i . \quad (6)$$

Thus, the total unit cost under the proposed approach will be calculated by the formula:

$$C_{ni} = c_i + a \times (Ц_i - c_i) , \quad (7)$$

and the criterion of choice that type of products, which need to expand, will be as follows:

$$Z' = \frac{Ц_i - c_i - a \times (Ц_i - c_i)}{t_i} \to \max . \quad (8)$$

The solution obtained according to the criterion (8), will be fully coincide with the solutions obtained by the criterion (3).

It should be noted that the selection of the best content and structure assortment of products enterprise must ensure reaching the largest financial results for a given fixed amount of its production capacity. Clearly, this problem statement is correct only in the short term.

Obviously, under such conditions is a significant issue substantiation criteria select the best composition and structure of the product range. Particular interest is the question of how adequate this criterion is a traditional indicator of the relative level of costs to production companies for its types, which is defined as the ratio between the total cost and price.

In our opinion, answering the question you need to consider separately the three most common cases of the situation on the market:

1. The enterprise produces (or can produce) simultaneously some products, prices are set by the market, and the enterprise cannot influence their level, changing the natural production amount. This case is typical, especially for a competitive market.

2. The enterprise produces (or can produce) simultaneously some products, prices at which it can adjust by changing the natural production amount. This case is typical in cases where enterprise has a significant market share of these types of products.

3. The enterprise produces (or can produce) simultaneously several interchangeable products, the price at which it can controll by altering the natural production amount. In this case, unlike the previous one, the change in production of certain goods leads not only to a price change of this type product, but also to changes in prices of other products that enterprise produces.

4. First consider more detailed the first case. In general, in this case for the production of each product do not need separate equipment, the enterprise should produce only one type of product, which provides the highest amount of profit for a given value of its production capacity. In other words, in this case the simultaneous production of multiple products will not lead to an increase in profit compared with option making only one type of product, which gives a maximum profit compared with other types of products. This combined annual profits of the enterprise of manufacturing i- type of product will be determined by the formula:

$$П_i = Ц_i' \times Q_{mi} - C , \quad (9)$$

where: the Пі - the total annual profits of the enterprise from producing i- type of product, UAH. Qmi - maximum annual natural production of i- that type of products (provided that the enterprise will produce only one given product); - unit price of i- type of products without VAT and the costs that vary with changing structure of the range of products (primarily material costs per unit i- that type product), UAH.

Formula (9) can be represented as follows:

$$П_i = Ц_i' \times \frac{C}{c_{ві}} - C = C \times (\frac{Ц_i'}{c_{ві}} - 1), \quad (10)$$

where: the $c_{ві}$ - the amount of costs that do not change with the change of the structure of the product range per unit of output i- that type , UAH.

We call the correlation $\frac{Ц_i'}{c_{ві}}$ by modified measure of the relative level of costs for production i - type of

product (in fact, it is the ratio of added cost to value added products). As follows from expression (10), the profit $П_i$ is uniquely determined by the value of this indicator. At the same time, the total profits of the enterprise based on the above assumptions will be the largest in the manufacture of the type of product for which the modified index of relative spending is the largest (it should be noted that the use of traditional indicator of the relative level of costs do not allow for selection of the best type of product for the company).

Now consider the case where the enterprise produces several products simultaneously, the price at which it can controll by altering the natural production of these products.

In this case, the enterprise is generally advisable to produce several products simultaneously and plan production program so as to provide for a given amount of production capacity maximum total profit from the sale of all products. In this formalized form a planning problem can be formulated as follows: to find the value of Qi, in which the objective function is maximized:

$$Z = \sum_{i=1}^{n} (Ц_i'(Q_i) - c_{вi}) \times Q_i \to \max , \qquad (11)$$

and the following conditions are satisfied:

$$\sum_{i=1}^{n} c_{вi} \times Q_i = B , \qquad (12)$$

$$Q_i \geq 0 , \qquad (13)$$

where: the $Ц_i'(Q_i)$ price of i- that type products without VAT and expenses depending on the natural output of this type of product, UAH; $c_{вi}$ - unit costs of i - that type products without material costs UAH.; B - the total value of the cost products enterprise without excluding the cost of materials, UAH.

It is important to note that when calculating unit cost excluding material costs under constraints on the total value of the complexity of the production program of the enterprise and the marginal efficiency of target, unlike the previous case, when, as the indicator of choice directions changing the structure assortment of products enterprise used indicator of absolute effectiveness of such calculations should include the following steps: 1) determining the complexity of manufacturing each product; 2) calculation of piece rates for each type of product that enterprise produces; 3) adding to the value of the size of piece-rate charges for social events and the calculation of this index for the entire amount of production of each product; 4) distribution of other costs that do not depend on changes in assortment of products enterprise (this is primarily a fixed cost) in proportion to labor costs of key workers including charges for social events and calculation of cost per unit of each product; 5) summation for each given product unit of labor costs with charges for social events and other costs that do not depend on changes in assortment of products enterprise per unit of output.

It should be noted that only the following sequence of calculations can provide the condition (12).

Suppose that under the current values of the function Qi (11) still does not reach its maximum value. Under these conditions obviously need to increase the production of certain products (hence reducing their prices) and reduce production of other products (thus increasing their prices). To determine which amounts, primarily products should be increased and which reduce, it is advisable to take advantage of the marginal rate of return i- that type product.

In general, the marginal rate of return i- that type of product can be calculated by the formula:

$$P_i = \frac{dП_i}{d(Q_i \times C_i)} , \qquad (14)$$

where: the *Pi* - the marginal rate of return i- that type given product, the share of unit.

By carrying out a series of transformations, formula (14) can be represented as follows:

$$P_i = \frac{E_i}{P_{вi}} + \frac{1}{P_{вi}} - 1 = \frac{1 + E_i}{P_{вi}} - 1 , \qquad (15)$$

where: the *Ei* - elasticities unit price i- that type amount for this type of product, the share of units; $P_{вi}$ - modified index of relative spending on manufacturing i- that type products, share unit.

Using the index (15), we can determine rational directions of assortment enterprise policy, namely: expedient to increase production of those products for which its value is the maximum and reduce production of those products for which the indicator value is minimal (and especially concise). Making such changes is expedient as long as the marginal index of return costs will not be the same for all types of products.

CONCLUSIONS

1. Supply-side potential of the enterprise can be described as the ability of the enterprise to manufacture and sell certain optimum output over time. An indication of potential of this type evaluation can serve the maximum possible size of its operating income for this period of time, or if make an the evaluation supply-side potential in relative terms - the ratio of the maximum possible value of operating profit entity to actual or planned size of the profits .

2. When structuring costs of the enterprise should understand the direction of management, which involves the division costs of the on a group (by type of expenditure, kinds of manufactured products etc.) and establish the best balance between the size of the cost of the various groups in which maximized certain financial performance of a business entity.

3. Assessment of supply-side potential of the enterprise should be based on the use of the optimization approach, with an optimization criterion should be maximum operating profits. A method of structuring

costs of industrial enterprises based on the account of the relationship between the relative level cost structure by product, as well as indicators of demand for it, and the total value of the company profits its operations. Under these conditions, according to the proposed rules regulating the composition and structure of the production program, the enterprise will be able to change the relative level and structure of costs and value prices for their products so as to achieve the maximum amount of profit from operations.

4. Further research on the structuring costs of industrial enterprise in the process of evaluation of its supply-side potential require more detailed consideration when the enterprise produces (or can produce) simultaneously several interchangeable products, the price at which it can adjust by changing the natural production amount.

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Method of morphological analysis of enterprise management organizational structure

N. Heorhiadi[1], N. Iwaszczuk[2], R. Vilhutska[1]

[1]Lviv Polytechnic National University; e-mail: r.b.vilhutska@gmail.com
[2]Krakow AGH University of Science and Technology

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Abstract. The essence of the method of morphological analysis of enterprise management organizational structure is described in the article. Setting levels of morphological decomposition and specification of sets of elements are necessary for morphological analysis. Based on empirical research identified factors that influence the formation and use of enterprises management organizational structures.

Key words: organizational management structure, method of morphological analysis, morphological graph, the levels of management, matrix of isomorphic distances, matrix of links distances, dendrite.

PROBLEM DEFINITION

Enterprise management organizational structure is a multilevel system organized according to functional definitions of its structural components. The analysis of the management organizational structure, therefore, should be conducted by means of decomposition of management layers and functions of its components. The morphological approach has been selected as the most appropriate method for this task. Although it has been used in science for nearly one thousand years, the morphological approach is still viewed as a set of system study principles rather than a precise methodological tool. This largely expands the field of its potential application, thus contributing to continuous development of morphology. The methodological aspects of morphological analysis are insufficiently developed, thus its practical application in enterprise management, in particular during the analysis of management organizational structure is problematic.

MAIN PRESENTATION

Morphological analysis method was developed by F. Zwicky. While working on specific problems in astrophysics, he proposed to break down a problem into individual components according to certain characteristics and attributes. F. Zwicky defined several principles of a morphological study such as equal interest to all objects of morphological analysis, elimination of all limitations and evaluations until the full structure of a studied area is defined, and most precise formulation of the problem [1, 255-256].

Based on these principles we propose a method of morphological analysis of enterprise management organizational structure. Its implementation foresees the following [2; 4; 7; 9]: 1) the formulation of the objective of morphological analysis – establishment of cause-result relationship between components and elements of the organizational structure and between the characterizing parameters; 2) definition of morphological decomposition levels fof the enterprise management organizational structure, including the parametrization of its elements (see Table 1); 3) identification of topological and metric spaces of the organizational structure of enterprise management; 4) synthesis of the analysis results.

To conduct a morphological analysis of organizational structure, levels of morphological decomposition (see Table 1) should be identified, and elements of sets that form local topological and metric spaces should be specified within each level. The topological space includes continuum (superset) and the system of subsets. We will build a fragment of the morphological graph of the upper enterprise management level based on notations provided in Table 1 (Fig. 1).

Table 1. Enterprise management organizational structure morphological decomposition levels

Management levels	Compo-nents of mana-gement organi-zational structure	Elements of manage-ment organi-zational structure	Indicators of efficient fulfillment of assigned tasks by employees[1]
B	B_1		$B_1 = f(x_1, x_2 ..... x_n)$
	B_2		$B_2 = f(y_1, y_2 ....., y_n)$
	B_n		$B_n = f(z_1, z_2 ..... z_n)$
	C_1	$C_{1.1}$	$C_{1.1} = f(i_1, i_2 ..... i_n)$
		$C_{1.2}$	$C_{1.2} = f(j_1, j_2 ..... j_n)$
		$C_{1.n}$	$C_{1.n} = f(u_1, u_2 ..... u_n)$
C	C_2	$C_{2.1}$	$C_{2.1} = f(o_1, o_2 ..... o_n)$
		$C_{2.2}$	$C_{2.2} = f(t_1, t_2 .... t_n)$
		$C_{2.n}$	$C_{2.n} = f(r_1, r_2 ..... r_n)$
	C_n	$C_{n.1}$	$C_{n.1} = f(e_1, e_2 ..... e_n)$
		$C_{n.2}$	$C_{n.2} = f(w_1, w_2 ..... w_n)$
		$C_{n.n}$	$C_{n.n} = f(q_1, q_2 ..... q_n)$
	H_1	$H_{1.1}$	$H_{1.1} = f(p_1, p_2 ..... p_n)$
		$H_{1.2}$	$H_{1.2} = f(l_1, l_2 ..... l_n)$
		$H_{1.n}$	$H_{1.n} = f(k_1, k_2 ..... k_n)$
H	H_2	$H_{2.1}$	$H_{2.1} = f(g_1, g_2 ..... g_n)$
		$H_{2.2}$	$H_{2.2} = f(b_1, b_2 ..... b_n)$
		$H_{2.n}$	$H_{2.n} = f(s_1, s_2 ..... s_n)$
	H_n	$H_{n.1}$	$H_{n.1} = f(a_1, a_2 ..... a_n)$
		$H_{n.2}$	$H_{n.2} = f(v_1, v_2 ..... v_n)$
		$H_{n.n}$	$H_{n.n} = f(m_1, m_2 ..... m_n)$

Note: Composed by article authors. Legend: B – the upper (institutional) level of enterprise management; B_1, B_2, B_n – the upper enterprise management includes the positions of director and his/her deputies; C – the middle enterprise management level; C_1, C_2, C_n – structura; $C_{2.1}, C_{2.2}, C_{2.n}$ – employees of department C_2; $C_{n.1}, C_{n.2}, C_{n.n}$ – employees of department C_n; H – the lower management level; H_1, H_2, H_n – structural departments of enterprise on the lower management level; $H_{1.1}, H_{1.2}, H_{1.n}$ – employees of department H_1; $H_{2.1}, H_{2.2}, H_{2.n}$ – employees of department H_2; $H_{n.1}, H_{n.2}, H_{n.n}$ – employees of department H_n.

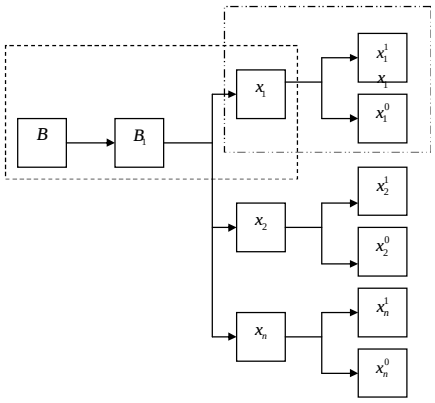


Fig. 1. A fragment of the morphological graph of the upper enterprise management level
Notes: Composed by article authors. A topological space is denoted with a dashed line, and a metric space with a dot-dashed line. Legend: x_1^1, x_1^0 – values of indicator x_1; x_2^1, x_2^0 – values of indicator x_2; x_n^1, x_n^0 – values of indicator

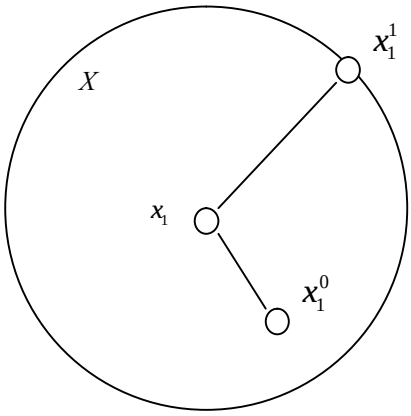


Fig. 2. Metric space of the morphological graph of the upper level of enterprise management
Note: Composed by article authors

All symbols with lower right index 1 represent indicators of timely completion of tasks by employees of the corresponding groups. Index 2 denotes indicators that reflect the completeness of task fulfillment, while index n refers to the quality of fulfillment.

The local topological space of the constructed morphological graph is denoted with a dashed line on Fig. 1. In this case $B \wedge B_1$ is an ordered pair, where B is a set, and B_1 is a system of subsets that satisfy the following conditions:

$$B \supset B_1 \equiv \Lambda_1; B_1 \supset x_1, x_2 .... x_n,$$
$$\Lambda_1 \equiv \{B \mid B \equiv B_1 \cap x_1, x_1 \in B\},$$
$$\Lambda_1 \equiv \{B \mid B \equiv B_1 \cap x_2, x_2 \in B\},$$
$$\Lambda_1 \equiv \{B \mid B \equiv B_1 \cap x_n, x_n \in B\},$$

where: Λ_1 is a topology on $B_{1.1}$.

Following the presented logic of relationship between elements of the morphological graph (see Fig. 1), it is level; $C_{1.1}, C_{1.2}, C_{1.n}$ – employees of department C_1; possible to create a topology $\Lambda_2 \wedge \Lambda_3$ on subsets $B_{2.2}$ i $B_{n.n}$:

$$B \supset B_2 \equiv \Lambda_2; B_2 \supset y_1, y_2 .... y_n,$$
$$\Lambda_2 \equiv \{B \mid B \equiv B_2 \cap y_1, y_1 \in B\},$$
$$\Lambda_2 \equiv \{B \mid B \equiv B_2 \cap y_2, y_2 \in B\},$$
$$\Lambda_2 \equiv \{B \mid B \equiv B_2 \cap y_n, y_n \in B\},$$
$$B \supset B_n \equiv \Lambda_3; B_n \supset z_1, z_2 .... z_n,$$
$$\Lambda_3 \equiv \{B \mid B \equiv B_n \cap z_1, z_1 \in B\},$$
$$\Lambda_3 \equiv \{B \mid B \equiv B_n \cap z_2, z_2 \in B\},$$
$$\Lambda_3 \equiv \{B \mid B \equiv B_n \cap z_n, z_n \in B\}.$$

The values of indicators that characterize the completeness and quality of work tasks fulfillment by employees are presented on Fig. 1 with superscript indices. The indicators together with their possible values make up the metric space of morphological graph. A metric space is the pair of a certain set and a distance defined for any pair of elements within this set. The metric space (X) in the given morphological graph can be demonstrated as a sphere with radius x_1^1 and a center in x_1 (Fig. 2). In the given case:

$$x_1^1 \Leftrightarrow r; x_1 \wedge x_1^1 \equiv x_1^0 \in X \mid d(x_1^1, x_1^0) \, \mathbf{p} \, x_1^1,$$

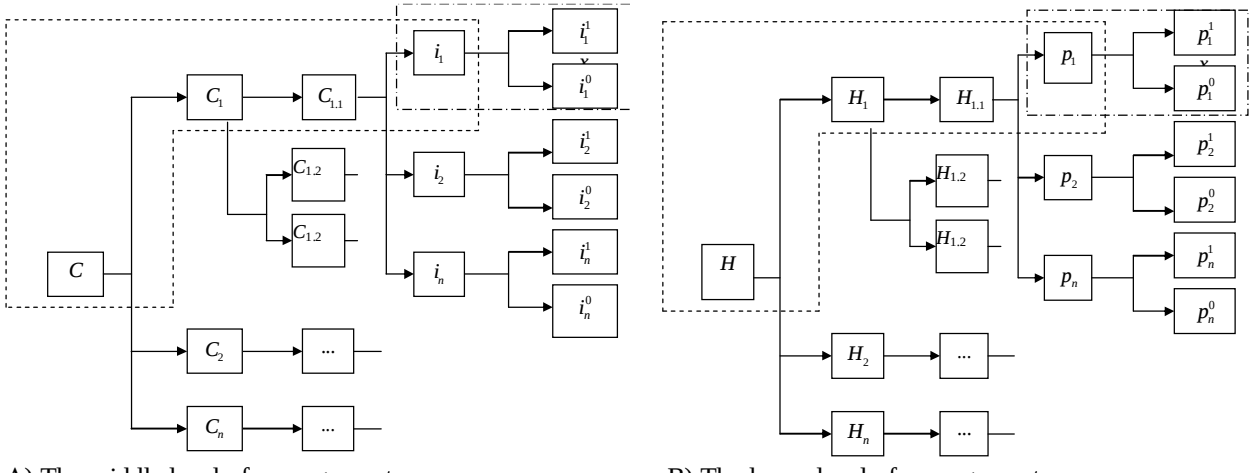
where: r – radius of sphere; d – distance between elements of the set.

Based on data from Table 1 and Fig. 1, beside the metric space $X : x_1 \wedge d(x_1^1, x_1^0)$, the upper level of enterprise management also includes other metric spaces (Y, Z), where $Y : x_2 \wedge d(x_2^1, x_2^0)$, $Z : x_n \wedge d(x_n^1, x_n^0)$.

The peculiarity of morphological decomposition of the organizational structure of enterprise management at middle and lower levels is that its components consist of more than one element, i.e., structural departments of the middle and lower management levels are not singleton sets [3; 5; 6]. A fragment of the morphological graph of middle and lower levels is presented at Fig. 3.

Topological spaces of the morphological graph of the middle enterprise management level are as follows:

1) $C \wedge C_1$, where C_1 denotes systems of subsets that satisfy the following conditions:



A) The middle level of management B) The lower level of management

Fig. 3. Fragments of the morphological graph of the middle and lower levels of enterprise management

Notes: Composed by article authors. A topological space is denoted with a dashed line, and a metric space with a dot-dashed line. Legend: i_1^1, i_1^0 – values of indicator i_1; i_2^1, i_2^0 – values of indicator i_2; i_n^1, i_n^0 – values of indicator i_n; p_1^1, p_1^0 – values of indicator p_1; p_2^1, p_2^0 – values of indicator p_2; p_n^1, p_n^0 – values of indicator p_n

$C \supset C_1 \supset C_{1.1} \equiv \Lambda_4; C_{1.1} \supset i_1, i_2 .... i_n,$
$\Lambda_4 \equiv \{C_1 \mid C_1 \equiv C_{1.1} \cap i_1, i_1 \in C_1\},$
$\Lambda_4 \equiv \{C_1 \mid C_1 \equiv C_{1.1} \cap i_2, i_2 \in C_1\},$
$\Lambda_4 \equiv \{C_1 \mid C_1 \equiv C_{1.1} \cap i_n, i_n \in C_1\},$
$C \supset C_1 \supset C_{1.2} \equiv \Lambda_5; C_{1.2} \supset j_1, j_2 .... j_n,$
$\Lambda_5 \equiv \{C_1 \mid C_1 \equiv C_{1.2} \cap j_1, j_1 \in C_1\},$
$\Lambda_5 \equiv \{C_1 \mid C_1 \equiv C_{1.2} \cap j_2, j_2 \in C_1\},$
$\Lambda_5 \equiv \{C_1 \mid C_1 \equiv C_{1.2} \cap j_n, j_n \in C_1\},$
$C \supset C_1 \supset C_{1.n} \equiv \Lambda_6; C_{1.n} \supset u_1, u_2 .... u_n,$
$\Lambda_6 \equiv \{C_1 \mid C_1 \equiv C_{1.n} \cap u_1, u_1 \in C_1\},$
$\Lambda_6 \equiv \{C_1 \mid C_1 \equiv C_{1.n} \cap u_2, u_2 \in C_1\},$
$\Lambda_6 \equiv \{C_1 \mid C_1 \equiv C_{1.n} \cap u_n, u_n \in C_1\},$

$C \supset C_2 \supset C_{2.1} \equiv \Lambda_7; C_{2.1} \supset o_1, o_2 .... o_n,$
$\Lambda_7 \equiv \{C_2 \mid C_2 \equiv C_{2.1} \cap o_1, o_1 \in C_2\},$
$\Lambda_7 \equiv \{C_2 \mid C_2 \equiv C_{2.1} \cap o_2, o_2 \in C_2\},$
$\Lambda_7 \equiv \{C_2 \mid C_2 \equiv C_{2.1} \cap o_n, o_n \in C_2\},$
$C \supset C_2 \supset C_{2.2} \equiv \Lambda_8; C_{2.2} \supset t_1, t_2 .... t_n,$
$\Lambda_8 \equiv \{C_2 \mid C_2 \equiv C_{2.2} \cap t_1, t_1 \in C_2\},$
$\Lambda_8 \equiv \{C_2 \mid C_2 \equiv C_{2.2} \cap t_2, t_2 \in C_2\},$
$\Lambda_8 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap t_n, t_n \in C_2\},$
$C \supset C_2 \supset C_{2.n} \equiv \Lambda_9; C_{2.n} \supset r_1, r_2 .... r_n,$
$\Lambda_9 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap r_1, r_1 \in C_2\},$
$\Lambda_9 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap r_2, r_2 \in C_2\},$
$\Lambda_9 \equiv \{C_2 \mid C_2 \equiv C_{2.n} \cap r_n, r_n \in C_2\},$

where: Λ_7 is a topology on $C_{2.1}$; Λ_8 is a topology on $C_{2.2}$; Λ_9 is a topology on $C_{2.n}$,

3) $C \wedge C_n$,

where: C_n denotes systems of subsets that satisfy the following conditions:

$C \supset C_n \supset C_{n.1} \equiv \Lambda_{10}; C_{n.1} \supset e_1, e_2 .... e_n,$
$\Lambda_{10} \equiv \{C_n \mid C_n \equiv C_{n.1} \cap e_1, e_1 \in C_n\},$
$\Lambda_{10} \equiv \{C_n \mid C_n \equiv C_{n.1} \cap e_2, e_2 \in C_n\},$
$\Lambda_{10} \equiv \{C_n \mid C_n \equiv C_{n.1} \cap e_n, e_n \in C_n\},$
$C \supset C_n \supset C_{n.2} \equiv \Lambda_{11}; C_{n.2} \supset w_1, w_2 .... w_n,$
$\Lambda_{11} \equiv \{C_n \mid C_n \equiv C_{n.2} \cap w_1, w_1 \in C_n\},$
$\Lambda_{11} \equiv \{C_n \mid C_n \equiv C_{n.2} \cap w_2, w_2 \in C_n\},$
$\Lambda_{11} \equiv \{C_n \mid C_n \equiv C_{n.2} \cap w_n, w_n \in C_n\},$
$C \supset C_n \supset C_{n.n} \equiv \Lambda_{12}; C_{n.n} \supset q_1, q_2 .... q_n,$
$\Lambda_{12} \equiv \{C_n \mid C_n \equiv C_{n.n} \cap q_1, q_1 \in C_n\},$
$\Lambda_{12} \equiv \{C_n \mid C_n \equiv C_{n.n} \cap q_2, q_2 \in C_n\},$
$\Lambda_{12} \equiv \{C_n \mid C_n \equiv C_{n.n} \cap q_n, q_n \in C_n\},$

where: Λ_{10} is a topology on $C_{n.1}$; Λ_{11} is a topology on $C_{n.2}$; Λ_{12} is a topology on $C_{n.n}$.

Topological spaces of the morphological graph of the lower enterprise management level are as follows:

1) $H \wedge H_1$, where H_1 denotes systems of subsets that satisfy the following conditions:

$H \supset H_1 \supset H_{1.1} \equiv \Lambda_{13}; H_{1.1} \supset p_1, p_2 .... p_n,$
$\Lambda_{13} \equiv \{H_1 \mid H_1 \equiv H_{1.1} \cap p_1, p_1 \in H_1\},$
$\Lambda_{13} \equiv \{H_1 \mid H_1 \equiv H_{1.1} \cap p_2, p_2 \in H_1\},$
$\Lambda_{13} \equiv \{H_1 \mid H_1 \equiv H_{1.1} \cap p_n, p_n \in H_1\},$
$H \supset H_1 \supset H_{1.2} \equiv \Lambda_{14}; H_{1.2} \supset l_1, l_2 .... l_n,$
$\Lambda_{14} \equiv \{H_1 \mid H_1 \equiv H_{1.2} \cap l_1, l_1 \in H_1\},$
$\Lambda_{14} \equiv \{H_1 \mid H_1 \equiv H_{1.2} \cap l_2, l_2 \in H_1\},$
$\Lambda_{14} \equiv \{H_1 \mid H_1 \equiv H_{1.2} \cap l_n, l_n \in H_1\},$
$H \supset H_1 \supset H_{1.n} \equiv \Lambda_{15}; H_{1.n} \supset k_1, k_2 .... k_n,$
$\Lambda_{15} \equiv \{H_1 \mid H_1 \equiv H_{1.n} \cap k_1, k_1 \in H_1\},$
$\Lambda_{15} \equiv \{H_1 \mid H_1 \equiv H_{1.n} \cap k_2, k_2 \in H_1\},$
$\Lambda_{15} \equiv \{H_1 \mid H_1 \equiv H_{1.n} \cap k_n, k_n \in H_1\},$

where: Λ_{13} is a topology on $H_{1.1}$; Λ_{14} is a topology on $H_{1.2}$; Λ_{15} is a topology on $H_{1.n}$,

2) $H \wedge H_1$, where H_1 denotes systems of subsets that satisfy the following conditions:

$H \supset H_2 \supset H_{2.1} \equiv \Lambda_{16}; H_{2.1} \supset g_1, g_2 .... g_n,$
$\Lambda_{16} \equiv \{H_2 \mid H_2 \equiv H_{2.1} \cap g_1, g_1 \in H_2\},$
$\Lambda_{16} \equiv \{H_2 \mid H_2 \equiv H_{2.1} \cap g_2, g_2 \in H_2\},$
$\Lambda_{16} \equiv \{H_2 \mid H_2 \equiv H_{2.1} \cap g_n, g_n \in H_2\},$
$H \supset H_2 \supset H_{2.2} \equiv \Lambda_{17}; H_{2.2} \supset b_1, b_2 .... b_n,$
$\Lambda_{17} \equiv \{H_2 \mid H_2 \equiv H_{2.2} \cap b_1, b_1 \in H_2\},$
$\Lambda_{17} \equiv \{H_2 \mid H_2 \equiv H_{2.2} \cap b_2, b_2 \in H_2\},$
$\Lambda_{17} \equiv \{H_2 \mid H_2 \equiv H_{2.2} \cap b_n, b_n \in H_2\},$
$H \supset H_2 \supset H_{2.n} \equiv \Lambda_{18}; H_{2.n} \supset s_1, s_2 .... s_n,$
$\Lambda_{18} \equiv \{H_2 \mid H_2 \equiv H_{2.n} \cap s_1, s_1 \in H_2\},$
$\Lambda_{18} \equiv \{H_2 \mid H_2 \equiv H_{2.n} \cap s_2, s_2 \in H_2\},$
$\Lambda_{18} \equiv \{H_2 \mid H_2 \equiv H_{2.n} \cap s_n, s_n \in H_2\},$

where: Λ_{16} is a topology on $H_{2.1}$, Λ_{17} is a topology on $H_{2.2}$; Λ_{18} is a topology on $H_{2.n}$,

3) $H \wedge H_n$, where H_n denotes systems of subsets that satisfy the following conditions:

$H \supset H_n \supset H_{n.1} \equiv \Lambda_{19}; H_{n.1} \supset a_1, a_2 .... a_n,$
$\Lambda_{19} \equiv \{H_n \mid H_n \equiv H_{n.1} \cap a_1, a_1 \in H_n\},$
$\Lambda_{19} \equiv \{H_n \mid H_n \equiv H_{n.1} \cap a_2, a_2 \in H_n\},$
$\Lambda_{19} \equiv \{H_n \mid H_n \equiv H_{n.1} \cap a_n, a_n \in H_n\}.$

$$H \supset H_n \supset H_{n.2} \equiv \Lambda_{20}; H_{n.2} \supset v_1, v_2 .... v_n,$$
$$\Lambda_{20} \equiv \{H_n \mid H_n \equiv H_{n.2} \cap v_1, v_1 \in H_n\},$$
$$\Lambda_{20} \equiv \{H_n \mid H_n \equiv H_{n.2} \cap v_2, v_2 \in H_n\},$$
$$\Lambda_{20} \equiv \{H_n \mid H_n \equiv H_{n.2} \cap v_n, v_n \in H_n\},$$
$$H \supset H_n \supset H_{n.n} \equiv \Lambda_{21}; H_{n.n} \supset m_1, m_2 .... m_n,$$
$$\Lambda_{21} \equiv \{H_n \mid H_n \equiv H_{n.n} \cap m_1, m_1 \in H_n\},$$
$$\Lambda_{21} \equiv \{H_n \mid H_n \equiv H_{n.n} \cap m_2, m_2 \in H_n\},$$
$$\Lambda_{21} \equiv \{H_n \mid H_n \equiv H_{n.n} \cap m_n, m_n \in H_n\},$$

where: Λ_{19} is a topology on $H_{n.1}$; Λ_{20} is a topology on $H_{n.2}$; Λ_{21} is a topology on $H_{n.n}$.

Table 2 presents metric spaces of the graphs of the middle and lower enterprise management levels.

Table 2. Metric spaces of the graphs of the middle and lower enterprise management levels

Management levels	Metric spaces
Middle enterprise management level	$I_1 : i_1 \wedge d(i_1^1, i_1^0); I_2 : i_2 \wedge d(i_2^1, i_2^0); I_n : i_n \wedge d(i_n^1, i_n^0),$ $J_1 : j_1 \wedge d(j_1^1, j_1^0); J_2 : j_2 \wedge d(j_2^1, j_2^0); J_n : j_n \wedge d(j_n^1, j_n^0),$ $U_1 : u_1 \wedge d(u_1^1, u_1^0); U_2 : u_2 \wedge d(u_2^1, u_2^0); U_n : u_n \wedge d(u_n^1, u_n^0),$ $O_1 : o_1 \wedge d(o_1^1, o_1^0); O_2 : o_2 \wedge d(o_2^1, o_2^0); O_n : o_n \wedge d(o_n^1, o_n^0),$ $T_1 : t_1 \wedge d(t_1^1, t_1^0); T_2 : t_2 \wedge d(t_2^1, t_2^0); T_n : t_n \wedge d(t_n^1, t_n^0),$ $R_1 : r_1 \wedge d(r_1^1, r_1^0); R_2 : r_2 \wedge d(r_2^1, r_2^0); R_n : r_n \wedge d(r_n^1, r_n^0),$ $E_1 : e_1 \wedge d(e_1^1, e_1^0); E_2 : e_2 \wedge d(e_2^1, e_2^0); E_n : e_n \wedge d(e_n^1, e_n^0),$ $W_1 : w_1 \wedge d(w_1^1, w_1^0); W_2 : w_2 \wedge d(w_2^1, w_2^0); W_n : w_n \wedge d(w_n^1, w_n^0),$ $Q_1 : q_1 \wedge d(q_1^1, q_1^0); Q_2 : q_2 \wedge d(q_2^1, q_2^0); Q_n : q_n \wedge d(q_n^1, q_n^0).$
Lower enterprise management level	$P_1 : p_1 \wedge d(p_1^1, p_1^0); P_2 : p_2 \wedge d(p_2^1, p_2^0); P_n : p_n \wedge d(p_n^1, p_n^0),$ $L_1 : l_1 \wedge d(l_1^1, l_1^0); L_2 : l_2 \wedge d(l_2^1, l_2^0); L_n : l_n \wedge d(l_n^1, l_n^0),$ $K_1 : k_1 \wedge d(k_1^1, k_1^0); K_2 : k_2 \wedge d(k_2^1, k_2^0); K_n : k_n \wedge d(k_n^1, k_n^0),$ $G_1 : g_1 \wedge d(g_1^1, g_1^0); G_2 : g_2 \wedge d(g_2^1, g_2^0); G_n : g_n \wedge d(g_n^1, g_n^0),$ $B_1 : b_1 \wedge d(b_1^1, b_1^0); B_2 : b_2 \wedge d(b_2^1, b_2^0); B_n : b_n \wedge d(b_n^1, b_n^0),$ $S_1 : s_1 \wedge d(s_1^1, s_1^0); S_2 : s_2 \wedge d(s_2^1, s_2^0); S_n : s_n \wedge d(s_n^1, s_n^0),$ $A_1 : a_1 \wedge d(a_1^1, a_1^0); A_2 : a_2 \wedge d(a_2^1, a_2^0); A_n : a_n \wedge d(a_n^1, a_n^0),$ $V_1 : v_1 \wedge d(v_1^1, v_1^0); V_2 : v_2 \wedge d(v_2^1, v_2^0); V_n : v_n \wedge d(v_n^1, v_n^0),$ $M_1 : m_1 \wedge d(m_1^1, m_1^0); M_2 : m_2 \wedge d(m_2^1, m_2^0); M_n : m_n \wedge d(m_n^1, m_n^0).$

Note: Composed by article authors.

Legend: $I_1, I_2, I_n, J_1, J_2, J_n, U_1, U_2, U_n$, $O_1, O_2, O_n, T_1, T_2, T_n, R_1, R_2, R_n$, $E_1, E_2, E_n, W_1, W_2, W_n, Q_1, Q_2, Q_n$ – metric spaces of the middle enterprise management level; $P_1, P_2, P_n, L_1, L_2, L_n, K_1, K_2, K_n, G_1, G_2, G_n$, $B_1, B_2, B_n, S_1, S_2, S_n, A_1, A_2$, $A_n, V_1, V_2, V_n, M_1, M_2, M_n$ – metric spaces of the lower enterprise management level.

The method of morphological analysis is normally concluded with results generalization. While studying organizational structures of enterprise management it is appropriate to perform this task with the aid of tools traditionally employed in digital systems synthesis. For example, an expression $B_1 = f(x_1, x_2 ..... x_n)$ from Table 1 can be viewed as a "blackbox" (Fig. 4), where the resulting value B_1 depends on factor values $x_1, x_2 ..... x_n$.

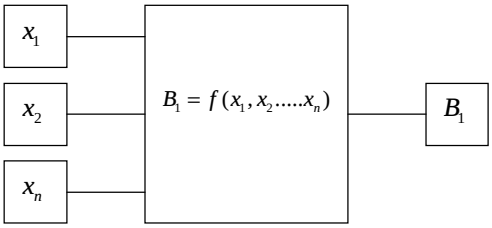


Fig. 4. "Blackbox" graphic model
Note: Composed by article authors.

Taking into consideration three inputs and one output, a truth table will be composed of eight variables and will reflect a ternary transformation of $x_1, x_2 ..... x_n$ into B_1 (Table 3).

Table 3. A truth table for x_2

	x_1	x_2	x_n	B_1
	0	0	0	0
1	0	0	1	1
2	0	1	0	1
	0	1	1	0
3	1	0	0	1
	1	0	1	0
4	1	1	0	1
5	1	1	1	1

Note: Composed by article authors.

The underlined and numbered rows in Table 3 have the resulting value of a "blackbox" equal to 1. We will develop a separate scheme of factor values transformation into the result value for each underlined row (Fig. 5).

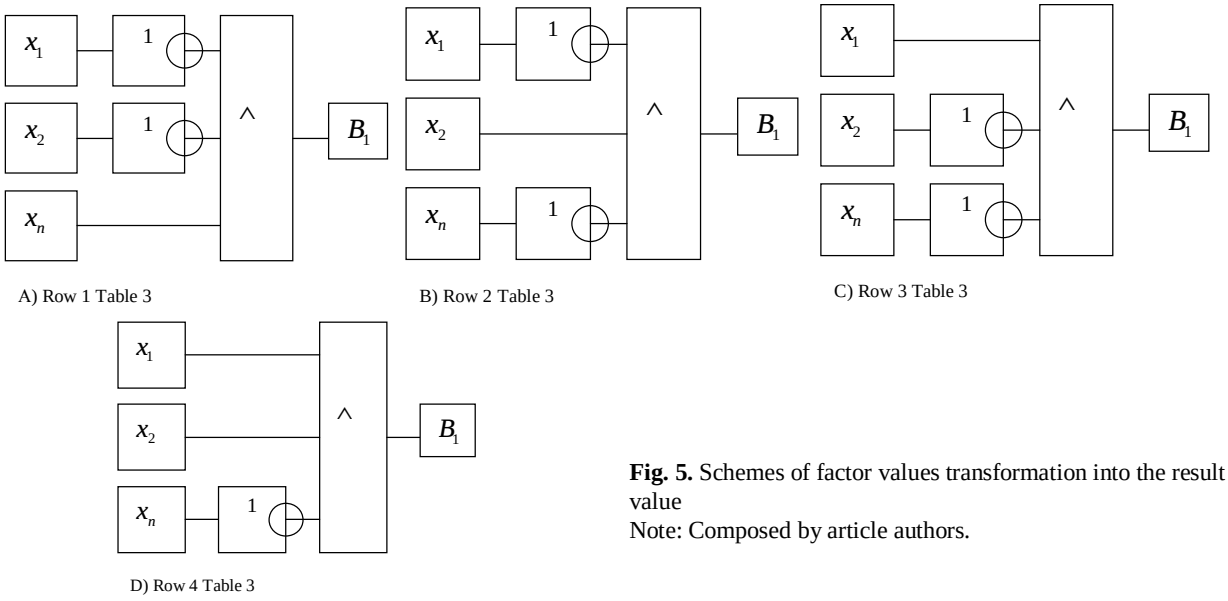


Fig. 5. Schemes of factor values transformation into the result value
Note: Composed by article authors.

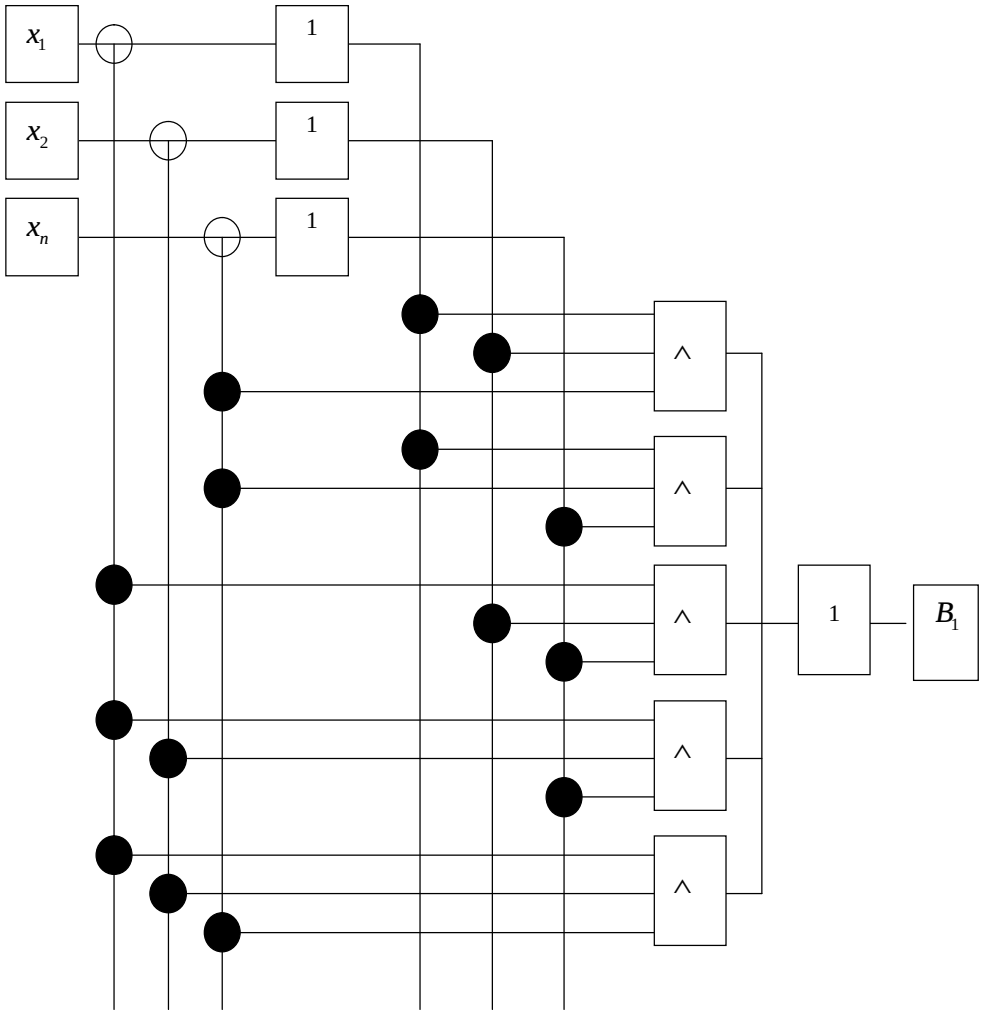


Fig. 6. Recompositional synthesized model of the reflection of the values of factor values $x_1, x_2 ..... x_n$ into the resulting value B_1

Notes: Composed by article authors. Transparent circles represent factor values that reflect the fifth row of Table 3. Positions of other rows of this table are represented with black circles.

For an enterprise analyst this scheme can serve as algorithm for reduction of disparate data on individual parameters of the considered fragment of the enterprise management organizational structure into an integral decision-making support system on current enterprise management structure reorganization.

Table 4. Classification of the factors that influence the enterprise management organizational structures

Classification by	Types of factors
Content	– Type of business activity – Form of business organization – Size of an enterprise – Objectives of an enterprise – Production automation – Enterprise integration into economic and production structures – Legal provisions that regulate activities of an enterprise – Level of managerial professionalism of directors, their vision, beliefs, and ambitions – Relevant qualification of departments staff – Competition and market conditions
Character	– Factors that positively influence the formation and use of enterprise management organizational structure – Factors that negatively influence the formation and use of enterprise management organizational structure
Impact	– Factors with strong influence on the formation and use of enterprise management organizational structure – Factors with weak influence on the formation and use of enterprise management organizational structure – Factors with neutral influence on the formation and use of enterprise management organizational structure
Connections	– Factors with direct connections – Factors with indirect connections
Source	– Factors of the internal organizational environment – Factors of the external organizational environment
Level of regulation	– Factors that can be regulated – Factors that require adaptation

Note: Composed by article authors.

It is possible to synthesize the results of morphological analysis on the basis of the schemes of the transformation of factor values into the result value. We will develop a recompositional synthesized model for the conversion of $x_1, x_2 ..... x_n$ values into result B_1 (Fig. 6).

As shown on Fig. 6, factor values can either define the result value with three inputs $(x_1 \wedge x_2 \wedge x_n) \rightarrow B_1$, or they can define it with as many as five inputs under condition that factor values are built into a cascade scheme.

The factors that influence the formation and use of enterprise management organizational structures have been identified and classified through empirical research (Table 4).

The type of business activity influences the enterprise management organizational structures. Beyond any doubt, the type of business activity (industrial production, financial services, commerce, etc.) defines the establishment of structural departments, division of their functions, internal communication, etc. Therefore the type of business activity defines business processes within the organization and, correspondingly, the enterprise management organizational structure is formed and used. The type of business activity is a factor of internal organizational environment. Considering the fact that every business entity can select its activity types, add other activities over time, or even change from one type of business activity to another, this factor can be regulated. From the point of view of the character of influence on the formation and use of enterprise management organizational structure, the type of business activity can be either positive or negative. The character of this factor can be changed under the influence of other factors, for example, due to changes in legislation, personal decisions of directors, etc.

The form of business organization and legal provisions that regulate business activities of enterprise are also factors that influence the enterprise management organizational structure during its formation and use. The applicable legislation, including provisions of Commercial Code of Ukraine (an external environment factor) defines the organizational structure of public limited companies, joint stock companies, limited liability companies, additional liability partnerships, etc. Although the legislation regulates types of management structure for particular forms of business entities, the form of business organization, selected during its foundation is an internal environment factor as the selection of the form of business is an individual or collective decision of its owners. Therefore, this factor can be regulated, contrary to the applicable legislation, which requires adaptation. The studies have shown the widespread examples of changing the form of business from one to another. Usually this happens while the initially selected form of enterprise for certain reasons transforms into the negative factor, for example, it does not allow using certain investment mechanisms, creates a threat of acquisition by competitors, etc.

The size of business entity also has influence on the formation and use of the enterprise management organizational structure. This is also a factor of the internal organizational environment, the influence of which can be regulated by owners and/or directors. Numerous examples show that the size of an enterprise is beyond doubt one of the determining factors that influence the size of its management organizational structure, the number of functional and direct connections within the management organizational structure, geographical diversification of structural departments, number of employees, etc. Beside that, an uncertain nature of the impact of this factor on the

effective use of enterprise management organizational structure remains. On the one hand, it is known that the size of an enterprise and, for example, geographical diversification of the management organizational structure allows savings on scale and an increase in revenue due to decrease of fixed costs per unit of production delivered by the company. On the other hand, the absence of effective logistics system and underuse of production capacity can become a precondition that turns the size of the entity into a negative factor and lead to the overspending on maintenance of a cumbersome enterprise management organizational structure. Therefore, the factor of enterprise size should be continuously monitored and its interconnection with other factors should be studied, the measures towards positive cash flows domination over negative cash flows should be taken, while investments into the development of enterprise management organizational structure should ensure the desired increase of economic development indices of the enterprise.

Production automation is a factor of internal organizational environment, and its influence on the formation and use of the enterprise management organizational structure can be regulated. The conducted studies showed that an increase in level of production automation causes the decrease in the number of employees at production level, requires higher level of professional training of employees, and causes the increase in the number of required managerial departments. Nevertheless, many companies with well-known global trademarks have reached high levels of production automation and became pioneers in the implementation of robotic manufacturing systems. As a result these companies ended up with a situation when their products are too expensive for the majority of countries of the world due to high capital and intellectual intensity of production and thus the export of their products is limited. Therefore, these companies try to transfer their production facilities to countries with lower level of economic development, where certain automated operations can be substituted by manual labor while salaries and social benefits to employees can be reduced. In conclusion, production automation has a positive influence on the formation and use of the enterprise management organizational structure but only to a certain degree and under certain conditions.

The objectives of an enterprise influence the formation and use of the enterprise management organizational structure as well. The design of any management organizational structure during the establishment of a business is based on defining the mission and setting the system of objectives of the organization. To be precise, the management organizational structure is being built in such a way that established objectives of the business enterprise can be achieved. It means that the fulfillment of assigned tasks by structural departments of an enterprise is a precondition for achieving the objectives of enterprise in general. In correspondence to the developed classification (Table 4), the objectives of organization are a factor of internal organizational environment that can be regulated. A need to regulate the influence of this factor on the formation and use of the enterprise management organizational structure emerges in cases when set objectives are not adequate, i.e., not sufficiently qualitatively and quantitatively parameterized and not defined in time, or their assigned realization period is unrealistic.

Enterprise integration into economic and production structures is also among factors that influence the formation and use of the enterprise management organizational structure. The conducted studies have shown that approximately three thousand national industrial enterprises active in mechanical engineering and instrumentation sphere are to certain extent integrated into various economic and production structures, such as innovative clusters, associations, concerns, consortiums, scientific and production associations etc. Whether this factor can be regulated or not depends on the character of the integration (statutory merger or union agreement). The decision on integration of a enterprise into a certain economic and production structure can be taken either by its owners and directors, or by competitors that acquire this enterprise. While taking this into consideration, the circumstances under which the incorporation of an enterprise into certain economic and production structures can also determine a possibility to regulate the influence of this factor on the formation and use of the enterprise management organizational structure.

Level of managerial professionalism of directors, their vision, beliefs and ambitions are a factor of direct action on the formation and use of the enterprise management organizational structure. The importance of the influence of this factor is difficult to overestimate because managers of an enterprise set objectives of the organization, take decisions on disbanding the existing perform the division of functions, roles and responsibilities, lay down the foundation for subordination within the organization, etc. This factor belongs to internal organizational environment, but due to its subjective character, its influence on the formation and use of the enterprise management organizational structure can vary. A possibility to regulate its impact on the formation and use of the enterprise management organizational structure significantly depends on management style implemented within the organization and on the extent of control that owners of the enterprise can exercise in the organization.

Empirical studies have shown that understaffing of the structural departments is often a reason for organizational changes that lead to the liquidation or merger of two or more structural departments into one. Therefore, sufficient staffing of the structural departments of enterprise is also a factor of internal enviro-

Table 5. Indicators that determine the significance of factors that influence the enterprise management organizational structure

Factor number	The average total score designated by experts	The general total score designated by experts	Coefficient of relative factor significance
1	8,70	435	0,87
2	8,72	436	0,872
3	9,36	468	0,936
4	9,46	473	0,946
5	8,06	403	0,806
6	8,10	405	0,81
7	8,10	405	0,81
8	9,30	465	0,93
9	4,24	212	0,424
10	5,14	257	0,514

Notes: Composed by article authors based on the results of experiments. The experts used a 10 point scale, where 1 was the lowest score and 10 was the highest score. Meaning of the factor numbers: 1. Type of business activity. 2. Form of business organization at foundation. 3. Size of an enterprise. 4. Objectives of an enterprise. 5. Production automation. 6. Enterprise integration into economic and production structures. 7. Legal provisions that regulate activities of an enterprise. 8. Level of managerial professionalism of directors, their vision, beliefs, and ambitions. 9. Relevant qualification of departments staff. 10. Level of competition and market conditions.

nment of the enterprise that has an influence on the formation and use of the enterprise management organizational structure. Its impact on the studied subject can be regulated by managers of an enterprise. The character of this factor can change with time, therefore managers should closely monitor and execute such human resources policy that leads towards constant increase of staff qualification, decrease in the number of conflicts at workplace, and stimulate employees towards improvement of performance.

In a market economy, known to be characterized by competition predominantly for markets and consumers, the level of market competition and market conditions is an important factor that influences the formation and use of the enterprise management organizational structure. This is an external environmental factor and an enterprise has to adapt to it. In practice this adaptation takes place through the realization of organizational changes with the help of which the existing enterprise management organizational structures get reorganized into new ones. The managers' ability to precisely identify the character of market fluctuations is directly linked with the adequate decisions on improving market positions of an enterprise. The study of the competition among transnational corporations for market positions in commodity sales has shown that they use combined, in particular matrix management structures. Their geographical distribution in general takes place within two stages. Initially mother companies create non-operational representations on a market, where their production and sales networks are planned to be developed. Their designation is to study the market, in particular consumer demands, prices, possible volumes of sales, existing and potential competitors, peculiarities of national legislation, and so on. After the consumer demands are known and the market is assessed as promising, the strategy for market entry, including the formation of complex advertisement campaigns, is being elaborated. During the second stage non-operational representations start organizing the launch of factories, sales centers, service centers, etc. on new territories. Domestic enterprises also have certain positive experience in taking into consideration the influence of this factor on the formation and use of the enterprise management organizational structure.

Based on the results of the conducted expert research the coefficients of significance of the discussed factors that influence the formation and use of the enterprise management organizational structure have been established (Table 5).Based on the results, the most significant factors are objectives of an enterprise (0,946), its size (0,936), and also the level of managerial professionalism of directors, their vision, beliefs, and ambitions (0,930). Relevant qualification of departments staff (0,424) and the level of competition and market conditions (0,514), in turn, appear to be the least significant factors.

During the process of the formation and use of the enterprise management organizational structure it is important to have information on the list of factors, their content, relevant significance and to understand how much these factors are interlinked with each other. This information is important from the point of view of understanding how decisions on the regulation of a certain factor will be reflected on other factors.

The appropriate way to study links between factors is to use cluster analysis tools, in particular spheres method that envisages the grouping of factors on the basis of establishing isomorphic similarities among them. With the help of a matrix of isomorphic distances (Table 6), initial chains between factors that have the highest isomorphic similarity can be obtained:

Chain 1 - 1 — 0,016504 — 3 — 0,015027 — 4 — 0,022933 — 6 — 0,023062 — 7 — 0,032783 — 10

Chain 2 - 2 — 0,018316 — 5 — 0,01744 — 8 — 0,034971 — 9

Table 6. Matrix of isomorphic distances between factors

Factors	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	0	0,022986	0,016504	0,017482	0,02034	0,024679	0,020704	0,021341	0,038024	0,029451
2	0,022986	0	0,01921	0,019453	0,018316	0,025676	0,024959	0,022651	0,033792	0,036036
3	0,016504	0,01921	0	0,015027	0,020039	0,018277	0,018427	0,020395	0,035924	0,030302
4	0,017482	0,019453	0,015027	0	0,018795	0,022933	0,020527	0,019906	0,034477	0,028193
5	0,02034	0,018316	0,020039	0,018795	0	0,026748	0,023393	0,01744	0,029082	0,030686
6	0,024679	0,025676	0,018277	0,022933	0,026748	0	0,023062	0,024956	0,039121	0,032279
7	0,020704	0,024959	0,018427	0,020527	0,023393	0,023062	0	0,025466	0,038432	0,032783
8	0,021341	0,022651	0,020395	0,019906	0,01744	0,024956	0,025466	0	0,034971	0,032937
9	0,038024	0,033792	0,035924	0,034477	0,029082	0,039121	0,038432	0,034971	0	0,041711
10	0,029451	0,036036	0,030302	0,028193	0,030686	0,032279	0,032783	0,032937	0,041711	0

Note: Composed by article authors.

According to the spheres method in order to cluster the objects, a critical value between objects based on the similarity of their structure should be determined with the help of a matrix of isomorphic distances. For this purpose we will select minimal isomorphic distances within the section of each column, and later we will select the maximum distance between the studied objects. As we can see, the minimum distances are the following: 0,016504; 0,01921; 0,016504; 0,015027; 0,01744; 0,018277; 0,018427; 0,01744; 0,029082; 0,029451. Among them the maximum distance is the distance between the first and the tenth factors – 0,029451.

Clusters can be formed based on the identification of the critical distance (Fig. 7).

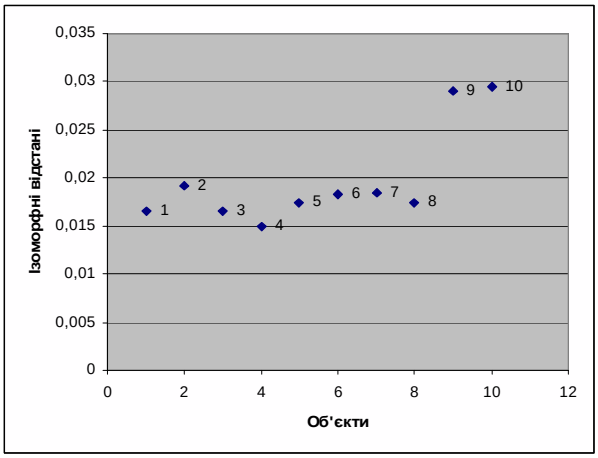


Fig. 7. Groups of factors that influence enterprise management organizational structure
Note: Composed by article authors

To identify the strings between the factors within the formed clusters it is important to form a dendrite. For this purpose we will use the above mentioned chains of factors and the matrix of distances between chains (Table 7).

To identify the strings between the factors within the formed clusters it is important to form a dendrite. For this purpose we will use the above mentioned chains of factors and the matrix of distances between chains (Table 7).

Table 7. Matrix of links distances

Chains	1	2
1	0	0,018795
2	0,018795	0
Minimal distances	0,018795	0,018795
Chains with the shortest distances	1 and 2	2 and 1

Note: Composed by article authors.

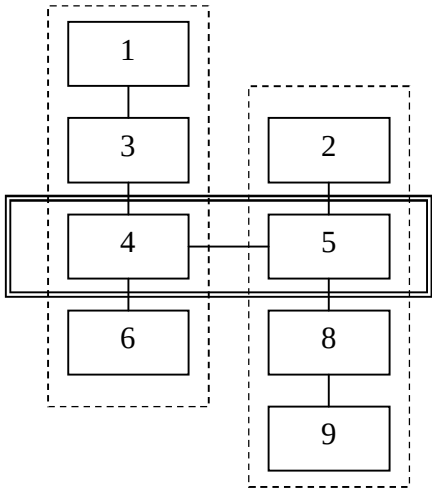


Fig. 8. Dendrite of factors that have influence on the enterprise management organizational structures
Note: Composed by article authors.

Table 7 shows that chains 1 i 2 are interconnected with each other through the fourth and fifth factors. The isomorphic distance between these factors is equal to 0,018795th of a unit. Based on this we will form a dendrite of factors that influence the enterprise management organizational structure (Fig. 8).

The formed dendrite indicated that while taking a decision on the regulation of any of the factors that influence the formation and use of the enterprise management organizational structure, it is important to take into consideration that this decision can have impact on the character of those factors that form the same chain together with the given factor. Also the impact of the decision, to certain extent, can be reflected on the factors from another chain, as these factors are directly or or indirectly interconnected. The situation that regulates the fourth and the fifth factor should be considered as a special case. These factors connect two chains into one tree-like structure. From this point of view, within the given situation there are more linear (direct) connections than in any other situation. It foresees stronger impact of the used measures on the list of selected factors than in any other situation.

CONCLUSIONS

Considering the fact that enterprise management organizational structure is a multilevel formation with a large number of components, elements and connections, the analytical results for the management decision-making process on improvement of the current management organizational structure should be sufficiently informative. By ‘sufficiently informative’ we understand both sufficient data for certain organizational decision-making and data objectivity. The data is considered to be objective if it has been obtained from different sources with the aid of scientific methods. The results of the undertaken studies prove that high level of informativeness of the analytical information on current enterprise management organizational structures can be achieved by means of morphological analysis. It allows considering all decomposition levels of the management organizational structure as topological and metric spaces, elements of which are interlinked with each other by causal relationships. With the aid of morphological analysis it is possible to identify the causes of problems emerging within the existing management organizational structures, determine the factors that are common for two or more local decisions towards solving them.

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Some features of application the delayed feedback control method to Cournot-Puu duopoly model

N. Iwaszczuk[1], I. Kavalets[2]

[1]AGH University of Science and Technology, Krakow, Faculty of Management
[2]Lviv Polytechnic National University, Lviv, Institute of Applied Mathematics and Fundamental Sciences, Applied Mathematics Department; e-mail: ira.kavalets@gmail.com

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Abstract. The Cournot-Puu duopoly model is considered. Delayed feedback control method (DFC-method) is applied to this model. The dependence of rate coming of the system at Cournot equilibrium on the feedback coefficient K choice is shown. The optimal value of this coefficient is defined. The dependence of rate coming of the system at Cournot equilibrium on parameter c_r (the ratio of marginal cost firms) is set. The application of DFC-method with two control laws to duopoly model is considered.

Key words: Cournot-Puu duopoly model, Cournot equilibrium, chaos, stability, delayed feedback control method (DFC-method).

INTRODUCTION

Review of the literature of recent years (see review in [15, 27]) shows the great interest of researchers to study of the oligopoly models and nonlinear dynamics, which is typical for them. The simplest but at the same time the most investigated among them is the Cournot oligopoly model [12]. One of the modifications of the model was proposed by T. Puu. He introduced the assumption that demand in oligopoly must be isoelastic and competitors must have constant, but different marginal costs [24].

Recent studies also indicate the existence of the chaotic dynamics in oligopoly models [1-3, 5, 6, 8-11, 13, 19, 21-23, 25, 26, 29, 30]. Among them, much attention is paid to the duopoly model, including the model of Cournot-Puu.

Our recent papers have been devoted to the construction of the generalized Cournot-Puu oligopoly model and study the stability of its equilibrium point [14, 17, 18, 20]. And in [18, 20] we described in detail duopoly model and defined such parameters of the system (the marginal cost of the firms), at which equilibrium point is stable, and there is chaos in the system (more precisely, there is a cascade of period doubling, which leads to chaos).

In this regard, there is a need to control this chaotic dynamic because unstable oscillations are undesirable for any economic system or process. Some methods for chaos control, such as OGY chaos control method [4,7], the adaptive control method and pole placement method [21] were applied to the Cournot-Puu duopoly model. In particular, in [11], the authors proposed the delayed feedback control method (DFC-method) to control the chaos that occurs in the Cournot-Puu duopoly model. This method is based on a feedback of the difference between the current state and the delayed state of the system. It requires relatively little information about the system and, therefore, is easy to use. We have implemented a generalization of this method for the case of presence n firms in the market (situation of oligopoly) for the generalized Cournot-Puu model, with the possibility of the application k $(1 \le k \le n)$ control laws to stabilize the system [16].

However, there are several important aspects that require detailed consideration and study. The first question is: what should be the optimal value of the feedback coefficient K at which the system will come to the Cournot equilibrium on the minimum number of steps (minimum time)? The second question is: far as will increase or decrease the number of time steps which must be executed to reach a state of equilibrium, depending on admissible values of the system parameters (marginal costs of the firms c_i). And the

third, how effective the use of more than one control law to control the chaos is effective? Let us consider these questions in detail, for example for duopoly.

INFLUENCE OF CHOICE OF THE FEEDBACK COEFFICIENT K TO SPEED OF SETTING THE SYSTEM AT COURNOT EQUILIBRIUM

In the case of duopoly there are only two firms F_1 and F_2 on the market in the same industry, with output q_1 and q_2 respectively. Firms have constant but different marginal costs c_1 and c_2, respectively.

According to the generalized model [18], Cournot-Puu duopoly model is as follows (see also [11]):

$$\begin{aligned} q_1(t+1) &= \sqrt{\frac{q_2(t)}{c_1}} - q_2(t), \\ q_2(t+1) &= \sqrt{\frac{q_1(t)}{c_2}} - q_1(t). \end{aligned} \tag{1}$$

Functions $q_1(t+1)$ and $q_2(t+1)$ with parameter values $c_1 = 1, c_2 = 6,25$ and initial conditions $q_1(0) = q_2(0) = 0,01$ have the form as it is shown in Fig. 1.

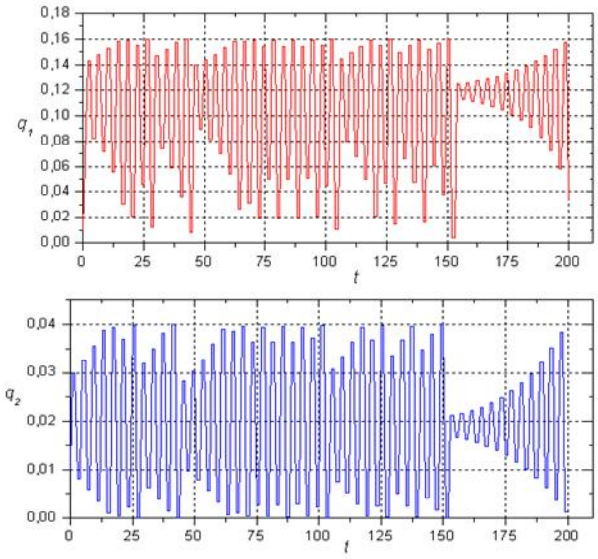

Fig. 1. The reaction functions of the firms F_1 and F_2

Nontrivial equilibrium point of the system (1) – Cournot equilibrium (Nash equilibrium) – is a point of intersection the reaction curves and has a value:

$$q_1^* = \frac{c_2}{(c_1+c_2)^2}, \quad q_2^* = \frac{c_1}{(c_1+c_2)^2}. \tag{2}$$

Profit of the duopolists at the Cournot equilibrium is respectively:

$$U_1^* = \frac{c_2^2}{(c_1+c_2)^2}, \quad U_2^* = \frac{c_1^2}{(c_1+c_2)^2}. \tag{3}$$

Stability of the equilibrium point (2) of system (1) is investigated in detail in [18,20], and in [24].

Denote the ratio of marginal costs $\frac{c_2}{c_1} = c_r$, and without loss of generality we will assume that $c_2 \geq c_1$ (i.e., $c_r \geq 1$). The equilibrium point (2) is stable if the ratio of marginal costs is in the range:

$$1 \leq c_r < 3 + \sqrt{8}. \tag{4}$$

Then equilibrium point is unstable if:

$$3 + \sqrt{8} \leq c_r \leq 25/4. \tag{5}$$

Limit cycles and chaos exist in the system at these values c_r. Bifurcation diagram for firms F_2 with output q_2 with respect to the ratio c_r of marginal costs is presented in Fig. 2.

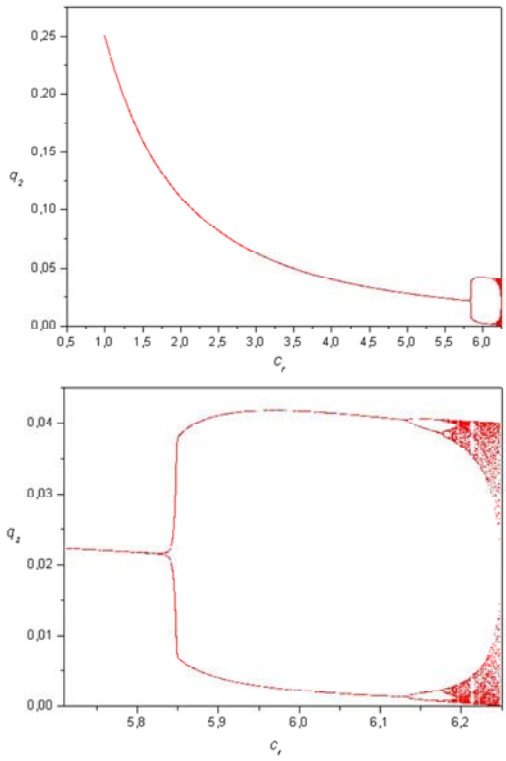

Fig. 2. Bifurcation diagram of the firm F_2 with the production q_2

Consider the following control form of the duopoly model (1):

$$\begin{cases} q_1(t+1) = \sqrt{\frac{q_2(t)}{c_1}} - q_2(t) + u(t), \\ q_2(t+1) = \sqrt{\frac{q_1(t)}{c_2}} - q_1(t). \end{cases} \tag{6}$$

$u(t)$ represents such DFC-law:

$$u(t) = K(q_1(t) - q_1(t-1)), \quad t \geq 1, \tag{7}$$

where: K is feedback coefficient.

In this paper DFC-law is applied to the structure (state) (output of the firm) of duopoly model. We can consider the application of DFC-law to the parameters (the marginal cost of firm) of the model.

As it is shown in [11], and also in detail in [20], Cournot equilibrium $\left(q_1^*, q_2^*\right)$ (2) is locally asymptotically stable if and only if:

$$-\frac{1}{2}-\frac{(c_r-1)^2}{8c_r}<K<1-\frac{(c_r-1)^2}{4c_r}. \qquad (8)$$

A graphical depiction of the region of asymptotic stability of the equilibrium point $\left(q_1^*, q_2^*\right)$ in the space of parameters $\{c_r, K\}$ is shown in Fig. 3.

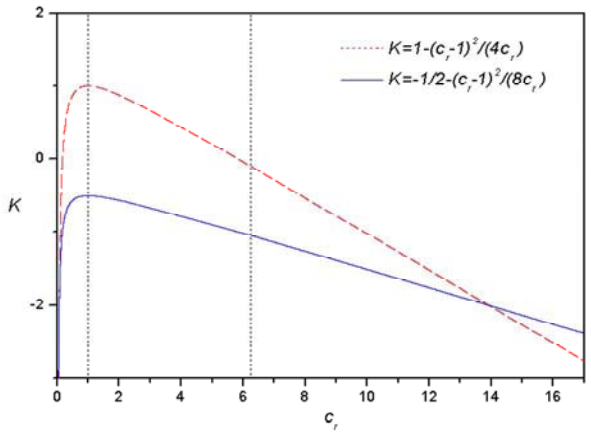

Fig. 3. The region of asymptotic stability of the equilibrium point $\left(q_1^*, q_2^*\right)$ when DFC-method is applied to the state of duopoly model

This region is determined by the conditions (8) and is bounded by the lines:

$$\mathrm{K}=1-\frac{\left(\mathrm{c_r}-1\right)^2}{4\mathrm{c_r}},$$

$$\mathrm{K}=-\frac{1}{2}-\frac{\left(\mathrm{c_r}-1\right)^2}{8\mathrm{c_r}}, \qquad (9)$$

$$\mathrm{c_r}=1, \quad \mathrm{c_r}=\frac{25}{4}.$$

Numerical experiments with using DFC-method to the state of Cournot-Puu duopoly model are carried out in [11]. The parameters are fixed as $c_1=1,$, $c_2=6{,}25$ initial conditions $q_1(0)=q_2(0)=0{,}01$, and the feedback coefficient $K=-0{,}5$. Chaotic trajectory is stabilized at Cournot equilibrium and control DFC-law $u(t)$, acting since time $t=50$, tends to zero. But some question arises here: how effective is the choice of such coefficient K? Maybe, there is some value of this coefficient from the allowable interval (8), for a given value of the ratio of marginal costs, which faster leads the unstable system to equilibrium point. The answer to this question we'll get in this section.

Let us consider the range of the parameter c_r at which Cournot equilibrium is unstable, i.e., $3+\sqrt{8}\le c_r\le\frac{25}{4}$. Consider the left end of this interval, i.e., $c_r=3+\sqrt{8}$ ($c_1=1, c_2=3+\sqrt{8}$). (We consider the ends of the interval of unstability, as they are the most interesting to study). Then, coefficient K, according to the system of inequalities (8), can be selected from the interval:

$$-1<K<0. \qquad (10)$$

For the right end of the interval, i.e., values $c_r=25/4$ ($c_1=1, c_2=25/4$), coefficient K, according to the system of inequalities (8), can be selected from the interval:

$$-\frac{841}{800}<K<-\frac{82}{800},$$

namely:

$$-1{,}05125<K<-0{,}1025. \qquad (11)$$

As we can see from (10) and (11), the left and right ends of the interval of values of the coefficient K, are displaced to the left (from (-1) to $(-1{,}05125)$ – for the left end, and from 0 to $(-0{,}1025)$ – for the right end) with increasing c_r from value $c_r=3+\sqrt{8}$ to the value $c_r=25/4$. That is, common to all values c_r from the interval $3+\sqrt{8}\le c_r\le\frac{25}{4}$ are values of K from the interval:

$$-1<K<-0{,}1025. \qquad (12)$$

Cournot equilibrium at selected values of the parameter c_r, according to (2), has the values that are presented in the Table 1.

Table 1. The equilibrium point $\left(q_1^*, q_2^*\right)$ at different values c_r

q^* \ c_r	$3+\sqrt{8}$	$25/4$
q_1^*	$\frac{1}{8}=0{,}125$	$\frac{100}{841}\approx 0{,}118906$
q_2^*	$\frac{1}{8(3+\sqrt{8})}\approx 0{,}021447$	$\frac{16}{841}\approx 0{,}019025$

We have conducted numerous studies to model (6) with control functions (7) for value $c_r=3+\sqrt{8}$ and initial conditions $q_1(0)=q_2(0)=0{,}01$, selecting the coefficient K from the allowable range (10). We received a number of time steps (intervals) needed the

each of the firms F_1 and F_2 with output q_1 and q_2 to come to the Cournot equilibrium $\left(q_1^*, q_2^*\right)$, for each selected value K (DFC-law $u(t)$ acts since time $t = 50$). Graphically this dependence is shown in Fig. 4.

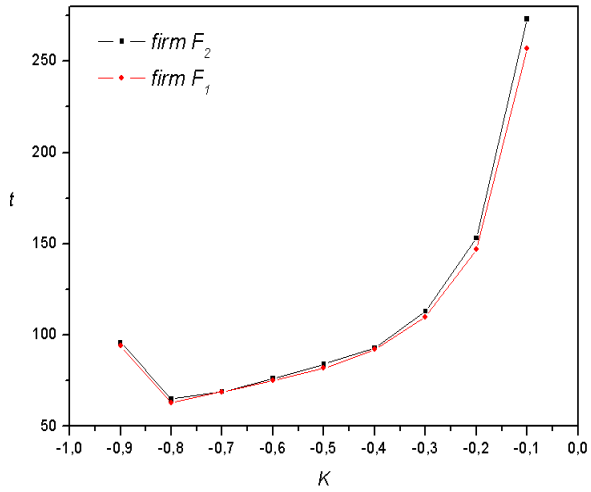

Fig. 4. Dependence of the number of time steps t on the selection of the coefficient K ($c_r = 3+\sqrt{8}$)

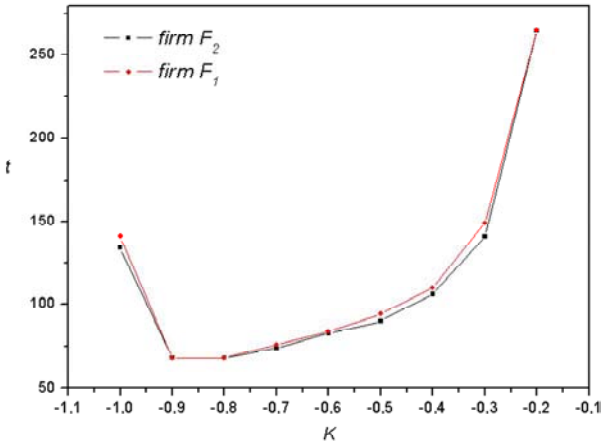

Fig. 5. Dependence of the number of time steps t on the selection of the coefficient K ($c_r = 25/4$)

The more we are moving away from the optimal value in the direction of the right end of the range of K, the system needs more time to come to the equilibrium point.

As it is shown in Fig. 4, both firms (with the same value of K) need almost the same number of steps to come to the equilibrium point. Also we see that the fastest system stabilizes at $K = -0{,}8$ ($t_1 = 63, t_2 = 65$, that is, by 13 steps to the first firm and 15 steps for the second, control law stabilizes the chaotic situation). Therefore, in order to stabilize the system as quickly as possible, it is better to choose K that close to this optimal value.

Similarly, we have conducted numerous studies for values $c_r = 25/4$ and initial conditions $q_1(0) = q_2(0) = 0{,}01$, selecting the coefficient K from the allowable range (11). Graphically the results of research are presented in Fig. 5.

As it is shown in Fig. 5, both firms (with the same value of K) need almost the same number of steps to come to the equilibrium point. Also we see that the fastest system stabilizes at $K = -0{,}9$ and $K = -0{,}8$ (the second value $K = -0{,}8$ is optimal for the previous case too) ($t_1 = 68, t_2 = 68$ for both values $K = -0{,}9$ and $K = -0{,}8$). So, in order to stabilize the system as soon as possible, it is better to choose those values K that are between the above optimal value and close to them. As in the previous case, the more we are moving away the optimal values to the right end of the range of values K, the system needs more time to come into equilibrium.

Application of the DFC-method to duopoly model with parameter value $c_r = 25/4$, initial conditions $q_1(0) = q_2(0) = 0{,}01$ and the value of the coefficient $K = -0{,}9$ is shown graphically in Fig. 6.

Control law begins to act from the moment of time $t = 50$ and stabilizes the system to the equilibrium point.

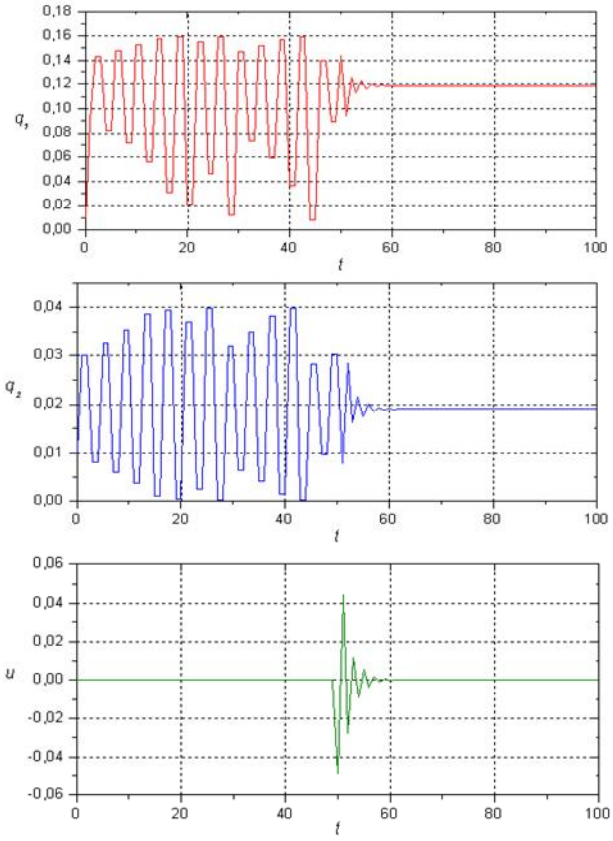

Fig. 6. Application of the DFC-method to duopoly model

DEPENDENCE OF THE RATE SETTING SYSTEM AT COURNOT EQUILIBRIUM ON THE VALUE OF THE c_r

In the study of duopoly model with applying DFC-method to it, the question arises: how will be change the number of time steps required the system to come to the Cournot equilibrium (increase or decrease) for different values of the ratio of marginal costs c_r ?

We have conducted two numerical study for the model (6), with the control function (7), for two values of the coefficient K from the interval (12) with the initial conditions $q_1(0) = q_2(0) = 0,01$. In the first case we have the optimal value of the coefficient $K = -0,8$, and in the second case, for comparison, value $K = -0,5$. Choosing the values of c_r in the interval of unstability $3+\sqrt{8} \le c_r \le \frac{25}{4}$, we got a number of time steps necessary to each of the firms F_1 and F_2 with the production q_1 and q_2, to come to the Cournot equilibrium. Graphically this dependence is shown in Fig. 7.

As it is shown in Fig. 7, in the first case (at $K = -0,8$) the system requires significantly less steps to come to the equilibrium point (Fig.7, left) than in the second case, i.e., at $K = -0,5$ (Fig. 7, right). Therefore, the results obtained in the preceding section are confirmed.

At the beginning of the interval of unstability (at $c_r = 3+\sqrt{8}$) the system needs less time to come to equilibrium. However, with the increasing c_r the number of steps also increases, but at the end of the interval (at $c_r = 25/4$) the number of steps decreases. If you look at the bifurcation diagram (Fig. 2), it is possible to explain this result. At the beginning of the unstable interval the equilibrium point oscillates between two values (beginning of period doubling tree) that are close to one another. With increasing c_r, two branches of the period doubling tree divergent more (the difference between the values, between which equilibrium point oscillates, increases) and the number of steps increases. Decreasing the number of time steps, for some values c_r, may indicate to a smaller difference of values between which equilibrium point oscillates.

APPLICATION of the DFC-METHOD WITH TWO control LAWS

In this section we'll consider application of the two control laws to the state of the duopoly model (1).

Consider the system:

$$\begin{cases} q_1(t+1) = \sqrt{\dfrac{q_2(t)}{c_1}} - q_2(t) + u_1(t), \\ q_2(t+1) = \sqrt{\dfrac{q_1(t)}{c_2}} - q_1(t) + u_2(t). \end{cases} \tag{13}$$

$u_1(t)$, $u_2(t)$ are the DFC-laws:

$$\begin{aligned} u_1(t) &= K_1\left(q_1(t) - q_1(t-1)\right), \quad t \ge 1, \\ u_2(t) &= K_2\left(q_2(t) - q_2(t-1)\right), \quad t \ge 1, \end{aligned} \tag{14}$$

where: K_1, K_2 are the feedback coefficients.

According to the generalized DFC-method [16, 20], for $n = 2$ and $k = 2$ (k is the number of the control laws), the Jacobi matrix of the linearized system of model (13) looks as follows:

$$J = \begin{pmatrix} 0 & p_1 & K_1 & 0 \\ p_2 & 0 & 0 & K_2 \\ -1 & p_1 & K_1 & 0 \\ p_2 & -1 & 0 & K_2 \end{pmatrix}, \tag{15}$$

where:

$$p_1 = \frac{c_2 - c_1}{2c_1}, \quad p_2 = \frac{c_1 - c_2}{2c_2}. \tag{16}$$

Next, define the conditions imposed on the choice of coefficients K_1 and K_2 to control laws (14) stabilize the system to the Cournot equilibrium. We apply the Routh-Hurwitz procedure for $n + k = 4$ [28].

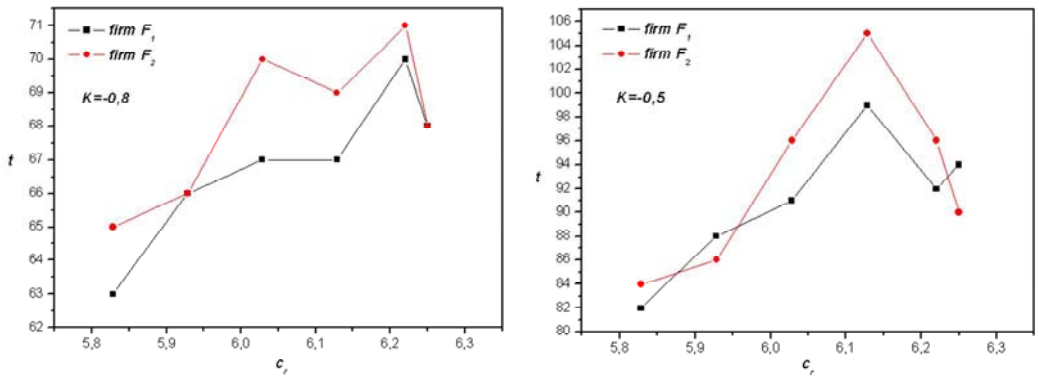

Fig. 7. Dependence the number of time steps t on the parameter c_r

Stability of the linearized system of model (13) is determined by the characteristic equation:

$$\det\begin{pmatrix} 0 & p_1 & K_1 & 0 \\ p_2 & 0 & 0 & K_2 \\ -1 & p_1 & K_1 & 0 \\ p_2 & -1 & 0 & K_2 \end{pmatrix} = 0 ,$$

or
$$l^4 + a_1 l^3 + a_2 l^2 + a_3 l + a_4 = 0 . \tag{17}$$

The coefficients of equation (17) look as follows:

$$\begin{aligned} a_1 &= -(K_1 + K_2), \\ a_2 &= K_1 + K_2 + K_1K_2 - p_1p_2, \\ a_3 &= -2K_1K_2, \\ a_4 &= K_1K_2. \end{aligned} \tag{18}$$

Equilibrium point (q_1^*, q_2^*) is locally asymptotically stable if for all eigenvalues l of the Jacobi matrix J condition holds [28]:

$$|l| < 1 . \tag{19}$$

According to the classical Routh-Hurwitz procedure, all eigenvalues satisfy condition (19) if the conditions hold:

$$\begin{aligned} &b_0 > 0, \quad b_1 > 0, \quad b_2 > 0, \quad b_3 > 0, \quad b_4 > 0, \\ &b_1b_2 - b_0b_3 > 0, \quad b_3(b_1b_2 - b_0b_3) - b_1^2b_4 > 0, \end{aligned} \tag{20}$$

where:

$$\begin{aligned} b_0 &= 1 + a_1 + a_2 + a_3 + a_4, \\ b_1 &= 2 + a_1 - a_3 - 2a_4, \\ b_2 &= 3 - a_2 + 3a_4, \\ b_3 &= 2 - a_1 + a_3 - 2a_4, \\ b_4 &= 1 - a_1 + a_2 - a_3 + a_4. \end{aligned} \tag{21}$$

According to the parameters $b_i, i = \overline{0,4}$ (21), the coefficients $a_i, i = \overline{1,4}$ (18) and the elements $p_i, i = 1,2$ (16), conditions (20) can be rewritten as:

(0) $1 + \dfrac{(c_r - 1)^2}{4c_r} > 0,$

(1) $2 - (K_1 + K_2) > 0,$

(2) $3 - (K_1 + K_2) + 2K_1K_2 - \dfrac{(c_r - 1)^2}{4c_r} > 0,$

(3) $2 + (K_1 + K_2) - 4K_1K_2 > 0,$

(4) $1 + 2(K_1 + K_2) + 4K_1K_2 + \dfrac{(c_r - 1)^2}{4c_r} > 0,$

(5) $(2 - (K_1 + K_2))\left(3 - (K_1 + K_2) + 2K_1K_2 - \dfrac{(c_r - 1)^2}{4c_r}\right) -$
$-\left(1 + \dfrac{(c_r - 1)^2}{4c_r}\right)(2 + (K_1 + K_2) - 4K_1K_2) > 0,$

(6) $(2 + (K_1 + K_2) - 4K_1K_2) \cdot$
$\cdot\left((2 - (K_1 + K_2))\left(3 - (K_1 + K_2) + 2K_1K_2 - \dfrac{(c_r - 1)^2}{4c_r}\right) -\right.$
$-\left(1 + \dfrac{(c_r - 1)^2}{4c_r}\right)(2 + (K_1 + K_2) - 4K_1K_2) -$
$-(2 - (K_1 + K_2))^2 \cdot$
$\left.\cdot(1 + 2(K_1 + K_2) + 4K_1K_2 + \dfrac{(c_r - 1)^2}{4c_r}\right) > 0,$ (22)

where: $c_r = \dfrac{c_2}{c_1}$.

Obviously, the first condition $1 + \dfrac{(c_r - 1)^2}{4c_r} > 0$ is always satisfied, since $c_r > 0$. You must choose the following coefficient K_1 and K_2 that satisfy the remaining six inequalities. This region is graphically represented in Fig. 8 (in the plane $\{K_1 + K_2, K_1K_2\}$), which satisfies the inequalities (22.1)-(22.6) at the value of the parameter $c_r = 3 + \sqrt{8}$. This region is bounded by curves constructed using the inequalities (22) by replacing the sign of inequality to equality, i.e.,

(1) $2 - (K_1 + K_2) = 0,$

(2) $3 - (K_1 + K_2) + 2K_1K_2 - \dfrac{(c_r - 1)^2}{4c_r} = 0,$

(3) $2 + (K_1 + K_2) - 4K_1K_2 = 0,$

(4) $1 + 2(K_1 + K_2) + 4K_1K_2 + \dfrac{(c_r - 1)^2}{4c_r} = 0,$

(5) $(2 - (K_1 + K_2))\left(3 - (K_1 + K_2) + 2K_1K_2 - \dfrac{(c_r - 1)^2}{4c_r}\right) -$
$-\left(1 + \dfrac{(c_r - 1)^2}{4c_r}\right)(2 + (K_1 + K_2) - 4K_1K_2) = 0,$ (23)

(6) $(2 + (K_1 + K_2) - 4K_1K_2) \cdot$
$\cdot\left((2 - (K_1 + K_2))\left(3 - (K_1 + K_2) + 2K_1K_2 - \dfrac{(c_r - 1)^2}{4c_r}\right) -\right.$
$-\left(1 + \dfrac{(c_r - 1)^2}{4c_r}\right)(2 + (K_1 + K_2) - 4K_1K_2) -$
$\left.-(2 - (K_1 + K_2))^2 (1 + 2(K_1 + K_2) + 4K_1K_2 + \dfrac{(c_r - 1)^2}{4c_r}\right) = 0.$

As it is shown on the right of Fig. 8, the range of permissible values of the coefficients K_1 and K_2 is determined by the fourth and sixth equalities.

We have conducted numerous studies that answer the question: whether is it appropriate to use two control laws in the duopoly model? Choosing values $K_1 + K_2$ and K_1K_2 from the permissible region, we have the number of steps required for the system to come to equilibrium point. The result of the study is shown graphically in Fig. 9.

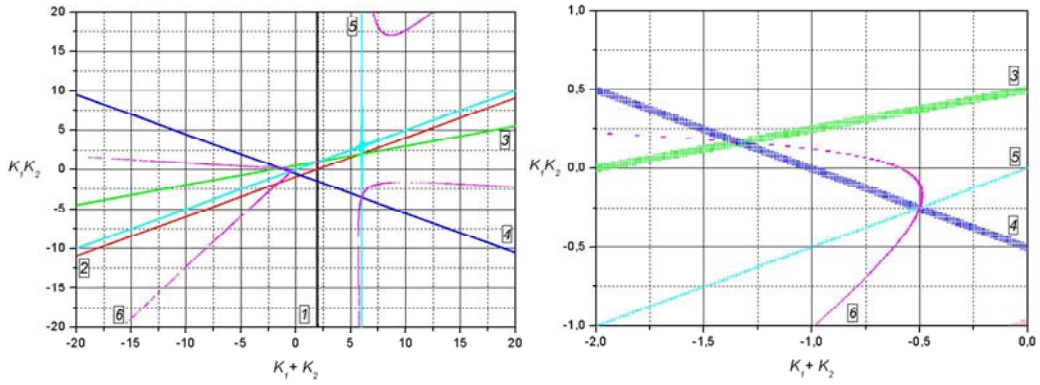

Fig. 8. The region of admissible values of the coefficients K_1 and K_2 ($c_r = 3+\sqrt{8}$)

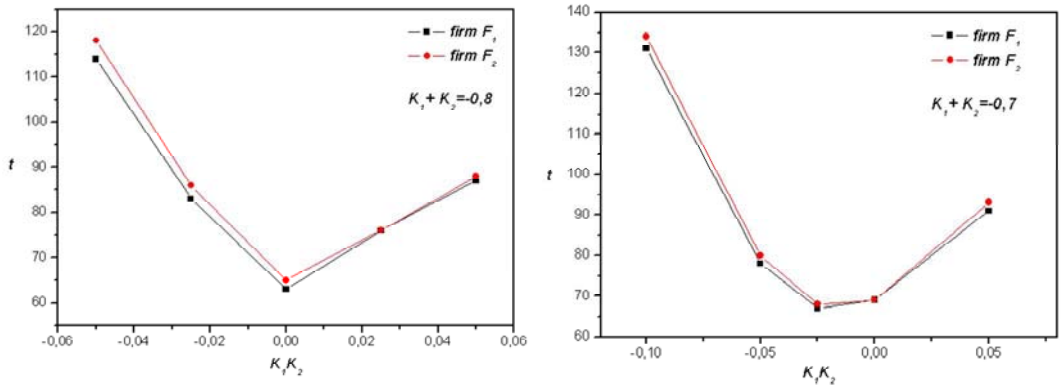

Fig. 9. Dependence the number of time steps t on K_1K_2 ($c_r = 3+\sqrt{8}$)

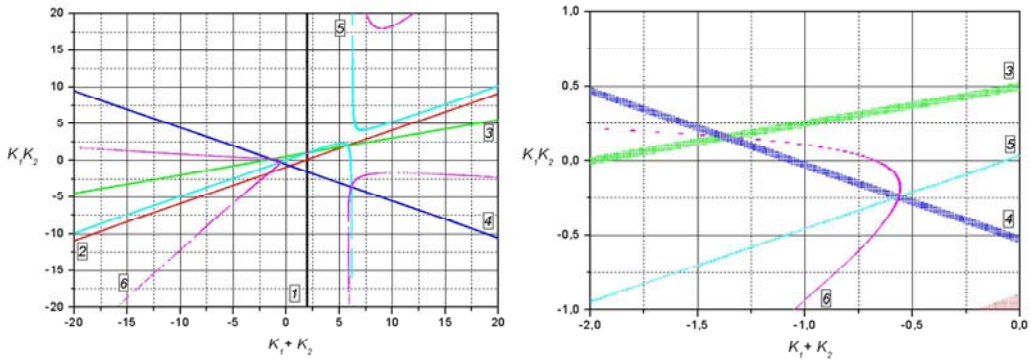

Fig. 10. The region of admissible values of coefficients K_1 and K_2 ($c_r = 25/4$)

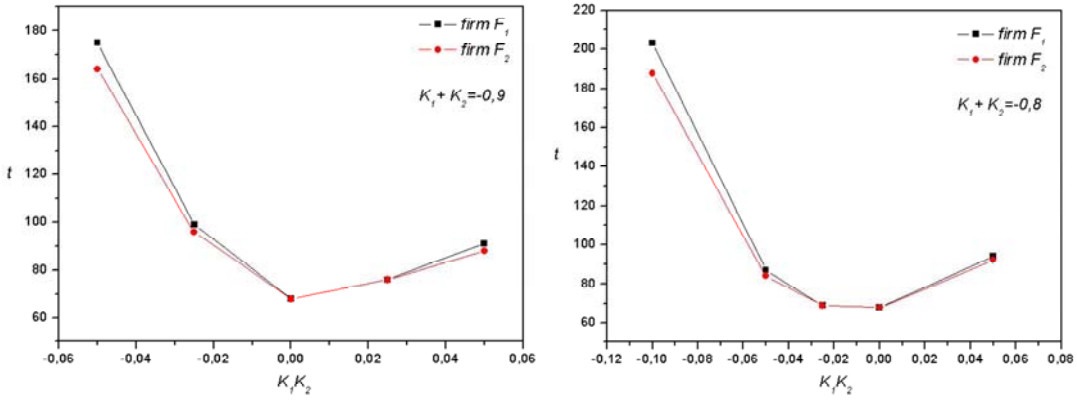

Fig. 11. Dependence the number of time steps t on K_1K_2 ($c_r = 25/4$)

As seen in Fig. 9 (left) at the value $K_1 + K_2 = -0,8$ and $K_1 K_2 = 0$ it needs the least time for the system to come to the Cournot equilibrium. The product $K_1 K_2 = 0$ means that either $K_1 = 0$ or $K_2 = 0$. Without loss of generality suppose that $K_2 = 0$. Then we have a situation when only one control law is applied to the model with the value of the coefficient $K_1 = -0,8$. This situation we have described in the preceding section when the value of coefficient $K = -0,8$ is the best value for DFC-method with the one control law. But the more we move to the left and to the right of the value $K_1 K_2 = 0$, the more time it takes to stabilize the system. The same situation we have for $K_1 + K_2 = -0,7$ (Fig. 9, on right).

Similar studies we have done for the right end of the unstability interval, that is for $c_r = 25/4$. This region is graphically represented in Fig. 10 (in the plane $\{K_1 + K_2, K_1 K_2\}$), which satisfies the inequalities (22.1)–(22.6) at the value of the parameter $c_r = 25/4$.

As in the previous case, the range of permissible values of the coefficients K_1 and K_2 is determined by the fourth and sixth equalities. Similarly, we have conducted numerous studies, choosing values $K_1 + K_2$ and $K_1 K_2$ from the permissible region. We received a number of steps necessary for the system to come to equilibrium point. The result of the study is shown graphically in Fig. 11.

As seen in Fig. 11 on left, at the value $K_1 + K_2 = -0,9$ and $K_1 K_2 = 0$ it needs the least time for the system to come to the Cournot equilibrium. But the more we move to the left or right of the value $K_1 K_2 = 0$, the more time it takes to stabilize the system. Similar conclusions we can do for $K_1 + K_2 = -0,8$ and $K_1 K_2 = 0$ (Fig. 11, right). But the product $K_1 K_2 = 0$ means that one of the coefficients is zero, i.e., we use DFC-method with only one control law for the model. And in this case, the values $K = -0,9$ and $K = -0,8$ are optimal.

So, summing up the results of research of this section, we have shown that the use of DFC-method with the two control laws to duopoly model is not effective.

Application of DFC-method to the state of the model is the method of individual control on a chaotic market when one of the firms can examine the market situation and change their course of action, observing the volume of production in the current and past periods. According to our research, controlling of unstable fluctuations by only one firm of the oligopolistic industry is more effective. If the two firms simultaneously will wish to do this, it'll need more time to stabilize the market situation (so that both firms have come to an equilibrium value of output).

CONCLUSIONS

Oligopoly is the predominant form of the market structure. Automobile industry, steelmaking industry, petrochemical industry, electrical industry, energy industry, computer industry and others are the oligopolistic industries. That is why it is important to study the processes occurring in such organizations of market relations.

In the paper we considered Cournot-Puu duopoly model (two firms in oligopolistic industries). Chaotic behavior at certain values of the ratio of marginal costs of firms c_r ($3+\sqrt{8} \le c_r \le 25/4$) is observed in the model. We studied some features of the application of the DFC-method to controlling the chaos that arises in this model.

First, we have shown that there is such value of feedback coefficient K at which firms come to the Cournot equilibrium fastest, namely $K = -0,8$. This value is optimal for almost all values of parameter c_r from the unstability interval.

We also examined how the value of parameter c_r influences on the rate of the system setting at the equilibrium point. At the beginning of the unstability interval (at $c_r = 3+\sqrt{8}$) the system needs less time to come to equilibrium. However, with the increasing c_r the number of steps also increases, but at the end of the interval (at $c_r = 25/4$) the number of steps decreases. This can be explained by the fact that at the beginning of the instability interval the equilibrium point oscillates between two values that are close to one another. With increasing of c_r, two branches of the period doubling tree divergent more (the difference between the values, between which equilibrium point oscillates, increases) and the number of steps increases too.

In this paper we have shown that the use of DFC-method with the two control laws (the ability of the two firms to control unstable fluctuations) is ineffective. We have shown that there is a certain range of values of the coefficients K_1 and K_2 at which firms come to Cournot equilibrium, but these values are not optimal. Because for any K_1 or K_2 from permissible range of values it needs more time to stabilize the system than with one control law.

Conducting such studies for the triopoly model is an alternative for further study.

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The instruments of the enterprises rating activity

O. Kuzmin, O. Melnyk, Yu. Chyrkova

Ukraine, Lviv Polytechnic National University
Educational-Scientific Institute of Economics and Management,
E-mail: okuzmin@ukr.net

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Abstract. The necessity of enterprise rating activity based on multiple criteria, as well as the significance of self-rating in modern business environment has been proven. The tools for enterprise rating evaluation, including structured methods for rating, and a system of indicators for rating evaluation of the enterprise's functioning were developed. Thereupon, technology of enterprises rating evaluation was improved and the procedure for selecting functional strategies for their activities according to rating results (partial and complex ratings and rankings) was proposed.

Key words: rating activity, rating, ranking, rating evaluation method, technology, polycriterial rating activity, system of indicators, strategy, enterprise.

INTRODUCTION

In modern dynamic environment, enterprise's activity must be accompanied by permanent tracking of effectiveness and coherence of all the key operation areas (industrial, technological, financial, human resources, innovation, marketing, foreign trade, etc.) to ensure the effective operation and determine strategic targets for the development. In order to diagnose problem areas in time and develop measures to address them, comprehensive assessment of economic entities on the basis of rating is used, it allows creating a coherent objective idea of the internal conditions of the industrial enterprises within self-analysis, defining its current place among competitors and form a basis for realistic forecast of enterprise development in the future. Despite the many scientific works on rating and significant results obtained by globally recognized experts and Ukrainian rating agencies, there are a number of important issues to be addressed in this area. In particular, the key methodological problem is that rating developers focus only on the assessment of the financial conditions and solvency of companies, and do not take into account results from other areas of their operation. This leads to ineffective and biased ratings and rankings of enterprises and thus hampers the development of rating technology. Moreover, the lack of uniformity within the system of indicators for rating evaluation and common interpretation tools for results presentation leads to conscious manipulation of rating results. This adversely affects all rating process participants, especially the enterprises – where rating is held – as they can suffer significant losses and damages due to inadequate decision-making based on rating. Therefore, tools for enterprise rating evaluation need improvement, with the development and implementation of rating methods and techniques, indicators and criteria based on multidisciplinary framework being primary tasks which confirm the relevance of this work.

ANALYSIS OF THE LITERATURE ON THE PROBLEM

Despite the crucial role of rating evaluation in ensuring conditions for effective functioning and development of enterprises, development of theoretical and applied framework for rating has not yet been properly studied. Methodology and tools for ranking evaluation of enterprises and organizations of different areas and fields of activity were studied in the research conducted by a number of domestic and foreign scientists: S.Aivazian, I.Alieksieiev, T.Anderson, O.Volkov, P.Harmydarov, M.Davison, H.Dieieva, O.Dobykina, M.Elkhori, S.Ishchuk, O.Karminskyi, V.Kovalova, R.Kostyrko, Ye.Krykavskyi, D.Kuvshynov, Yu.Lysenko, A.Mazaraki, A.Miedviediev, Ye.Nehashev, A.Neznamova, A.Peresetskyi, A.Petrov, Y.Petrovych,

V.Pliut, P.Polovtseva, N.Prytula, H.Prosvietov, V.Prohorova, R.Saifulin, S.Salyhf, D.Fennel, Z.Khelvih, Yu.Tsal-Tsalko, I.Chulipa, H.Shadrina, A.Sheremeta etc. The abovementioned authors focused their attention on the development of methodology for businesses activity ranking to assess their financial and economic situation and develop enterprise management systems based on rating. However, despite the significant diversity of methods for rating systems, the results obtained using different approaches are often different, and thus are incommensurable and cannot be compared with each other, making it impossible to use a unified approach to the interpretation of ratings and creating the opportunity for abuse. Some authors misclassify similar rating methods and techniques putting them in different classification groups, thus complicating the process of selecting the most appropriate methodological framework for rating based on the objectives of the rating survey. Moreover, the focus of the existing rating methods and techniques on the use by financial institutions (primarily financial and credit system) introduces several limitations (such as accounting, regulatory ones) for the use in the process of enterprise rating in general, and therefore requires expanding and clarification.

THE PURPOSE OF THE PAPER

The purpose of the article is to improve methods, criteria and indicators for rating evaluation on multicriteria basis.

PRESENTATION OF THE MAIN RESEARCH MATERIAL

Based on the results of literature analysis and the study of rating experience, we can argue that the rating evaluation plays a crucial role in ensuring success of the enterprises. Specifically, the rating evaluation, carried out by the company itself, is now used as an effective diagnostic tool and lays the foundation for diversified decision-making. Enterprise ratings also form the basis for competitive analysis, becoming an active element of the advertising campaign and one of the key factors for creating the image in relations with the public and public authorities. [1] The special value of ratings for businesses consists in establishing the preconditions for obtaining credit and investment resources, including the ones provided on concessional terms in order to avoid funding crisis, ensure continuity of the production process and stimulate development.

The conducted research suggests that enterprise rating is a type of activity that involves a comprehensive assessment of manufacturing, financial, economic, marketing, human resources and other areas of the studied enterprise and building rating based on the abovementioned information, which briefly reflects its real position in a ranking list according to the developed scale and allows us to make a realistic forecast of its development in the short and long term. [2] Since rating is actively applied as one of the most effective diagnostic tools in enterprise management system, it should be noted that the abovementioned notion should not be mixed up with “rating management”. The latter implies a much broader range of functional activities and is aimed at making diverse managerial decisions based on the rating results to influence the company, its subsidiaries, employees, etc. [3-6].

Therewith, we consider it necessary to identify rating with "rating activities" and "rating evaluation" because they are processes aimed at obtaining the same result - rating. Rating is a certain score that is valid at a specified time or during a period of time and which is attributed to the industrial enterprise being rated and is considered to be the most suitable for its positioning according to the selected criterion or a set of criteria among other similar entities. Modern structure types of enterprise and organizations ratings are extremely diverse [1, 5, 7-11], however, they include the most characteristic types: rating by the duration - long-term and short-term ratings, by the subject of rating - credit and non-credit ratings, by the reliability of company conducting rating - investment, speculation, outsider ratings, by the directions for use - public and custom rankings, etc.

Development of a specific rating type for the target group of enterprises involves the drawing up of special lists - rankings, where rated enterprises are positioned according to the ratings obtained, which proves that the notions of "rating" and "ranking" are different. We disagree with the viewpoint of some researchers [1, 19; 11, 84] who argue that ranking is "a list of entities that are ranked based on one indicator". These rankings are formed mainly in the periodical publications (the indicators are: income, assets and profit) and their information content is very poor. In a complex rating, for example, a number of different activity indicators are taken into account (financial, HR, etc.) which enables the drawing up of rankings, where enterprises and organizations are ranked according to obtained generalized polydimensional rating scores. In view of the above mentioned information, ranking is a list of objects (entities), placed in a single list, and ranked according to the established criterion (mono- or multidimensional), which reflects operations effectiveness of the enterprise covered by this list. It should be noted that in the case of developing ratings and rankings by specialized companies (rating agencies), both notions become rating products which are the objects for sale for the interested users.

Despite the importance of ratings and rankings for management, recent events in the global economy against the backdrop of the financial and economic crisis have damaged the reputation and dented trust in ratings, even the ones conducted by recognized international specialized companies (Moody's Investors Service, Fitch Ratings and Standart & Poor's). This situation led to the need for the development of enterprises self-rating and

created new requirements for methodology and methods applied in rating in this area.

A detailed study of current rating environment and its trends makes it possible to argue that there are a number of reasons behind the low level of effectiveness and objectivity of ratings and rankings made by specialized agencies:

- Lagged ratings, leading to “post factum” reaction of the rating agencies to the macro- and microeconomic changes in the activities of their researched entities, although the key task of these agencies is to use complex methods to carry out an objective prognostic evaluation and to provide opportunity to predict possible crisis trends;

- A tendency to give priority to qualitative parameters of evaluation and predominant use of expert analysis, which creates the preconditions for the development of ratings with a significant level of subjectivity, which adversely affects their adequacy and reasonableness;

- Identical methods of assessment used for rating of entities belonging to different categorical groups by size, activities, organizational and legal forms, intensify such positive ratings features as comparability and flexibility, however, it makes it impossible to conduct a comprehensive activity analysis of the investigated entity, thus reducing the efficiency of the resulting value;

- Biased conservative attitude of international rating agencies experts to developing countries, and the practice of overstated ratings for enterprises representing highly developed countries, create a high risk of discrepancy between the developed rating and the real state of the company in the domestic environment and encourage rating abandoning.

The consequence of the above mentioned errors in the methods applied by rating agencies are significant losses suffered by the industrial enterprises – rated entities which, guided by disclosed false information about their market place, made inadequate management decisions. In particular, international industrial companies Steel Corporation Arcelor Mittal, aerospace giant The Boeing Company, world famous car manufacturers General Motors, Nissan, Toyota, manufacturers of mobile equipment Nokia, Sony Ericsson, Samsung, which in recent years have occupied leading positions in the world rankings, now scale down production, slash jobs and ask government for help in order to avoid bankruptcy [12].

At the same time, huge financial losses were also suffered by rating companies due to a sharp drop in trust in them by interested users. The study of some analytical and journalistic materials, as well as statistical data reflected in the financial statements of internationally recognized rating agencies and their holding companies-owners allowed to say that the most powerful international operators of rating market Moody's (owned by Dan and Brand street Inc., USA), Fitch Ratings (owned by The McGraw-Hill Companies, USA) Standart & Poor's (owned by Fimalac SA, France) declare a catastrophic decline in revenues, losses and the loss of a huge number of customers. In particular, in 2012, at Moody's, the proportion of operating income (income from rating) decreased by more than 50% (from 61.08% ($1258.87 million) to 39.5% ($732.13 million)) of its total amount compared with 2006, which was the biggest decline of profitability among key international rating agencies for the last 6 years (a drop within Standart & Poor's amounted to 15%, within Fitch IBCA - 27%) [13; 14]. These trends prove that there are serious problems in the modern rating environment that hamper the development of enterprise rating evaluation, since the latter accuse rating agencies of manipulating information, particularly in providing biased ratings, which is unacceptable in economic studies area [15, 42-43; 16, 30].

As to the features of the rating market in Ukraine, it should be noted that domestic rating operators (Credit-Rating Ltd., RA IBI-Rating Ltd, RA Expert Rating Ltd., Riurik Ltd., Ukrainian Credit Rating Agency Ltd., Standard Rating Ltd., etc.), while preparing rating evaluation of the enterprises, focus their attention on analyzing and identifying their solvency and financial condition, excluding manufacturing and technological, marketing, foreign trade, HR, innovation activities [7, 16]. Moreover, domestic rating companies actively develop rating methods and techniques for financial-credit institutions (banks, insurance companies, asset management companies, etc.) while the spread of rating evaluation of other enterprises, particularly those working in the field of production, is extremely limited [17].

Quality, completeness and accuracy of ratings depends on the selected method of rating, i.e. a set of economic-mathematical, technical, technological, social, organizational and administrative methods and techniques necessary to determine ratings and rankings formation. The research helped to improve enterprise rating methods typology (Table 1) [2].

The choice of the most appropriate methods of rating depends on the list of factors of micro and macro environment for the operation of industrial enterprises. The most important macroeconomic factors include: the stability and predictability of the environment for rated enterprises, organizational and legal framework for their activities, the impact of the international economic environment, etc.

The study of modern enterprises operation showed that their rating evaluation requires complexity and multidimensionality in order to take into consideration performance of all areas of activity and form an adequate generalized effectiveness indicator - rating. Under such conditions, polycriterial approach to entities rating evaluation is of exceptional importance [18].

Table 1. Industrial enterprise rating methods typology

Typological features of rating methods	Rating methods types according to relevant typological features
1	2
By the authorship of rating companies	- Copyright methods (including methods developed by company experts); - Methods of rating agencies; - Methods of state authorities.
By recognition	- International; - National.
By the type of enterprise activity	- Industrial enterprises; - Trade organizations; - Banking, insurance and other financial institutions; - Educational, health, sports and other non-profit organizations; - Travel companies; - Consulting companies, etc.
By the level of technological implementation	- Computerized; - Manual; - Mixed
By the duration of the developed rating evaluation	- Methods for short-term ratings; - Methods for long-term ratings
By the ranting subject	- Elementwise; - Complex
By the level of formalization	- Quantitative; - Qualitative; - Combined
By the type of component indicators integration	- Additive; - Multiplicative
By the form of assessment	- Static; - Dynamic
By the type of ranking drawing up	- Single list; - Categorical list
By the type of ranking building	- Number based; - Points based; - Index based
By the degree of transparency	- Open; - Closed
By tracking type	- Remote; - Insider; - Combined
By the rating information support	- Based on public reporting; - Based on specially conducted research
By the type of ratings evaluation results representation	- Numeric; - Literal
By results illustration	- Table; - Graphics
By the type of comparison	- With the standard; - With the average for the industry; - With normative values. - Combined

Polycriterial rating activity, unlike monocriterial approach, enables to explore not only financial, but also industrial, technical, HR, marketing and other areas of business based on a specially designed exponential-criteria tools, these areas, being interconnected, create a decisive influence on the efficiency of its functioning, particularly in the industry. Thus it does not only provide prerequisites for the development of generalized rating indicator which comprehensively reflects the state of the company and its competitive position in the ranking, but also enables us to track power and direction of each element's impact of each of these areas on a total rating with a view to taking management decisions regarding the reasonability of the selected functional strategies. Given the above mentioned information, there is a need for the development and implementation of polycriterial rating (Fig. 1) in order to improve enterprises' economic diagnosis and, consequently, the effectiveness of the management system (Fig. 1) [19].

The determining factor in the implementation of polycriterial rating is the creation of exponential matrices X^I of the size n*m for each of the areas of enterprise operation (financial, economic, industrial, technological, human resource and market), i.e. we set the values of n parameters for m companies being rated. In order to meet the criterion of optimal size and other fundamental criteria, on the basis of which the selection of indicators for rating evaluation is carried out, the most representative indicators (see Fig. 2) are selected for each of the areas, these indicators form the most objective and complete picture of the studied companies efficiency.

STEP 1.
Information support of polycriterial rating of enterprise activity

Information sources: No.1, "Balance sheet", the No.2, "Income statement", No.1-ПВ "Report on industrial production", No.1-innovation "Survey of innovation activity of industrial enterprises", No.11-ОЗ "Report on the presence and movement of assets", No.1-ПВ "Report on the work", reports on faults, technological equipment passports, forms containing the results of equipment time management, the average industry standards for indicators, reports on the company market value establishment, market surveys, etc.

STEP 2.
Developing the indicators systems for activity rating based on key areas of operation

- To assess **FINANCIAL AND ECONOMIC AREA (F):** financial independence coefficients, current liquidity, return on invested capital, and return on equity;
- To assess **PRODUCTION AREA (P):** the cost effectiveness of production, production flow, proportion of defects in sold products, product updates;
- To assess **TECHNOLOGICAL AREA (T):** yield on capital investment, fixed assets renewal, capital-labor ratio, the extensive use of machinery, capacity load;
- To assess **HR AREA (H):** factors of productivity, staff turnover, the average wage within the company, effectiveness of time management;
- To assess **MARKET AREA (M):** indicators of market share, profitability, capitalization level, receivables and payables payback period

STEP 3.
Construction of input exponential matrices for key areas of operation of entities which undergo polycriterial rating

Fill the input matrices X^I in accordance with ranking objects according to the data obtained:

$$X^I = \begin{pmatrix} x_{11} & x_{1j} & x_{1n} \\ x_{i1} & x_{ij} & x_{in} \\ x_{\cdot} & x_{\cdot} & x_{\cdot} \end{pmatrix},$$

where: x_{ij} – the value of the i-th indicator of the 1st area of the j-th enterprise; i = [1;m] – index number j = [1, n] – company number.

STEP 4.
Normalization of the exponential matrix elements and turning them into standardized ones to eliminate inadequacy and create the model matrix

The matrix of standardized indicators (Z^I) will be as follows:

$$Z^I = \begin{pmatrix} z_{11} & z_{1j} & z_{1n} \\ z_{i1} & z_{ij} & z_{in} \\ z_{m1} & z_{mj} & z_{mn} \end{pmatrix},$$

where: $z_{ij} = \frac{x_{ij} - \overline{x_i}}{s_i}$, $\overline{x_i} = \frac{\sum_{i=1}^{n} x_i}{m}$ - average value of the i-th indicator for the total number of enterprises ; $s_i = \sqrt{\frac{\sum_{j=1}^{n} (x_{ij} - \overline{x_i})^2}{m}}$ - the standard deviation of the i-th indicator.

STEP 5.
Construction of model matrix for each of the key areas of enterprise by selecting standardized matrix elements that correspond to the best values of these elements within the exponential matrix in terms of their value approximate to regulatory criteria

Model matrix for the i-th area of activity:

$$\mathbf{Z^{IE}} = (z_1^E \; z_2^E \; z_3^E \ldots z_m^E),$$

where: z_i^E → normative criterion.

STEP 6.
Calculation of partial rating scores using taxon approach and its generalization using additive convolution with the adjustment of factors weight according to Thurstone matrix

Partial and generalized ratings for each of the companies are calculated using the formulas:

$$R_{oj}^I = (\sum_{j=1}^{n} z_{ij} - z_i^E)^2; \; R_{oj} = \sum_{j=1}^{n} R_{oj}^I * k^I,$$

where: R_{oj}^I - partial ranking score for I-th area; generalized rating; k^I – weight factor for I-th area, defined by Thurstone matrix;

with: $R_{oj}^I \rightarrow \min$, $R_{oj} \rightarrow \min$.

STEP 7.
Development of final rankings

The position of enterprises in the ranking (r_{ij}) is established based on the criterion which minimizes their partial estimates and generalizes rating (higher position corresponds to a lower rating).

Fig. 1. Implementation of polycriterial enterprise rating activity

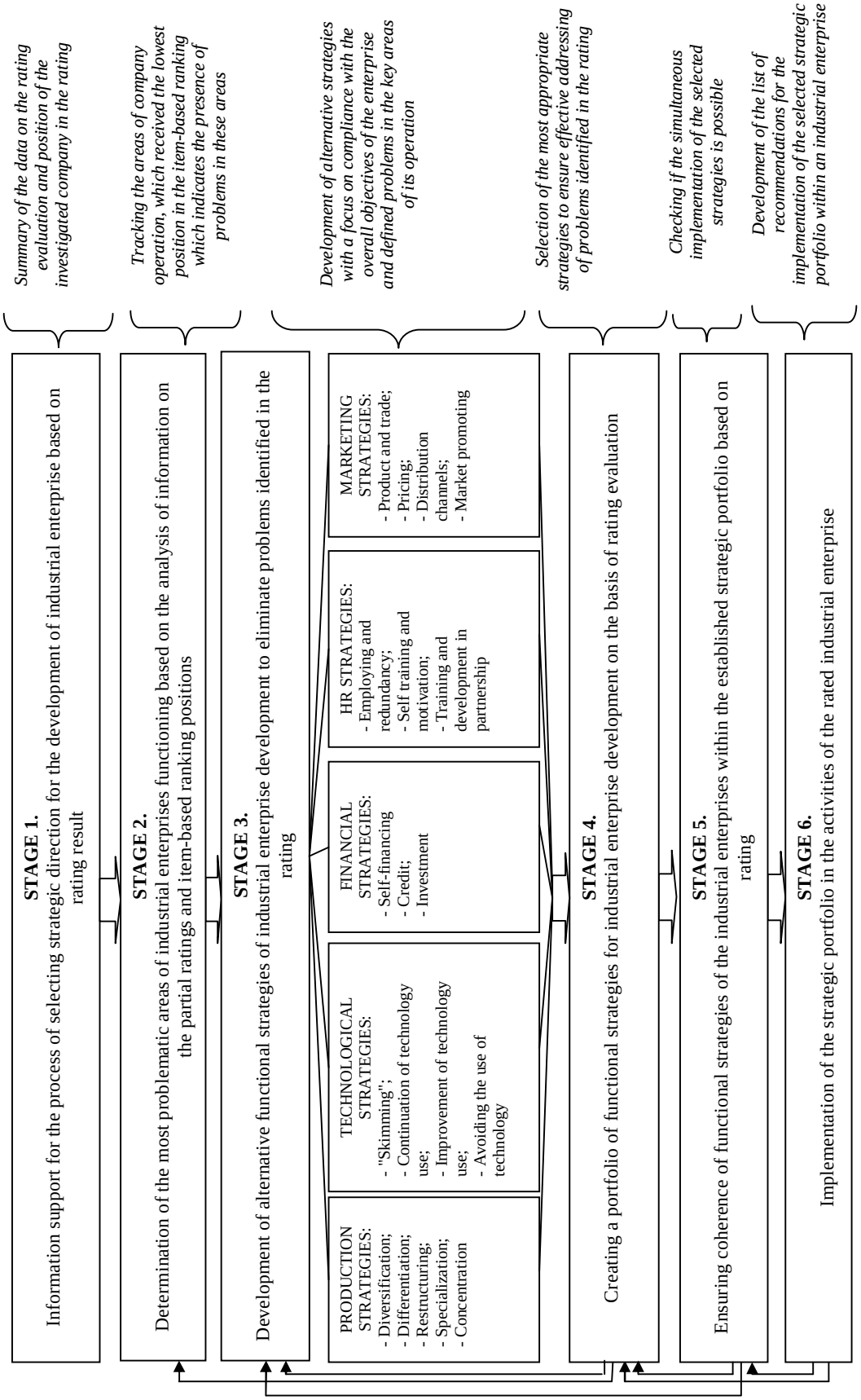

Fig. 2. Selection of functional development strategies for industrial enterprises based on rating results

In this context, the crucial task is the adequate choice of the development direction for the studied enterprises, which, given the strong position, should ultimately provide the solution to the problems discovered in the process of rating [20]. The proposed process for selecting functional development strategies of industrial enterprises on the basis of the rating results is displayed in Fig. 2.

It should be noted that in order to address issues of one of the areas, within a functional strategies portfolio creation, that is carried out within the fourth stage of the proposed functional strategies selection process, one should not always use only those strategies that are directly linked with the specified area. For example, the maximum success in financial, HR and market areas (high level of financial stability due to the lack of credit obligations and the availability of reliable counteragent, highly qualified staff, as well as strong market activity both in Ukraine and abroad) will make it possible for a company to gain a leading position in the final ranking. However, according to the results of the partial ranking r(T), the company may have some technological problems which hamper the development, because a number of labour-consuming manufacturing operations are currently performed using primitive equipment. It is obvious that the problems associated with obsolete and run-down equipment or other obstacles that may arise in the technological field of the enterprise require the use of not only one of the technological strategies (e.g., "abandoning the use"), but also financial strategies (to determine the sources of financing for the purchase of new equipment) as well as improvements using HR strategies, because the use of new equipment requires the improvement in employees' skills and abilities, especially when it comes to introducing modern precision equipment. Similar mutual impact may occur in the process of improvement of any other area of enterprise operation, so all managers should use the principle of consistency and coherence while creating corrective measures based on rating results to develop a comprehensive set of the most optimal strategic decisions.

CONCLUSIONS

Rating evaluation of companies and organizations is one of the most widely used management technologies in the economic analysis of the conditions and development prospects in modern competitive environment. However, the dynamic and unstable economic conditions, where the rated enterprises are working today, require the selection of adequate methods and techniques for rating procedures and the development of generalized rating by rating agencies. Consequently, complete and logical structuring of tools used for entities rating (rating methods, principles, criteria, indicators, and strategic points) is exceptionally important. Using the tools the rating agency can quickly choose the most efficient operation environments (both its own and the ones of the rated entity) taking into account the results of a comprehensive analysis, and obtain the basis for their further improvement.

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Definition of the semantic metrics on the basis of thesaurus of subject area

V. Lytvyn, O. Semotuyk, O. Moroz

Department of Information Systems and Networks, Department of Appliued Lingustics
Lviv Polytechnic National University, 79012, Lviv, Bandery st. 12, Ukraine
e-mail: vasyll@ukr.net, orest.semotiuk@gmail.com, olha.moroz.81@gmail.com

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Abstract. The paper proposes an approach to construction of semantic metrics based on thesaurus of the domain of linguistics. The process of constructing a thesaurus is described. A way is proposed to use the built knowledge base to find potential partners who are engaged in similar research issues in the subject area for which thesaurus was constructed.

Key words: thesaurus, knowledge base, semantic metrics, relation, weight ratio.

INTRODUCTION

The language of science is structured scientific knowledge, sets a hierarchical multilayer formation, which allocated blocks: terminological, nomenclature, methods and rules for forming apparatus and conceptual terms.

Encyclopedias, dictionaries and terminology on which terminological system of the subject area is based tend to have a clear structure and consist of entries. It is therefore necessary to investigate their possible arrangements to recognize concepts and relations between them to build a thesaurus software.

In [1-3] the construction of a thesaurus is described in detail. This paper proposes to use a thesaurus of linguistic terms developed by the authors to find potential partners who are engaged in similar research problems in a given software. To solve this problem it is necessary to build a semantic metric.

METHODS FOR DETERMINING SEMANTIC METRICS

There are several ways to determine the semantic metrics.

Table 1 shows how to calculate the degree of similarity of text documents (TD) based on:

- word frequency in text documents,
- distance in the taxonomy of concepts,
- word frequency and distance in the taxonomy of concepts simultaneously.

Google Distance - a degree of semantic coherence, which is calculated based on the number of pages obtained by pursuing Google for a given set of keywords. The table shows the formula for calculating the normalized Google distance (NGD) for two terms: *x* i *y*, where M is the total number of web-pages indexed by Google; $f(x)$ i $f(y)$ – number of pages containing keywords *x* i *y*, respectively $f(x, y)$ – number of pages containing both *x*, and *y*. If *x* and *y* are found on all pages together, then we consider *NGD*=0, if they occur only separately , then we consider *NGD*=∞.

We select a class of metrics that compute similarity based on taxonomy data. These metrics are used to compute the similarity of concepts WordNet [6], GermaNet, Wikipedia [4].

In [13] a formula is proposed that takes into account both the depth in the hierarchy of concepts, and the depth of the *lcs* (least common subsumer):

$$wup(C_1, C_2) = \frac{lcs(C_1, C_2)}{depth(C_1) + depth(C_2)}.$$

Ryeznyk [8] proposed to consider that two words are the more similarly the more informative concept is, which relate to these two word, this means the lower in the taxonomy is a common top concept (synset in

Table 1. Semantic metrics classification

Formula/ description of the algorithm	Title
1. Word frequency in text document	
$NGD(x,y)=\frac{max(\log f(x),\log f(y))-\log f(x,y)}{\log M-min(\log f(x),\log f(y))}$	Normalized distance Google (*NGD*)
$jaccard(x,y)=\frac{Hits(x\wedge y)}{Hits(x)+Hits(y)-Hits(x\wedge y)}$	Jaccard [4]
2. Distances in the taxonomy of terms	
Distance corresponds to the number of edges shortest path between concepts	Metrics was used for the concepts of Roget's thesaurus [5]
$lch(C_1,C_2)=-\log\frac{length(C_1,C_2)}{2D}$	Leacock & Chodorov 1997, [6] pp. 265-283
$wup(C_1,C_2)=\frac{lcs(C_1,C_2)}{depth(C_1)+depth(C_2)}$	Wu & Palmer [7]
$res_{hypo}(C_1,C_2)=1-\frac{\log(hypo(lcs(C_1,C_2))+1)}{\log(C)}$	Metrics *res* [8], adapted to the taxonomy of the Wikipedia categories
3. Frequency words and distances in the taxonomy	
$res(C_1,C_2)=\max_{C\in S(C_1,C_2)}[-\log(P(C))]$	Distance *res* [9]
$lin(C_1,C_2)=\frac{2\cdot\log(P(C_0))}{\log(P(C_1))+\log(P(C_2))}$	Distance *lin* [10]
4. Text intersection	
Text intersection (based on WordNet)	Lesk [11]
extended gloss overlap – text crossing considering the neighboring concepts WordNet	Banerjee & Pedersen, 2003 [12]
$relate_{gloss/text}(T_1,T_2)=tanh\frac{overlap(T_1,T_2)}{length(T_1)+length(T_2)}$	Відстань *relate* [4]

wordNet). In constructing probabilistic functions $P(C)$, it is considered that the concept probability should not be changed while moving up the hierarchy: $res(C_1,C_2)=\max_{C\in S(C_1,C_2)}\left[-\log(P(C))\right]$. Then abstract concepts are less informative. Ryeznyk proposed to estimate the probability over frequency synonyms concept in a text document (TD) so: $P(C)=\frac{freq(C)}{N}$, $freq(C)=\sum_{n\in words(C)}count(n)$, where $words(C)$ –are nouns with the value *C*; *N* – total number of nouns in text document.

In the paper [9] Ryeznik's metric has been adapted to Wikipedia and informative category was calculated as a function of the hyponyms number (categories in Wikipedia), but not statistically:

$$res_{hypo}(C_1,C_2)=1-\frac{\log(hypo(lcs(C_1,C_2))+1)}{\log(C)},$$

where: *lcs* is the least common subsumer of concepts C_1 і C_2, *hypo* – number of Hyponyms of this subsummer, and *C* – total number of concepts in the hierarchy.

In [10] Lin determines the similarity of objects A and B as the ratio of the amount of information required to describe the similarity of A and B, to the amount of information that fully describes A and B. To measure the similarity between words *lin* takes into account the frequency distribution of words in the text (similar to the measure Reznik):

$$lin(C_1,C_2)=\frac{2\cdot\log(P(C_0))}{\log(P(C_1))+\log(P(C_2))},$$

where: C_0 – nearest common super class in the concept hierarchy for both conceps C_1 і C_2, *P* –probability of concept, calculated on the basisf of his frequency in the text document. It differs from the formula *res* by normalization method, correct computation $lin(x,x)$ (independent of the concept's position in the hierarchy), takes into account existence of common and distinctive properties in objects.

In the paper [4] similarity of the two texts T_1 і T_2 is calculated from the double normalization (the length of the text and using hyperbolic tangent) as:

$$relate_{gloss/text}(T_1,T_2)=\tanh\frac{overlap(T_1,T_2)}{length(T_1)+length(T_2)},$$

$$overlap(T_1,T_2)=\sum_n m^2,$$

where *n* phrases та *m* words overlap.

Thus the analysis showed that no semantic metric is not based on thesauri, only a few of them take into account the taxonomy of concepts.

To say clearly, is introduced the metric on the feature space. In this space is defined the point corresponding to the current problem, and in the frames of this metric is detecting the nearest point to it among the points, which represent the precedents. To each attribute is prescribed weight, considering its relative value. Completely the degree of proximity precedent by all parameters can be calculated by using of generalized formula, which looks like:

$$\sum_k w_k \cdot sim\left(x_{ki}, x_{kj}\right), \ \sum_k w_k = 1,$$

where: w_k – weight of k-feature , sim – function of similarity (metric), x_{ki} and x_{kj} – meaning of the feature x_k for the current problem i of the precedent – j. After the calculating the degrees of proximity, all precedents are ranking. The current situation is referring to the precedent with the highest rank.

Selecting a metric (or degree of proximity) is the central point from which will greatly depend on searching for the relevant precedents. In every particular problem this choice is in its own way, with including the main goals of the research, physical and statistical basis of information etc. As methods for solving such a problems use algorithms such as Lazy-Learning, for example – known algorithms of the nearest neighbor and of the nearest k-neighbors, neural networks, genetic algorithms, Bayesian networks, decision trees.

The main disadvantage of the paradigm of the neural network is the necessity to have a very big amount of training samples. Another significant disadvantage is that the scale of several hundred interneural connections, are not a subject of analysis and interpretation by a human.

The popularity of the decision trees is associated with clearness and clarity. But for them very actual is the problem of importance. The fact is that some nodes on every new-built tree level correspond to less and less number of data records – tree fractions data for a large number of individual cases, so it does not give statistically valid answers. How the practice shows, in the most of systems, which are using decisions trees, this problem can't find satisfactory solution. By the way, well-known, and it's easy to show, that the decision trees give useful results only in case of independent features. Otherwise they only create the illusion of the logical derivation (output).

Genetic algorithms also have several disadvantages. Selection criterion of chromosomes and used procedures are heuristic and don't guarantee to find "better" solution. Besides, efficiently formulate objectives, identify criteria for selection of chromosomes in strength only to the specialist. Because of these factors today genetic algorithms are in need to be treated more like a research tool than as a means of analyzing data for practical application. In our opinion, to get rid of the above disadvantages allow the ontology of the subject area and the ontology of the problems.

APPROACH TO THE CONSTRUCTION OF THE THESAURUS OF SUBJECT AREA

Thesaurus is a list of logical- semantic relations between linguistic terms. This thesaurus embraces not only set of the terms provided in the form of an alphabetical list of their definitions , but also contains the models which represent relationships between terms. Based on the achievements of modern linguistics in a compact and accessible form given interpretation of terminological units from terminological dictionaries and encyclopaedias. The thesaurus contains terms in main research areas of theoretical and applied linguistics: grammar, word formation, lexicology, semantics, lingvosemiotisc, computational linguistics, lexicoghraphy etc. We selected these terms from the abstracts of papers, published in the Ukrainian linguistic periodicals in the 2009-2011.

Building a thesaurus provides for the disclosure of the main types of relations between concepts, the main ones are correlation, synonymy, hiponymy/hyperonymy, holonymy/meronymy. Contents relations expanded so that you can reach the widest layer of terms , which linked the analyzed period as the registry .

Title ratio is double predicate R (A, B), which binds headword article (A) and put this predicate term (B) [14].

APPROACH TO CONSTRUCTION OF SEMANTIC METRICS ON THE BASIS OF THE THESAURUS

For the definition of the importance of the weight of concepts and relations, we are proposing to use the methods of the intellectual data analysis (IDA), such as decisions trees. Using IDA, we define the weight of some subset of concepts, which we are calling – basic. Then based on the ontology of the SA, we will develop the received weights for the whole ontology. This procedure we will make for every precedent. Then for searching the relevant precedent we will use the value of such N_i concepts, which for proper precedent have the biggest weight. As for the importance of the weight of the relations, we are offering to make them like it is shown on the table 2.

We consider, that the weight of the vertical relations (hierarchy, aggregation) is equal to 1, 2 (the more specific, the better). Relations by quantum are not examined, because the synonymy and the harmonization don't make any influence on the value of the attributes. At the same time this is believed to be one and the same attribute.

Table 2. The weights of the importance of relations

Group of relations	Relation	The value of the weights of the importance
Hierarchy	Genus↔species	*1,2*
	Attribute↔the value of the attribute	*1,2*
	Invariant↔variant	*1,2*
Aggregation	Integer↔part	*1,2*
	Object↔the realization space (localization) of the object	*1,2*
	Object↔property/attribute	*1,2*
	level↔one unit of the level	*1,2*
Semiotic	The term↔way of expression	*0,2*
	The term↔way of representation	*0,2*
	The term↔the main mark of the term	*0,2*
Functional	Object of the action↔action↔subject of the action	*1*
	Reason↔consequence	*0,9*
	Condition↔action	*0,9*
	Fact↔action	*0,9*
	State↔action	*0,9*
	Fact↔state	*0,9*
	Tool↔action	*0,9*
	Data↔action	*0,9*

The set of relations R we divide into types (correlation, hyperonymy - hyponymy, synonymy, holonymy-meronymy) - $R=\{R_1,R_2,...,R_k\}$. n_i indicates the number of relations of type R_i in the thesaurus. Then the total number of relations is $N=\sum_{i=1}^{k} n_i$. We consider that the weight of the ratio is more, when this type of relation is more frequent in the thesaurus. This weight of the ratio we define as $L_i=\frac{n_i}{N}$.

Let us weigh our semantic network that sets the thesaurus. For this purpose we define the weight of the relationship between thesaurus terms. The smaller the weight, the terms are more similar. Therefore, the weight oft he arcs of semantic network is defined as inversely proportional to the weight of such ratio that sets this arc: $l_i=\frac{K}{L_i}=\frac{K\cdot N}{n_i}$, where K is some constant that specifies the amount of weight measurement arcs semantic network [15-17].

We use the thus weighted semantic network to find potential partners who are engaged in similar research issues in the subject area for which the thesaurus was built.

To do this, we should define a set of key terms $C=\{C_1,C_2,...C_n\}$ from the thesaurus, which we believe best define specific research issues. Search Engine finds a set of documents, which contain terms from the thesaurus. For each such document T_s we will build a set with capacity m, which contain terms from the thesaurus that are frequently used in the document T_s: $\hat{C}^s=\{\hat{C}_1^s,\hat{C}_2^s,...,\hat{C}_m^s\}$. By the Floyd-Warshall or DEikstra Method [18] we find $n\times m$ of the shortest distance $d_{ij}^s=d\left(C_i,C_j^s\right)$ between terms from sets C and $\hat{C}^s$. Then we calculate the distance to the document found T_s according to the formula: $d^s=\sum_{i=1}^{n}\sum_{j=1}^{m} d_{ij}^s$. We rank found documents according to increasing values d^s. The authors oft the document with the higher rank may be our potential partners [19-21].

CONCLUSIONS

This article contains the approach to construction of semantic metrics based on the thesaurus of linguistic terms. Detailed description of the process of constructing a thesaurus as semantic network is given. It was proposed to build a set of arcs of the network scales as inversely proportional to the number of relations of a certain type. We constructed a semantic metric based on the weighted semantic network. We consider that this metric can be used to find potential partners who are engaged in similar research issues in the subject area for which thesaurus was constructed.

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Problems investment support innovative development of the national economy and solutions

S. Paranchuk[1], A. Korbutyak[2]

1Lviv Polytechnic National University; e-mail: kafedrafin430@mail.ru
2Bukovina State Finance and Economics University; e-mail: Olenets2007@ukr.net

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Abstract. This paper highlights the main problems of investment support innovative development of the national economy. Noted the need for incentives to attract venture capital, create an enabling institutional environment for innovation, fostering innovation at all stages, creating a legal environment conducive to high-tech industries, the development of intellectual property, development of specific infrastructure innovation.

Key words: investment providing, innovation development, innovation activity, the national innovation system, foreign investment, savings, venture capital.

INTRODUCTION

The low level of investment activity in Ukraine is particularly aggravated the global financial crisis caused mainly by factors such as worsening mortgage crisis, high levels of external debt, the failure of Ukraine's commitments to international organizations in the legalization of shadow capital and return on investment, imbalances and instability in investment activity and economic freedom, the outflow of capital, lack of effectiveness of changes in the financial market of Ukraine. This will certainly affect the formation and resource financial system in general and investment support innovation in particular.

The economic development of the country must be accompanied by a steady increase in the competitiveness of industrial products. Basis of national industrial policy should be the establishment of Ukraine as a state with advanced, industry is able to produce the latest high-quality products.

There are two ways to improve the competitiveness of industrial products: lower prices and improve quality [4]. Domestic producers have realized that commercial enterprise can survive only under conditions of continuous improvement of technical, economic, market indices of manufactured products. To solve this problem only through the constant introduction of innovative projects crossing the path of innovative development of the whole industry.

In the current economic conditions appears a problem of finding and effective use of financial resources, the improvement of the financial mechanism of innovation priorities of the national economy.

Addressing the innovative development of the national economy − complicate and lengthy process of overcoming them requires immediate action, raising funds, which determines the relevance of research investment problems of innovative development of the national economy.

Many works of native and foreign scientists such as I. Alekseev, A. Galchinskiy, V. Denysyuk, P. Druker, L. Fedulova, R. Kaplan, M. Kizym, S. Komlev, O. Kuzmin, L. Krushvits, O. Melnyk, D. Norton, V Osetskiy, M. Pashko, M. Porter, N. Chuhray, J. Schumpeter etc. are dedicated to innovative development of the national economy, especially its financial support, solutions to these problems. However, despite the great interest of scientists in solving a given problem and a large number of works devoted to her many problems associated with investing innovation development remain. In particular, there is a need to explore deeper issues of investment innovation. There is a need to identify factors enhance innovation processes and the choice of effective forms of investment innovation [2,3,4,916].

ANALYTICAL INSTRUMENTS

Introduction of innovative technologies aimed at improving the effectiveness and efficiency of management. Thus, effective financial management is

directly related to funding and innovation, providing investment in these innovative programs and projects that provide a high financial return.

Investing innovative processes is risky, but if successful, the return on investment is much greater than the current activity. Typically, companies seek to finance projects with significant potential for efficiency and provide them high profits. It is a scientific and technological innovation, organizational, economic and social spheres. The economic results of their implementation depend primarily on the characteristics of the innovation, but of great importance for the successful implementation of an innovative project with conditions to attract financial resources and, therefore, a source of funding.

V. Denysyuk notes that increasing innovation activity at all levels of the national economy is a priority of state policy. The author notes that funding is fundamentally a factor of innovation, which requires appropriate conditions of formation of investments, reducing the risk of financing innovative projects, optimize the structure, organizational forms and sources of funding. V. Denysyuk emphasizes critical financial support for highly knowledge-intensive industries and stresses the need to increase the volume of private investment in high-tech manufacturing sector. It should agree with the author's conclusions about the need to diversify sources of funding for innovation sector and ensuring the proper and effective use of funds [3].

A. Shnypko proves decisive importance of accumulation of capital in the industry to ensure a high level of competitiveness of the economy. The author notes that this process should be based on technological modernization and improvement of material and technical base of production. It should be noted that the innovative activity gives the opportunity to create "new investment" through the development of innovative technology products, which is the basis for the intensification of economic growth [14].

A. Galchynskiy and S. Levochkin substantiate the importance of national investment model of economic growth. The authors point out that the investment model should provide not only sustainable (long-term) growth but also structural and investment updates economy. I must agree with the authors regarding the direction of increasing financial security that affect the innovative activity of enterprises. Among the areas highlighted the development of technology parks. His study authors demonstrate the importance of intensive technical and technological renovation of production, the underlying structural innovation model of economic growth [1].

L. Fedulova and N. Pashuta say that the problem of financing R & D and innovation are complex. The priority in this area is to determine the optimal balance in the amount of financial resources allocated for the implementation of individual stages of the acquisition, use, and create new knowledge. The authors note that the slow and insufficient volume of financial support in all stages of the innovation process underlying negative trends utilization and development of innovative potential at all levels of the economy. Partly it is necessary to agree with the statement of the authors that the increase in foreign investment is an important factor positive impact on the effectiveness of the innovation process. Foreign investment innovation sector certainly has undeniable benefits for foreign investors mainly focus on long-term infusion of large amounts of money, give advice, know-how and so on. At the same time foreign agents pursue their own interests, as seeking to increase profits from the use of investment resources. They are the owners of that created by the resources provided by them, even if manufactured products or results of the research will be used on the territory of Ukraine. Because of this, foreign investment only partially positive for the national innovation development and can be used in cases of shortage of national investment [16].

O. Lapko notes that the resource potential of the country is the subject of innovation policy. Financing innovation process, as it follows from the study author, is an important factor in improving the efficiency of the national economy. Therefore policy should provide for an increase in financial investment in an innovative sector, primarily by stimulating the private sector to invest. You must use diversified instruments of state influence, form which must be based on international experience and national identity [10].

M. Sharko writes that a model of the national innovation system of Ukraine should include a system of financing innovation that would hide features of modern investment process in the country. From the author's research shows that government involvement in the provision of financial innovation activities of the corporate sector needs to grow primarily not to the extent of direct funding and in the organization, indirect regulation of financial investments and monitoring effective (intended) use of funds.

The effectiveness of innovative development largely depends on the availability of optimal (cost recovery) of investment sources. The term "investment" means investment in all its forms in different objects (tools) its business activities for profit and to achieve other economic or non-economic effects, based on market principles and factors associated with time and liquidity.

When it comes to investing innovation development entities, this process can be described as follows: the process of investing capital (physical, intellectual, etc.) at any changes that lead to the creation of new (better) goods, products, technology, process implementation of new ideas, object embedded to save the others, which will allow domestic enterprises to enter the higher, better, energy and materials retaining level of development.

In today's economy development the key to successful management of domestic enterprises is the

consideration of the features of the process of organization and management, establishment of organizational and management capacity, maximize and optimize the use of investment resources. This is important to establish a resource potential of the company that provided the opportunity to achieve a timely and complete implementation of the goals of innovation development.

One of the main tasks of the resource management in the process of innovation is to ensure the formation of sufficient investment resources according to the projections of innovation. This problem is solved by balancing the amount of attracted investment of resources in all their forms (cash, inventory, intangible) with projections of innovative activity. Important role in the realization of this objective justification schemes of financing plays some real projects and optimize the structure of sources of capital for innovation enterprise as a whole and to develop measures to attract them various forms of capital invested with alleged sources.

Also, the issue of financing of innovative development entities closely associated with the provision of financial balance in the process of innovation. The equilibrium is characterized by a high level of financial stability and solvency of the enterprise at all stages of its development. It is one of the most important conditions for effective implementation of enterprise investment and innovation. This is a significant diversion of resources invested in large amounts and is usually for a long period. In addition, cash flows for innovation differ substantially uneven and highly probable that they will return. Therefore, implementing innovation in all its aspects, entities must predict in advance what effect it will have on the level of financial stability and solvency, and optimize for that purpose structure of capital invested.

Thus, in the process of investing innovative development companies certain tasks must be optimized together to effectively implement their strategic goals. Ranking individual tasks performed by determining the significance of each of the priority given to the position of enterprises and increase their market value.

The results indicate that the unavailability of bank loans to domestic enterprises inability of the state to be an investor, if you have a huge free outflow of funds abroad much weight gain foreign investments.

Making using of successful foreign investment enterprises could expand the total market size of goods, services, labor and thus contribute to the revival of the economy. By way of purchase of shares by foreign investors and enterprises are able to provide start-up capital production facilities that are idle. Foreign investment could be an important factor in economic growth in Ukraine, but did not contribute to this lack of volume and, consequently, a very small proportion of them among the means obtained for the revival of production [11].

In developing countries and in transition economies, foreign investment is considered an important source of organizational and technical innovations. Among domestic scientists, economists and experts widely believed that most foreign investors are able to reorient the economy of Ukraine on innovative rail. However, as the analysis shows, in fact, foreign investment coming to Ukraine remain low and their structure does not allow hope for their innovative nature, due to the unstable political situation in the country and imperfect tax legislation.

It is estimated that annual investment need for foreign direct investment exceeds $ 4 billion. USA. Since independence, Ukraine has been able to attract as of January 1, 2013 only $ 4.1 billion. USA foreign direct investment is 112 dollars per 1 resident of Ukraine. The largest investor countries act Cyprus, Germany, Netherlands, Russia and others. In 2012, the increase of foreign capital amounted to 4681.2 million. Which is 25.3% less compared with their growth in 2010 [17]. In comparison, foreign investment in Poland is $ 40 billion, Hungary - 17 billion. USA.

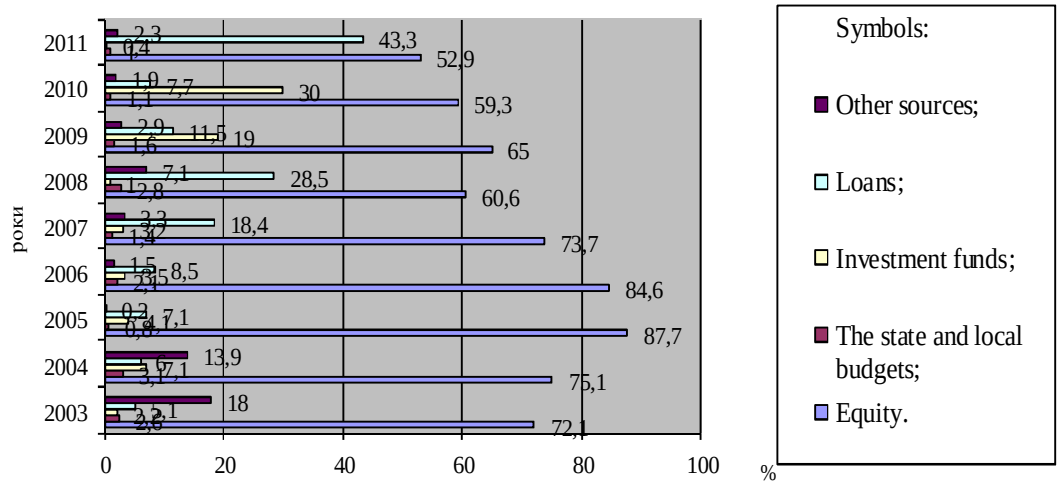
The most attractive for investments in Ukraine are wholesale companies and Brokering - $ 996.3 million USA (15.0% of total investments) and light industry - $ 988.3 million USA (14.8%) [131]. Investment is generally attractive projects that are implemented in such economic activities as metallurgy and metal processing - $ 368.3 million USA (19.2%), light industry - $ 182.9 million USA (13.1%), extraction of power metal - $ 127,3 million USA (8.4%), manufacture of machinery and equipment - $ 101.1 million USA (7.2%), hotels and restaurants - $ 92.7 million USA (6.6%), chemical production - $ 82.8 million USA (5.9%) [5].

In 2001-2011 years was the main source of funding for technological innovation by companies' own funds, whose share in total financing innovative activities ranged from 59.4 (2010) - 87.7% (in 2005), although in 2011 share fell compared to 2010 - by 6.5% (Picture 1).

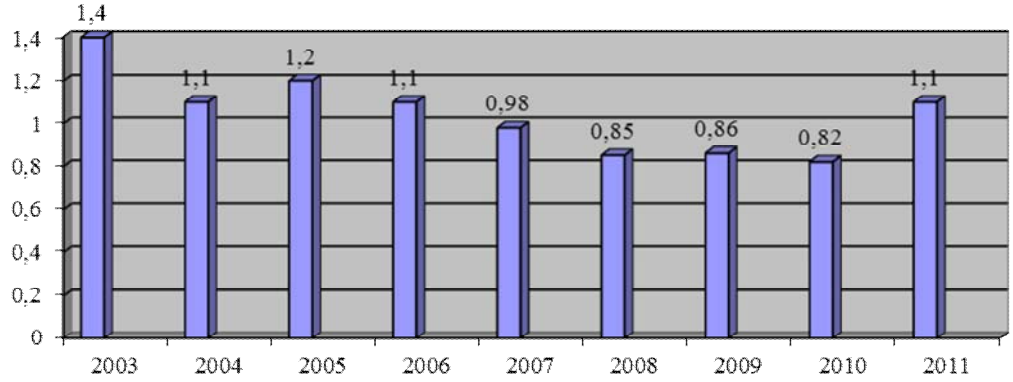
Funding innovative work on the state budget is also characterized by a tendency to decrease: from UAN 336.9 million in 2008 to UAN 149.2 million - in 2011. Moreover, its share was only 1.0% compared to 2.8% in 2008.

In the financing of innovation companies used foreign investors, particularly in the amount of UAN 56.9 million or 0.4% in 2011, which is lower by UAN 2354.5 million or by 29.6% than in 2010, due to the effects of the financial crisis and distrust of foreign investors in the domestic business environment.

The structure of financing innovation in recent years there have been some positive changes, as observed in the dynamics of growth in respect of innovation, as evidenced by an increase in attention from enterprises to the development of innovations. Moreover, despite the negative impact of the economic crisis, funding for innovation has slightly increased: at UAN 6288.4 million. in 2011 compared to 2010.



Picture 1. Financial sources of innovation activity in Ukraine in 2003-2011 years *
**Note: Done with materials of the State Statistics Committee of Ukraine [17]*



Picture 2. The share of funding scientific and technical work in Ukraine's GDP, %*
**Note: Done with materials of the State Statistics Committee of Ukraine [17]*

In spite of the President of Ukraine Decree of 20 August 2001 that the Cabinet of Ministers of Ukraine instructed to provide since 2002 in projects Ukraine's state budget funds for financing scientific and technological activities in accordance with the Law of Ukraine "On research and scientific and technical activities" (1991) of 1.7% of GDP, the actual amount of such state funding is less than a half (Picture 2). The analysis also shows that by far the funding of innovation activity in Ukraine due to the development of III and IV of the technological structures. Hence, emerging economic model, which in its basic characteristics requires innovation does not form an internal effective demand for innovative products, has incentives to invest in human capital.

The effectiveness of innovation and technological development depends on adequate funding. The level of funding for scientific and technological sphere in the modern world is defined objectives that apply to the relevant sectors of the political leadership of a particular State, and is a key factor in realizing these objectives. In particular, if the country's spending on science do not exceed 1.1% of GDP, its scientific potential can realize only a very limited objective functions. Only after going through this index certain threshold (at least 1.7% of GDP), which has a degree of scientific and technological development, can provide real impact of scientific and technological advances on the economy - a prerequisite for the transition to innovative development of society, and its science becomes a direct productive force.

Today in Ukraine own investment resources of enterprises, banks and foreign investment can not ensure economic growth, which necessitates radical revision forms of accumulation and mechanisms of transformation of savings into investment. Problem savings (real investment potential of the country is concentrated in the population is estimated at 20-25 billion dollars USA) as a source of investment is one of the most urgent and difficult in transitional economy [11]

Saving resources or "financial capacity of the population" - is the amount of effective actual demand, which is part of the personal savings of the population in the form of liquid assets and the masses paid in the

period revenues (not yet transformed into elements accumulated assets). [9] On the other hand "financial capacity" - it is not free or cash back (or other highly liquid) public resources that can be directed to different investment objectives.

It is important that in practice monetary savings do not act as a source of investment. Even if people really took the decision to invest, it does not often make it yourself, buying, for example, the securities industry. Most people trust their savings to banks on behalf manage resources. And it is not necessary that banks will invest the money in production. They can use these resources to speculation in the financial markets or, for example, give them to the state debt by purchasing government securities.

Thus, not enough people decided to invest their savings in production, has not left the money in his or offered them a loan state also requires that banks, which in most cases people trust their savings, also took the decision to invest in their production. This requires the creation and maintenance of Ukraine macroeconomic environment that will facilitate the transformation of resources into real investment demand. This state should form the legal field, in the middle of which the investor would be able to realize their economic interests without fear of limiting their rights of ownership and the investor will make a safe investment process and cheapen it by reducing transaction costs.

In a market economy transformation savings through the banking sector is the main condition for expanded reproduction. In transition economies, this transformation is not very active. Moreover, in contrast to a market economy in transition economies banking system provides virtually no capital inflow in the real sector, and its outflow. The volume of capital outflows from the sector of financial speculation abroad through commercial banks is more than half of the accumulation fund in the domestic economy [11].

In solving this problem it is necessary to use foreign experience conducting monetary policy in the restructuring of the banking sector. So, after the Second World War, Japan was a system which by Japan Development Bank, Export-Import Bank of Japan and other public institutions of ensuring economic transformation of savings into investment business. This system continues to function effectively and present. So as the world experience, revive and revitalize the economy without transforming savings into investments possible.

Examine the operation of venture capital funds allow us to draw the following conclusions. Basic research to a greater extent held by the state budget for non-returnable basis. In the second stage, the applied nature study, funded both by the budget (state scientific programs or competitive), and by the customers. At this stage, there is the possibility of losing your investment, so investment in this case is risky in nature. By attracted venture capital funding that actively invests its funds in all phases of commercialization of innovation, and most of all - the stage of development and innovation. In developed countries, placing long-term financial resources in innovation is largely through venture capital.

Especially important venture capital is in high technology for enterprises that plays an important role in the development and introduction of new ideas and new technologies [7]. Such enterprises in developed economies are quite common. In particular, in Canada for the last time, the amount of venture funding has increased dramatically due to the development of the sector in the economy, which is based on high technology. Along with growth in venture funding increases investments in innovation projects. In addition to investment projects already known venture funds involved and the newly created. They not only invest in projects, but also participate in the management, create "incubators" for the maintenance of high-tech firms and companies. Rising quantitative indicators in Canada is accompanied by qualitative changes in the activity of innovative entrepreneurs. In the last three or four years they were much bolder and invest their money in new companies at the earliest stages of their development. It is very important for the development of science-tech sectors of science, and the fact that young innovative companies is possible, if necessary, to attract sufficiently large volume of funds is in the early stages of development. According to experts, to realize their potential high-tech companies at each stage of development should tend increasingly large capital injection [7].

Some venture projects funded by grants through international funds and programs of technical assistance. Most funding for innovative entrepreneurship works in Ukraine through lending business development. Mechanism of earning profit venture funds and banks differ. Venture capital funds provide funds to enterprises on non-returnable basis, and in return they receive securities confirming the right to participate in business and in the distribution of income. Typically, venture funds do not acquire shares in the secondary market, and there are private equity funds. The purpose of the venture business is getting excess profits after technological innovation cycle and simultaneously output from these sector entities after them their mission. This procedure is called "leaving the business venture" and performed in the following forms [15]:

- a public sale of shares;
- sale of shares to a strategic investor;
- sale of shares to financial investors.

Poor business venture in Ukraine is largely due to the poor development of the stock market, making it difficult to profit venture capital by selling its shares. But the main reason which is the most serious to the development of venture funding is a lack of legal

support. Existing legislation in Ukraine in the field of venture capital has not created conditions that would stimulate its development [12].

However, international practice suggests that an important factor activation of innovation is creating a network of venture capital funds. They first appeared in the United States, where today the most developed infrastructure of venture financing. However, the most widespread gained venture capital funding in the UK. According to the Association of European venture capital funds, about half of all Western European venture capital fund is at present the UK. For the survival of venture capital funds during their formation governments of many Western European countries committed full support to this new form of investment. For example, in the Netherlands developed and used a special system of state support for venture capital funds. Under this system, the government guarantees repayment of 50% of the possible losses arising from investments in venture capital funds projects of private companies. This event early 80s spurred the rapid growth of venture capital funds, respectively, active and financial investment in the economy. In Holland, the main investors of venture funds are the big banks and insurance companies. In the UK, such investors are primarily pension funds [13].

As for the stock market, in Ukraine it uses the prospective sources of financing innovation as a means to issue corporate bonds and issue of shares. However, transactions in the securities market, as international practice, are an important financial instrument investment. That is why many scholars are inclined to believe that the essential conditions to attract investment in Ukrainian economy is to increase the efficiency of the securities market and reduce investment risks. Invest ments in real sector through the stock market, attract these goals through the stock market is not speculative domestic and foreign capital have become an important source of new economic growth. Exactly herein setting of securities is creation of a financial mechanism to launch investment for the survival and recovery industry.

Thus, the investment model of development of the national economy is a system of targeted interventions of public authorities to provide innovative economic restructuring. Such a model today should be a core component of domestic and foreign policy of Ukraine. Construction of an innovative economic model in Ukraine and its integration into the European economic space requires significant acceleration of innovation, enhance the impact of innovation on economic growth.

One of the ways to improve the competitiveness of domestic products is to stabilize and increase production with innovative industrial products. To determine ways to stabilize and increase production of innovative products by the authors constructed economic-mathematical models (for enterprises of Ukraine, Chernivtsi region) in which the volume of innovative products (Y1) and made scientific and technical work made (Y2) dependent on the following factors: funding for innovation own resources (X1), state funds (X2), foreign investors (X3) and other funding sources (X4).

Thus, the method of determining the measures to stabilize and increase the volume of innovative products and enterprises of Ukraine and Chernivtsi region by building a linear multiple regression model.

It is clear that for every economic indicator Y, tends to affect not just one, but several factors X1, X2, ..., Xm.

Table 1. Multiple regression models of innovative investment

Characteristics of the models	The determinant of the matrix with the appropriate model	View multiple regression model under certain vectors $\vec{b}^*$
Model of innovation financing in Ukraine at the value Y1	1,29169E +26	Y1 = 2764,163 + 5,109·X1 + 58,454·X2 + 3,538·X3 – 1,614·X4
Model of innovation financing in Ukraine at a value Y2	1,29169E + 26	Y2 = 744,214 + 0,586·X1 + 13,480·X2 + 2,255·X3 – 0,347·X4
Model of innovation financing in the Chernivtsi region at a value Y1	9,27164E + 32	Y1 = 95,823,93 + 2,665·X1 – 16,923·X2 + 0,155·X3 + 2,864·X4
Model of innovation financing in the Chernivtsi region at a value Y2	9,27164E + 32	Y2 = 5755,049 + 0,857·X1 – 2,095·X2 + 1,282·X3 + 0,072·X4

Table 2. The results predicted on the basis Yi indicator constructed models of innovation investment

Description of indicators Yi	The calculated value for the constructed model, 2012	Predicted values for the constructed model, 2013	Projected values built refined model, 2013	Rejection (+, -) 2013 (refined) from 2012
The value of Y1 in Ukraine, mln. UAN	51780,2	52381,94	52824,47	1044,27
The value of Y2 in Ukraine, mln. UAN	9003,1	9102,55	9273,84	270,74
The value of Y1 in Chernivtsi region, ths. UAN	37890,0	40162,15	40277,21	2387,21
The value of Y2 in Chernivtsi region, ths. UAN	35035,0	43120,14	43406,11	8371,11

Using Microsoft Excel after transposition matrix for each model in Ukraine and in the Chernivtsi region we obtain the determinant is different from zero, meaning that there is no multicollinearity bath and data models have their place. Thus, multiple models after transposition will be as follows (Table 1).

After checking the adequacy of models and pairwise kolinearnist using Fisher's exact test was built refined model of innovation investment, in which predicted values of product innovation and research papers on Ukraine, Chernivtsi region next year.

The results predicted values for each multiple linear regression are summarized in Table 2.

Thus, the calculated values for Y2013 built models are virtually identical, indicating that the adequacy of the constructed models and the possibility of their practical application.

Thus there is a significant deviation in terms Y1 in Chernivtsi region, as calculated indicators (coefficient of determination and the Fisher's criterion) show that the cumulative effect of the explanatory variables in the model dependent variable Y is negligible, and therefore the quality of the model in this case is low. Mathematical language - is due to large amplitude oscillations of innovative products in the Chernivtsi region during 2002-2012.

In general, the projections of the point to the positive trend of general indicators of innovative development of the national economy, the volume of innovative products and volume of scientific and technical work under the condition that the funding of innovation activity in Ukraine, including own funds, funds budget and foreign investments will continue to grow. It is therefore advisable to use this model in practice.

Requires time basis for the strategic course of Ukraine, its defining priorities should be the development and implementation of public policies aimed at structural upgrading of industries as soon as possible its transition to an innovative way of development and establishment of Ukraine as a state with what is an extremely important task today.

Revival of investment activity in Ukraine envisages attracting financial resources, new technologies and best practices government cash flows, which will raise the Ukrainian economy. But the development of real events requires constant research issues and trends activation policy in investment activity in Ukraine.

CONCLUSIONS

For a country to be successful in the economic, political and social development, such a system is needed that would strongly stimulated the development and generation of knowledge. For such a system requires a broad application of information and computer technology, the development of research facilities, improving the quality of higher education, a combination of industrial and scientific fields. Moreover, the additional investment in the economy providing goods has early growth through innovation in production.

The investment model of development of the national economy is a system of targeted interventions of public authorities to provide innovative economic restructuring. Such a model today should be a core component of domestic and foreign policy of Ukraine. Construction of an innovative economic model in Ukraine and its integration into the European economic space requires significant acceleration of innovation, enhance the impact of innovation on economic growth.

Experience of other countries shows that one of the most important areas to improve the financial mechanism of investing innovation in times of crisis is, above all, increased regulation of capital investment on the part of the state, which is accompanied by a re-prioritization of public investment and improving procedures requires the allocation of budget funds to implement certain strategic priorities, creating conditions of economic restructuring on the basis of innovation based on existing scientific, technological and innovation capabilities.

Investing Ukraine innovation in modern times of crisis mechanism requires simultaneous funding from various sources, because of the different purposes of investment: initial investment, financing the initial stage, development financing, financing an operation. The principle of multi-source financing (by creating off-budget funds for financing R & D activities through private investments, commercial banks, other financial institutions, the use of financial instruments) is best suited to meet the realities of today, Ukraine's economy.

The article noted the need for incentives to attract venture capital, create an enabling institutional environment for innovation, fostering innovation at all stages, creating a legal environment conducive to high-tech industries, the development of intellectual property, development of specific infrastructure innovation.

The measures for solving the basic problems of investment innovation and the creation of favorable innovation economy as a whole are essential and both require further systematic study and improve in order to solve problems that are as rapid response to new scientific and technological developments and selecting those to be economically viable in the long term.

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Influence of some speed parameters on the dynamics of nonlinear flexural vibrations of a drill column

P. Pukach[1], I. Kuzio[2], Z. Nytrebych[1]

[1]Department of Higher Mathematics, Lviv Polytechnic National University,
[2]Department of Mechanics and Mechanical Engineering Automation,
Lviv Polytechnic National University,
79013 Lviv, Stepana Bandery str., 12, e-mail: ppukach@i.ua

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Abstract. We investigate the influence of the motion of fluid flushing the cutter of a well drilling column, and the angular rotational velocity upon dynamic characteristics of its flexural vibrations. We take into account the nonlinear elastic features of column material. As a base of the research we took the Galerkin method and the Van der Pol method. Combining those two methods made possible to obtain the relations describing the main parameters of the dynamical process in both nonresonance and resonance case.

Key words: nonlinear elastic properties, mathematical model, Galerkin method, Van der Pol method, resonance.

THE URGENCY OF THE TOPIC AND THE PROBLEM STATE

The investigation of dynamical processes in various media and oscillating systems in the applications where one not always can use classical methods of integrating partial differential equations, is an urgent technical-engineering problem. This applies first and foremost to problems describing dynamical processes of longitudinally moving media. It is a matter of longitudinal and flexural vibrations of belt, rope or chain transmissions; pipelines with moving fluid inside; auger machines with viscous or granulated medium moving along; the process of vibroseparation (to a certain extent) etc. As shown in [1-3], the longitudinal component of the media motion velocity affects not only quantitative characteristics of the systems mentioned above, but could also significantly affect the qualitative side of the process – lead to an oscillation stop or stability loss. The fluids being transported by the pipelines or used in technological processes, e.g. in well drilling columns, cause the changes of quantitative, and in some cases qualitative, characteristics of dynamical process. This applies first and foremost to the amplitude-frequency characteristic and the stability of dynamical process. The issues on the influence of constant velocity of the motion of one- and two-dimensional media upon the main characteristics and the stability of its nonlinear vibrations have been studied e.g. in [4–7]. In the case of well drilling columns, the problem gets more complicated because the column performs a rotary motion as well. It is a matter of such plants, in which a combined drill actuator (rotary and hydraulic) is used. In such plants, the fluid moves under a certain pressure with a high velocity. Moreover, interacting with a rock, the drill permanently perturbs the column vibration. All the facts mentioned above imply the urgency of studying dynamics of a drill column allowing for the fluid motion and the angular rotational velocity of the column. ***The aim of the paper*** is developing the methodology of estimating the influence of entire complex of factors (external and internal) upon the dynamic process of the drilling column; obtaining the calculating relations useful for engineering research, which determine the influence of main physico-mechanical, kinematical, geometrical characteristics upon the main oscillation parameters.

PROBLEM STATEMENT

As a mathematical model of flexural vibrations of the well drilling column, rotating with an angular velocity Ω and with incompressible fluid moving along

it with constant relative linear velocity V, we consider the equation:

$$L(u)=(r_1+r_2)\frac{\partial^2 u(x,t)}{\partial t^2}+r_2V\frac{\partial^2 u(x,t)}{\partial t\partial x}-$$
$$-\left(S(x)-r_2V^2\right)\frac{\partial^2 u(x,t)}{\partial x^2}-\frac{\partial S(x)}{\partial x}\frac{\partial u(x,t)}{\partial x}+$$
$$+EI\frac{\partial^4 u(x,t)}{\partial x^4}-(r_1+r_2)\Omega^2 u(x,t)=$$
$$=k_1EI\frac{\partial^2}{\partial x^2}\left(\frac{\partial^2 u(x,t)}{\partial x^2}\right)^3-k_2\frac{\partial u(x,t)}{\partial t}. \qquad (1)$$

In equation (1), $u(x,t)$ is a transverse deviation of the column section with x coordinate at arbitrary instant of time t, r_1, r_2 are respectively masses of length unit of the column and the fluid, moving inside, $S(x)$ is an axial thrust in any column section made by special loads for the pressure on the drill, and the force of column weight, EI is a flexural rigidity of the column, k_1 and k_2 are the coefficients that define deviation of elastic properties of the drilling column material from a linear law and the resistance force respectively. Here the resistance force is assumed proportional to relative velocity of column motion.

Taking into account that the upper part of the column is placed into a bearing with a fixed upper clip, and the lower one gets small horizontal displacement (external perturbations) caused by the interaction of the drill and a rock, we can write down the boundary conditions in the form:

$$u(0,t)=\frac{\partial^2 u(0,t)}{\partial x^2}=0,$$
$$u(l,t)=k_3\sin(pt+q),\quad \frac{\partial^2 u(l,t)}{\partial x^2}=0. \qquad (2)$$

In relations (2) k_3, p, q are constants (amplitude, frequency and initial phase of external periodic perturbation respectively).

In what follows, we assume that the gyroscopic moment is small and neglect one in the motion equations. Also assume that for the drilling column the flat cross-section hypothesis holds, and the reference frame, in which the deflection is registered, is attached to movable vertical plane and coincides with the maximum deflections plane. Besides, assume from now on that the coefficients $k_i, i=1,2,3$ are small in comparison with flexural rigidity.

Note that the issue of substantiation of well-posedness of certain weakly and strongly nonlinear mathematical models of nonlinear oscillating systems has been considered in the works [8–19]. In particular, in those works there have been developed a methodology of investigating the well-posedness (existence and uniqueness of solutions) of mixed problems for quasi-linear and strongly nonlinear evolutional equations of beam vibration type (in the case of presence of dissipative forces in the system) in bounded and unbounded domains.Thus, the problem on investigating flexural vibrations of a well drilling column has been reduced to constructing and investigating the solution of boundary value problem (1), (2).

SOLVING METHODOLOGY

First of all, we shall reduce the problem with nonhomogeneous boundary conditions to simpler one – problem with homogeneous boundary conditions. For this purpose, in equation (1) we shall perform a change of variables:

$$u(x,t)=v(x,t)+k_3w(x,t). \qquad (3)$$

In representation (3), the function $v(x,t)$ is a solution of homogeneous boundary value problem:

$$(r_1+r_2)\frac{\partial^2 v}{\partial t^2}+r_2V\frac{\partial^2 v}{\partial t\partial x}-\left(S(x)-r_2V^2\right)\frac{\partial^2 v}{\partial x^2}+$$
$$+EI\frac{\partial^4 v}{\partial x^4}-\frac{\partial S(x)}{\partial x}\frac{\partial v}{\partial x}-(r_1+r_2)\Omega^2 v=$$
$$=k_1EI\frac{\partial^2}{\partial x^2}\left(\frac{\partial^2 v}{\partial x^2}\right)^3-k_2\frac{\partial v}{\partial t}-L(w), \qquad (4)$$
$$v(0,t)=\frac{\partial^2 v(0,t)}{\partial x^2}=0,$$
$$v(l,t)=\frac{\partial^2 v(l,t)}{\partial x^2}=0. \qquad (5)$$

And the function $w(x,t)$ is a solution of the differential equation:

$$\frac{\partial^4 w}{\partial x^4}=0,$$

under the boundary conditions:

$$(r_1+r_2)\ w(0,t)=\frac{\partial^2 w(0,t)}{\partial x^2}=0,$$
$$w(l,t)=k_3\mathbf{sin}(pt+q),$$
$$\frac{\partial^2 w(l,t)}{\partial x^2}=0. \qquad (6)$$

Considering (6), the solution of the boundary value problem could be found quite easily. Directly we make sure that:

$$w(x,t)=\frac{k_3}{l}x\sin(pt+q). \qquad (7)$$

Considering (4) and the obtained solution (7), to find the function $v(x,t)$ we use the autonomic differential equation:

$$(r_1+r_2)\frac{\partial^2 v}{\partial t^2}+r_2V\frac{\partial^2 v}{\partial t\partial x}-\left(S(x)-r_2V^2\right)\frac{\partial^2 v}{\partial x^2}+$$

$$+EI\frac{\partial^4 v}{\partial x^4}-\frac{\partial S(x)}{\partial x}\frac{\partial v}{\partial x}-(r_1+r_2)\Omega^2 v=$$
$$=k_1 EI\frac{\partial^2}{\partial x^2}\left(\frac{\partial^2 v}{\partial x^2}\right)^3-k_2\frac{\partial v}{\partial t}+$$
$$+\frac{k_3}{l}\left(p^2+\Omega^2\right)\sin(pt+q)-$$
$$-2Vr_2\frac{k_3 p}{l}\cos(pt+q) \qquad (8)$$

in which the function $v(x,t)$ should satisfy the homogeneous boundary conditions (5). It is easy to make sure that the system of functions $\{X_k(x)\}=\left\{\sin\frac{kp}{l}x\right\}$ satisfies the condition:

$$X_k(0)=X_k(l)=X_k''(0)=X_k''(l)=0.$$

This allows expressing the solution of boundary value problem (8), (5) according to Galerkin method in the form:

$$v(x,t)=\sum_k X_k(x)T_k(t). \qquad (9)$$

To find unknown functions $T_\kappa(t)$ in expression (9), we obtain the system of ordinary nonlinear differential equations:

$$\frac{d^2T_k(t)}{dt^2}+\frac{\left(S_0+\frac{r_1 gl}{2}-r_2V^2\right)\left(\frac{kp}{l}\right)^2}{r_1+r_2}T_k(t)+$$
$$+\frac{EI\left(\frac{kp}{l}\right)^4-(r_1+r_2)\Omega^2}{r_1+r_2}T_k(t)=$$
$$=\frac{2k_3}{(r_1+r_2)l}\left\{\frac{k_1 EIl}{k_3}\left(\frac{kp}{l}\right)^8 T_k^3(t)-\frac{k_2 l}{k_3}\frac{dT_k(t)}{dt}+\right.$$
$$\left.+\frac{(r_1+r_2)l}{kp}\left(p^2+\Omega^2\right)\sin(pt+q)\right\}. \qquad (10)$$

In the relation above, we took into account that the axial thrust $S(x)$ changes according to the linear law:

$$S(x)=S_0+r_1 g(l-x),$$

where: S_0 is a constant component of the axial thrust, made by special loads placed in the lower part of the column for the pessure of the drill onto a rock, and $r_1 g(l-x)$ is the force in the column section caused directly by its weight.

Differential equation (10) allows to determine directly the proper frequency w of linear vibrations of the column (without considering the nonlinearly elastic properties of the column material):

$$w=\sqrt{\frac{\left(S_0+\frac{r_1 gl}{2}-r_2V^2\right)\left(\frac{kp}{l}\right)^2+EI\left(\frac{kp}{l}\right)^4-(r_1+r_2)\Omega^2}{r_1+r_2}}. \qquad (11)$$

Note that in formula (11) and below for the sake of more compact expression of the results, we omit the "k" index, which specifies the form of a "dynamical balance".Not less important problem of operation of wells for drilling is studying the influence periodical forces upon nonlinear column vibrations and their stability. It is a matter, first of all, of resonant phenomena prevention. Those problems could be solved mainly basing on constructing a solution of the perturbed equation (10).As it was emphasized before, the coefficients $k_i, i=1,2,3$ are small quantities in comparison with flexural rigidity and other coefficients of the right-hand side of equation (1). This allows for searching for solution of equation (10) to use general approaches for constructing asymptotical solutions of ordinary quasi-linear equations. Below we shall use relatively simple, useful for engineering research, Van der Pol method [20]. According to it, the solution of unperturbed ($k_3\to 0$) equation, which corresponds to equation (10), i.e. $T(t)=a\cos(wt+j)$, could be considered as a solution of perturbed one (with such a difference that parameters a and j would be functions of time). For finding those parameters a and j we obtain the system of ordinary differential equations:

$$\frac{da}{dt}=\frac{-k_3}{(r_1+r_2)l}\left\{\frac{k_1 EIl}{k_3}\left(\frac{kp}{l}\right)^8 a^3\cos^3 f+\right.$$
$$\left.+\frac{k_2 l}{k_3}aw\sin f+\frac{(r_1+r_2)l}{kp}\left(p^2+\Omega^2\right)\sin(pt+q)\right\}\sin f,$$
$$\frac{dj}{dt}=\frac{-k_3}{(r_1+r_2)al}\left\{\frac{k_1 EIl}{k_3}\left(\frac{kp}{l}\right)^8 a^3\cos^3 f+\right. \qquad (12)$$
$$\left.+\frac{k_2 l}{k_3}aw\sin f+\frac{(r_1+r_2)l}{kp}\left(p^2+\Omega^2\right)\sin(pt+q)\right\}\cos f$$

where: $f=wt+j$.

For differential equations (12), we shall consider two cases: nonresonant case $rw\neq sp$ and resonant case $rw\approx sp$.

In the nonresonant case, the amplitude and the phase of the dynamical process in the first approximation does not depend on a harmonic perturbation. This allows, without loss of accuracy of approximation, to average the equation (12) by the phases of proper vibrations f and forced ones $J=pt+q$. Therefore, in nonresonant case, the dynamical process is described by the relation as follows:

$$\frac{da}{dt}=-\frac{k_2 w}{(r_1+r_2)p}a,$$
$$\frac{df}{dt}=\frac{-\bar{k}_1 EI}{(r_1+r_2)}\left(\frac{kp}{l}\right)^8 a^2+\ldots$$

As to the case of main resonance, introducing in (12) the phase difference $g = f - J$ of proper and forced vibrations, i.e. $f = g + J$, $J = pt + q$, we obtain:

$$\frac{da}{dt} = \frac{-k_3}{(r_1 + r_2)l}\left\{\frac{k_1 EIl}{k_3}\left(\frac{kp}{l}\right)^8 a^3 \cos^3(g+J) + \right.$$
$$+\frac{k_2 l}{k_3} aw \sin(g+J) +$$
$$\left. +\frac{(r_1 + r_2)l}{kp}\left(p^2 + \Omega^2\right)\sin J\right\}\sin(g+J)$$
$$\frac{dg}{dt} = w - p - \frac{k_3}{(r_1 + r_2)al}\left\{\frac{k_1 EIl}{k_3}\left(\frac{kp}{l}\right)^8 a^3 \cos^3(g+J) + \right.$$
$$+\frac{k_2 l}{k_3} aw \sin(g+J) +$$
$$\left. +\frac{(r_1 + r_2)l}{kp}\left(p^2 + \Omega^2\right)\sin J\right\}\cos(g+J). \qquad (13)$$

The fact that the resonant process largely depends on the phase difference of proper and forced vibrations, allows to simplify relations (13) slightly. Actually, the averaging of system of differential equations (13) by the phase of forced vibrations would not change the approximation accuracy. This allows to replace that system by the following one:

$$\frac{da}{dt} = -\frac{k_2 w}{(r_1 + r_2)p} a + \frac{k_3}{kp}\left(p^2 + \Omega^2\right)\cos g,$$
$$\frac{dg}{dt} = w - p - \frac{k_1 EI}{(r_1 + r_2)}\left(\frac{kp}{l}\right)^8 a^2 -$$
$$-\frac{k_3}{kp\,a}\left(p^2 + \Omega^2\right)\sin g.$$

The last equations determine the resonant curve:

$$-\frac{k_2 w}{(r_1 + r_2)p} a + \frac{k_3}{kp}\left(p^2 + \Omega^2\right)\cos g = 0,$$
$$w - p - \frac{k_1 EI}{(r_1 + r_2)}\left(\frac{kp}{l}\right)^8 a^2 -$$
$$-\frac{k_3}{kp\,a}\left(p^2 + \Omega^2\right)\sin g = 0.$$

Below there is given a graphical representation of dependence of the proper frequency w of linear column vibrations on other parameters of the oscillating system. On Fig. 1 we give a graphical dependence $w = w(\Omega,\ V)$ under: $\rho_1 = 35\frac{kg}{m}$, $r_2 = 35\frac{kg}{m}$, $l = 50\ m$, $EI = 2{,}85 \cdot 10^6\ Nm^2$, $S_0 = 1000\ N$, $k = 1$, $g = 9{,}8\frac{m}{s^2}$.

On Fig. 2 we give a graphical dependence $w = w(\Omega,\ l)$ under $r_1 = 35\frac{kg}{m}$, $r_2 = 35\frac{kg}{m}$, $V = 0$, $EI = 2{,}85 \cdot 10^6\ Nm^2$, $S_0 = 1000\ N$, $k = 1$, $g = 9{,}8\frac{m}{s^2}$.

On Fig. 3 we give a graphical dependence $w = w(V,\ l)$ under $r_1 = 35\frac{kg}{m}$, $r_2 = 35\frac{kg}{m}$, $\Omega = 10\ s^{-1}$, $EI = 2{,}85 \cdot 10^6\ Nm^2$, $S_0 = 1000\ N$, $k = 1$, $g = 9{,}8\frac{m}{s^2}$.

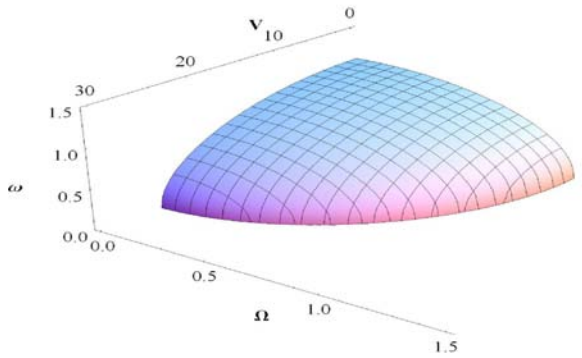

Fig. 1. Graphical dependence $w = w(\Omega,\ V)$

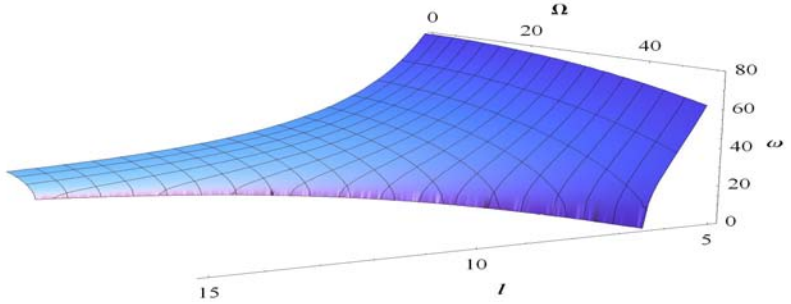

Fig. 2. Graphical dependence $w = w(\Omega,\ l)$

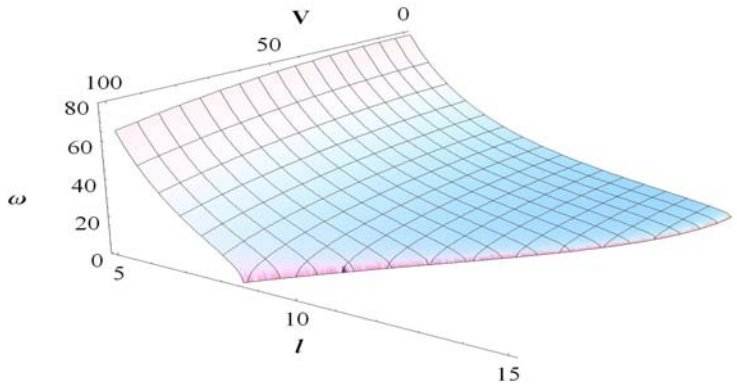

Fig. 3. Graphical dependence $w = w(V,\ l)$

CONCLUSIONS

From the obtained results we conclude that:

a) for greater values of the angular rotational velocity of the column and the fluid motion velocity, the proper vibrations frequency of the column becomes less,

b) under the constant angular rotational velocity of the drilling column Ω_1, the oscillation stop comes when the fluid longitudinal motion velocity equals to:

$$V_{cr} = \sqrt{\frac{S_0 + \frac{r_1 g l}{2} + EI\left(\frac{kp}{l}\right)^2 - (r_1 + r_2)\Omega_1^2\left(\frac{l}{kp}\right)^2}{r_2}},$$

c) under the constant fluid motion velocity V_1 along the tube of the drilling column the oscillation stop comes when the angular rotational velocity equals to:

$$\Omega_{cr} = \left(\frac{kp}{l}\right)\sqrt{\frac{S_0 + \frac{r_1 g l}{2} - r_2 V_1^2 + EI\left(\frac{kp}{l}\right)^2}{r_1 + r_2}}.$$

The obtained results should be considered in the drilling technological processes, because the oscillation stop is closely connected with such negative phenomenon as the loss of stability of the process. Moreover, the relations obtained show the ways of preventing the oscillation stop: if the technological process allows the column rotation with angular velocity near Ω_{cr} then the fluid should be delivered with linear velocity different from (less than) V_1 and vice versa, if the fluid motion velocity in the tube equals V_{cr} then the angular rotational velocity of the drilling column should be less than Ω_1.

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Theoretical approaches to communications management in IT industry of Ukraine

V. Semenyshyn[1], I.Oleksiv[2]

[1]Department of Management, Lviv National University Named Ivan Franko
email: semenyshyn@gmail.com
[2]Department of Management and International Business
Lviv Polytechnic National University, mail: ihoroleksiv@yahoo.com

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Abstract. In this article the theoretical approaches to communications management on the labour market of Ukrainian economy are presented. Moreover, the process of communications management on IT industry labour market is analyzed at macro- and micro- levels. Furthermore, the influences of methods of the state regulation on communications processes management of IT industry are discusses in the article.

Key words: communications, communications management on labour market, methods of communications management.

The quality of communications processes is one of the factors of effective market functioning. Hence, the communications management on a certain market is a complicated problem which requires a constant research. Even more complicated and peculiar problem is communications processes management on a market of specific means of production. The aim of this research is to examine the communications processes on IT industry labour market of Ukraine.

The problem of communications was examined by many authors, such as [1–9]. Mentioned authors made a classification of communications, developed methods to communications management on micro level, methodical recommendations to increase effectiveness of communications processes at micro level etc.

Moreover, many authors studied the problems of labour market functioning in Ukraine and abroad. The following authors conducted the research [10-14].

Nevertheless, the question of communications management on IT industry labour market at macro level is not fully researched.

Therefore, the aim of this research is the formation of theoretical approaches to communications management on IT industry labour market at macro level.

It should be taken into account, that the communications processes management on IT industry labour market can be performed at both – macro and micro levels. It is important to note that this research is conducted at macro level. However, using of some methods of state regulation leads to changing of the system of communications processes management of IT industry labour market at micro level, i.e. actions of the state often support the changing of approaches which are used by entities of communication processes. For the purpose of this research it is important to conduct it at both – macro and micro levels. The latter includes the study of influence of solutions (the using of methods of state regulation) which are adopted at macro level to systems of communications management carried out at micro level.

Therefore, it is reasonable to conduct the analysis of communications management system according to the following sequence that is shown on Fig. 1.

The sequence depicted on Fig. 1 contains the preceding analysis of levels of communication management on the IT industry labour market. Depending at the level of communications management, the list of entities involved in it and methods which can be used for communications management changes.

During the research of the characteristics of communications management on IT industry labour market, it is sensible to define levels at which the

management process is implemented. As stated above, the communications processes management can be performed at micro and macro levels. Depending on the level of communications processes management on IT technology labour market, the entities who provide the management processes and objects on which the management methods and methods which allow to spread influence of former on the latter will be undergoing changes. The management of communication processes on IT industry labour market at macro level of Ukrainian economy is shown on Fig. 1.

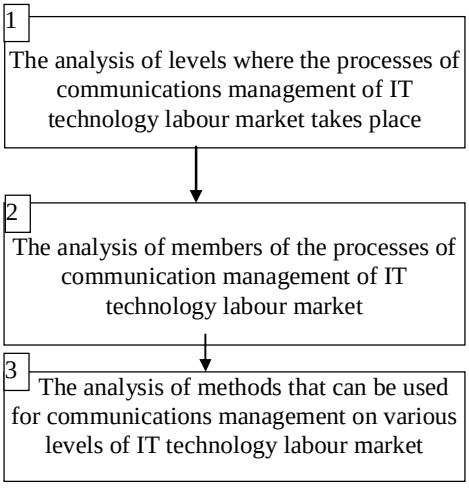

Fig. 1. The sequence of research of the system of communications management on the IT industry labour market
Note: developed by the author

It has to be stressed that nowadays the actual communications management at macro level is practically not performed. The communications management at macro level is basically restricted to state regulation using economic, administrative and judicial methods which can affect the intensity of communication processes on labour market of Ukrainian economy.

The study of communication system of IT industry labour market and also the research conducted in the first chapter of this article help to classify entities of communications management at macro level (Table. 1).

The analysis of entities who perform management (regulation) of the communication system of IT industry labour market on the macro level is given below:

- The president of Ukraine by passing ordinances which are directed at improvement of IT industry in general or its labour market in particular;
- Verkhovna Rada of Ukraine by passing the laws which are directed at improvement of IT industry in general or its labour market in particular. For instance, in 2012 the following law of Ukraine was passed "About the state support of the development of software industry" [17], in which the main directions of IT industry development in Ukraine are described;
- The Cabinet of Ministers of Ukraine regulates the functioning of IT industry by enacting regulations and orders which are directed at the improvement of IT industry in general or its labour market and communicative system in particular. For example, in the regulation enacted by the Cabinets of Ministers of Ukraine on September 21, 2011 N 1036-p "About the approval of actions for providing the development of education in Information Technologies industry until 2013" [18] the main regulations for the ministries and departments about the development of education standards in IT industry are stated;
- The Ministry of Social Policy of Ukraine controls the IT industry by issuing ordinances, which are directed at the Ukrainian labour market in general but some specific industry (in this case - IT), in particular;
- State Employment Office of Ukraine affects the IT industry labor market by creating the conditions for the exchange of information between employers and potential employees. It should be added that the websites of the State Employment Office of Ukraine [19] and Lviv Regional Employment Center [20] contain the information about open vacancies on the labour market including IT industry, as well as the information that helps potential employees in their job hunting process.

At the macro level, the indirect way of communications management (regulation) on the labour market of Ukrainian economy can be used by the Ministry of Education and Science of Ukraine, which accepts regulations that recognize the relationship between the higher educational establishments (universities) and enterprises and thus affect the information transmission between those entities. Moreover, the Ministry of Education and Science of Ukraine forms the industry standards for teaching courses in IT field in Ukrainian universities.

The analysis of literature [15, 16] revealed that the management of communication system of IT industry labour market by carrying out of the state regulations can be performed either by direct influence on the entities of communication system or by indirect (economic) stimulation of labour market entities who carry out the state politics on this market.

The basic communication management at micro level is reduced to classical influence of controlling system on controlled one [3, 6, 9]. It should be emphasized that at micro level (the carrying out of the management process at some organization) the management (the influence of controlling system on controlled) is carried out using standard procedure, i.e.: on the first stage the planning, organization, motivation and controlling functions of management are implemented; the result of implemented management functions is the formation of methods of management

(economic, social-psychological and administrative) on the basis of which the management decisions are made on the last stage. The process of management at micro level is described in [3; 6; 9]. On the Fig. 3 the process of communication management of IT industry labour market at micro level is shown.

In this research, the process of communications management at micro level is crucial from the perspective of studying the influence of state regulation politics of the labour market on the communications management systems of the separate business entities.

Table 1. The list of entities who perform the communications management on the IT industry labour market at macro and micro levels

Entities who perform communications management on the IT industry labour market at macro level	Entities who perform communications management on the IT industry labour market at micro level
• The president of Ukraine • Verkhovna Rada of Ukraine; • The Cabinet of Ministers of Ukraine; • The Ministry of Social Policy of Ukraine; • State Employment Office.	• Enterprises; • The association of Information Technology enterprises and their employees; • Higher Educational Establishments; • Recruiting agencies; • Staff recruitment agencies.

Note: developed by the author based on the analysis of literature [6; 9].

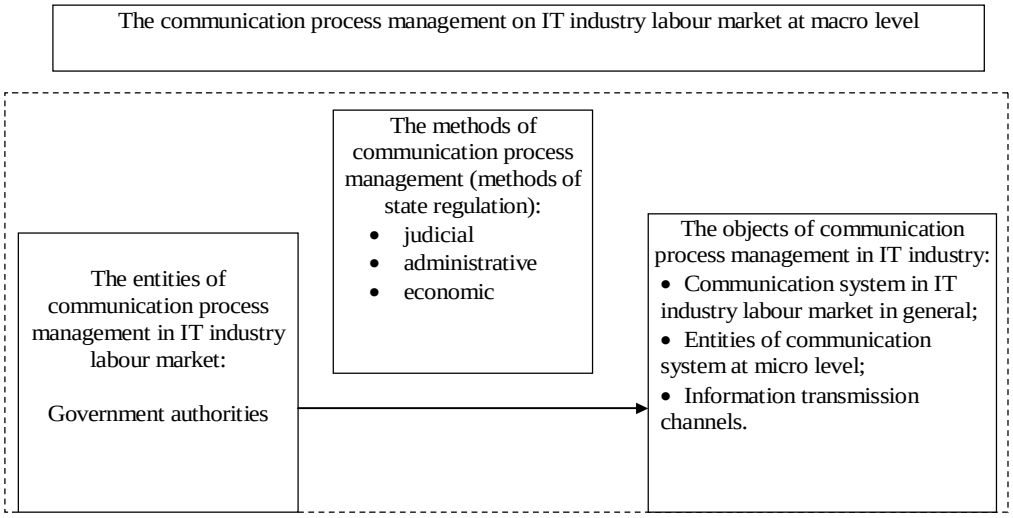

Fig. 2. The communication process management on IT industry labour market at macro level
Note: developed by author based on the study of literature [15; 16].

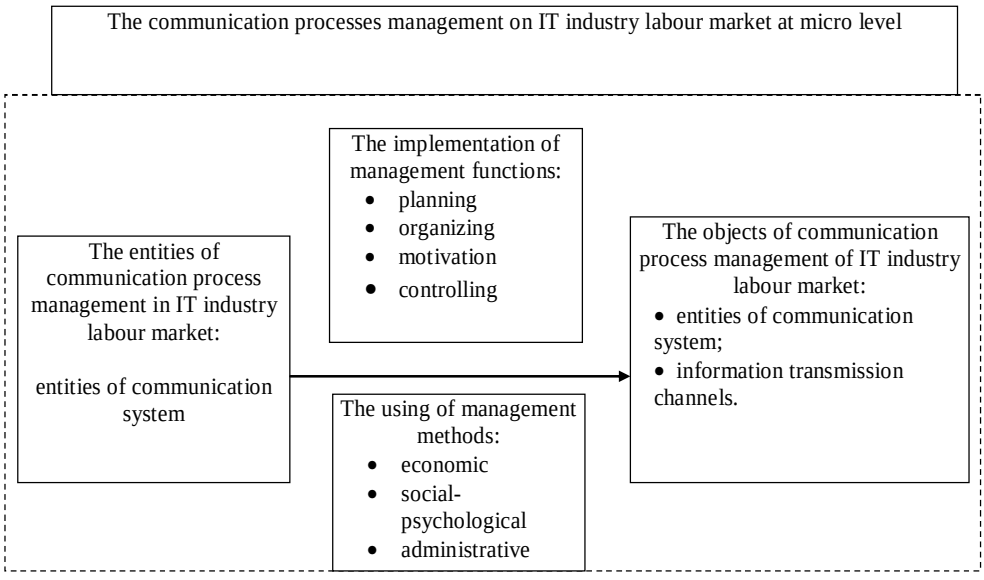

Fig. 3. The communication processes management on IT industry labour market at micro level
Note: developed by author based on the study of [3; 6; 9].

The study of the communication system of the Ukrainian IT industry labour market resulted in identification of communications management entities at micro level.

At micro level all entities of communication processes, who take part in the formation of communication system of the market, control the IT industry labour market communication processes.

A detailed list of communication management entities at micro level of IT industry is given below:

- the enterprises that employ employees. The biggest IT industry enterprises nowadays are: SoftServe, Ciklum, Luxoft, Eleks, GlobalLogic, EPAM, ISD, ABT Solutions, Acobby, Ainstainer Group, Lohika, Malkos UA, Marka Software, Master Of Code, MediaLine, Mindsfromua, MindWorks, Miratech Corporation, SoftUkraine, Acceptic, Softwarium, Sterch LTD, Synchron, TEAM International, TechInsight, TechnoPark Corp. Apart from that, the main enterprises in Lviv and Lviv district are: Arivo Solutions, Eleks, Itera Consulting, Lohika, N-iX, SoftServe, Symphony Solutions;
- the association of enterprises and employees of the IT industry. There three associations of enterprises and employees of the IT industry existing today in Ukraine. It has to be emphasized that the associations of enterprises protect the interests of employers on the labour market. In the meantime, the activity of employees associations is directed at the protecting the rights and interests on the IT industry labour market. There are the following associations of enterprises in IT industry: Ukrainian Hi-Tech Initiative [21], which is the leading Ukrainian association of software developers and also enterprises that have foreign customers. As for today, Ukrainian Hi-Tech Initiative has more than 70 enterprises where almost 8500 professional employees work. IT Ukraine [22] – this is an association that has approximately 25 enterprises-software providers. Also the IT industry employees association is DOU [23],which has almost 20000 members;
- Universities, which provide IT industry market with IT specialists. The analysis of universities revealed the following results: there are such leading universities that train IT specialists: Taras Shevchenko National University of Kyiv, National Technical University of Ukraine “Kyiv Polytechnic Institute”, National Technical University “Kharkiv Polytechnic Institute”, National University “Lviv Polytechnic”, Ivan Franko National University of Lviv etc. The collaboration of the universities with the IT industry labour market is carried out in two directions: forming of the educational programs that train IT specialists and the organization of career fairs to form the possibilities for their graduates to get a job in one of the leading Ukrainian IT companies. The analysis of work of Ukrainian universities gives the following result – it is reasonable to carry out the formation of IT curriculums based on the competence approach. It means that universities form their curriculum taking into account the representatives of leading IT companies;
- the main recruiting agencies which take part in management of IT industry labour market are: recruiting agency Business Support Center “NewBiznet”, The "Alternativa"All-Ukrainian Recruitment Agency, “Shans” Recruitment Agency, “Venture” Recruitment Agency, “Bez Problem” Recruitment Agency, «Brainsource» Recruitment Agency , “Maksimus” Recruitment Agency. These companies search employees for the leading Ukrainian IT companies;
- the main staff recruitment agencies which take part in management of IT industry labour market are: staff recruitment agency “Artel”, staff recruitment and consulting agency «Profi-Service», staff recruitment agency “Garant», staff recruitment agency “Sontur”, staff recruitment agency “Sana-Center”.

Based on these results, it is reasonable to implement the analysis of communication system management system by studying of the communications systems management at both – macro and micro levels.

It has to be emphasized that, the using of judicial, administrative and economic methods of state regulation of IT industry market can often have not the direct influence on the entities of communication system but indirect, that is forming of the necessity for the entities of labour market communication system to change the systems of communication management at micro level which will implement the state policy on the labour market of Ukrainian economy in the future. In the indirect approach the implementation of the state policy of communication processes management on the IT industry labour market is carried out using the scheme, which is presented in Fig. 4.

For instance, the introduction of the competence approach in the development of the universities curriculum which trains specialists of IT industry contributes to the necessity of universities to plan communications with enterprises-future employers of their graduates. The aim of those communications is mainly the gaining of information concerning competence which the graduates are supposed to have for the successful employment at software development companies.

Hence, the previously mentioned universities which train IT specialists must plan seminars, meetings, conferences, to share information about competences which are essential to the employers for the successful employment of future graduates.

The introduction of competence approach in forming of the university curriculums for training of the IT specialists is the administrative method of state regulation, which is the factor of alteration of the planning systems, organization and controlling of the communicative systems entities on the labour market (uni-

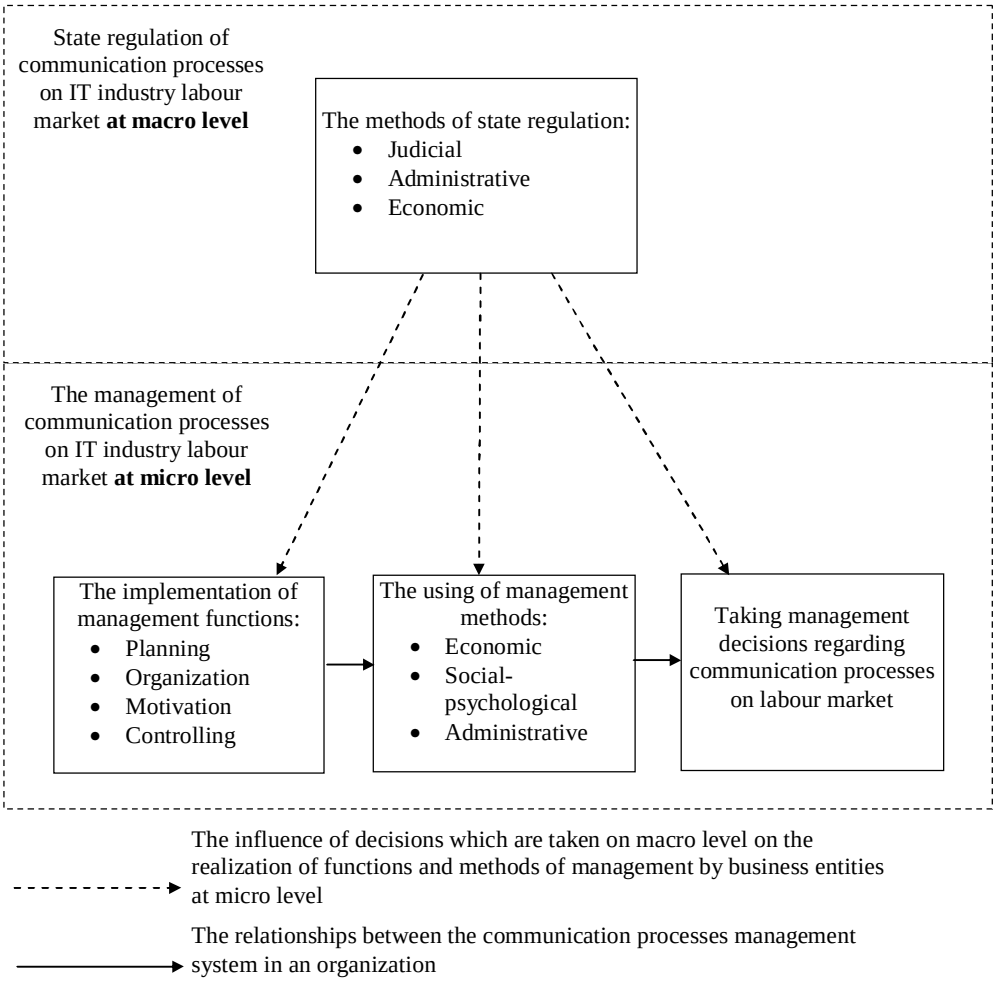

Fig. 4. The relationship between the state regulation of communicative processes on IT industry labour market at micro level and the system of communications management of a certain business entity at micro level
Note: developed by the author

versities). Simultaneously, the changing of those systems leads to the change of management methods which are used by universities in the realization of the management functions and changing of the management decisions that are taken due to the realization of management functions and making the management decision.

The presented theoretical approaches to the communications management on the IT industry labour market at the macro and micro levels will help to enhance the effectiveness of communication processes and also will contribute to the improvement of effectiveness of the IT industry functioning.

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Optimization of linear parametric circuits in the frequency domain

Yu. Shapovalov, B. Mandziy, D.Bachyk

Lviv Polytechnic National University
S.Bandery 12, 79013 Lviv, Ukraine

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Abstract. The possibility of application of the frequency symbolic method of analysis of linear parametric circuits to the decision of optimization tasks is considered. There are examples of optimization of single- and double-circuit parametric amplifier using the objective function based on the calculation of parametric transfer function of a circuit with a symbolic representation of the parameters of the parametric capacity. By the frequency symbolic method the parametric transfer functions are approximated by trigonometric polynomials of Fourier.

Key words: symbolic frequency method, objective function, function – characteristics.

INTRODUCTION

In [1,2] described symbolic frequency method (FS-method), which showed high efficiency of analysis of established modes of parametric linear circuits in the frequency domain. The FS-method is based on the solution of the so-called equation of L.A.Zade [3] and approximations of a transfer function $W(s,t)$ of a linear parametric circuit by trigonometric polynomial of Fourier which it is convenient to represent to the complex form:

$$\hat{W}(s,t) = W_0(s) + \sum_{i=1}^{k}\left[W_{+i}(s)\cdot\exp(+j\cdot i\cdot\Omega\cdot t) + W_{-i}(s)\cdot\exp(-j\cdot i\cdot\Omega\cdot t)\right], \quad (1)$$

where: $s = jw$ - the complex variable of the Laplace transform, t - time, $T = 2p/\Omega$ - period of change of parameter of parametric element, k - the number of members in approximating polynomial. The solution of the differential equation of L.A.Zade for approximation of the solution by expression (1) is translated in the solution of system of the linear algebraic equations that are independent of a time (SLAE) [2], usually, by that, s and some or all parameters of elements of circuit are given by symbols (the variable t is present only in the exponential term of (1) and also symbolic). The result of solving SLAE is a searched fractional rational expressions $W_0(s)$, $W_{+i}(s)$, $W_{-i}(s)$ of approximating polynomial (1). The value k is chosen such that provides the necessary accuracy of coincidence functions $W(s,t)$ and $\hat{W}(s,t)$ [1,2].

The present paper to determine the optimal values of parameters of elements of para-

metric circuit are used mentioned transfer functions. Calculations carried out in environment of MATLAB 7.6.0 using the program SAPC [4].

THE FORMULATION OF OPTIMIZATION TASK

Usually in optimization tasks the objective function (optimality criterion) is the function that evaluates the quality of the optimization and implies the existence of the varied parameters whose values in process of optimizing changing and affect the value of the objective function. The solution of optimization task deem such final values of varied parameters providing the minimum (maximum) value of the objective function at specific limitations.

During optimization of characteristics of electrical circuits formation of objective function are often is done via the other two functions - the function of goal that is defines of desirable characteristics of circuit (goal of optimization), and function- characteristics of circuit by the selected values of the varied parameters. Function of goal is determined in the space of independent variables, in our case, a complex variable s and time t and does not depend on varied parameters. Function-charac-

teristics of circuit determined by in the space of the same independent variables s and t, however, depends on the varied parameters. The degree of coincidence of these two functions - the function of goals and function characteristics - is objective function which is formed on their basis by the chosen method [5]. Thus coincidence determined by for a number of specific values of the independent variables $s_i = jw_i$ and t_j, which is usually in the optimization process are fixed, and thus objective function is a function only the varied parameters.

In this paper the objective function F formed on the basis transfer functions of the form (1). Let us consider that the parametric element of the circuit is parametric capacity, which periodically varying in time t according to the expression:

$$c(t) = c_0(1 + m \cdot \cos(\Omega \cdot t)). \quad (2)$$

Parameters c_0 and m choose the varied, so in the calculation the transfer function of circuit they should be left in the form of symbols. By changing the latter necessary determine such optimal values of c_0^* and m^*, that are providing maximum coincidence module M_W transfer function of circuit $W(c_0, m, w, t)$ with module $M_0(w,t)$ given function in the frequency w_i and time t_j points, though, by the criterion of minimum of sum of squared deviations [5]:

$$F(c_0, m) = \sum_{i=1}^{p} \sum_{j=1}^{q} \left(M_W(c_0, m, w_i, t_j) - M_0(w_i, t_j) \right)^2 . \quad (3)$$

In this way, the functions $M_0(w,t)$ and $M_W(c_0, m, w, t)$ - is a function of goal and function-characteristics, respectively. Thus, solving of optimization task is to determine the values of c_0^* and m^* that provide minimum value of objective function $F(c_0, m) = F_{\min}$ with restrictions $c_0 > 0$, $0 < m < 1$.

THE PROCEDURE OF OPTIMIZATION

The procedures of optimization are implementing by the following method:

1. The function of goal $M_0(w,t)$, as a function of two variables, set by plural of values in a discrete of points w_i, t_j as a surface in coordinates of frequency-time.

2. The function characteristics of circuit $W(c_0, m, w, t)$ we determine by the frequency symbolic method in the form of (1) provided that the varied parameters are given in symbols. According the obtained expression we calculate the set of values of the function characteristics in the same discrete points w_i, t_j that the function of goal, but with unknown (the varied) parameters given in symbolic form.

3. The objective function $F(c_0, m)$ F (optimality criterion) are forming as the sum of squares of deviations between the values of the function-characteristics and function of goal at selected discrete points w_i, t_j ,as surface in coordinates of the varied parameters.

4. The minimum value of the objective function defined by one of the selected optimization methods determines desired values the varied parameters.

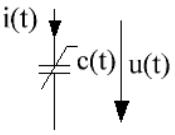
5. As a limitation, the value unknown parameters are selected based on the capabilities of their physical implementation and ensure stability established mode of circuit.

Optimization in the following examples done by the tools of MATLAB 7.6.0 functions [6,7]: «fminunc», «fminsearch» and «patternsearch».

THE EXAMPLES OF OPTIMIZATION OF LINEAR PARAMETRIC CIRCUITS

Example 1. Let the parametric circuit represents a separate parametric capacity $c(t)$ from fig.1. Necessary to determine the value of c_0^* and m^*, that the provide minimum of objective function $F(c_0, m) = F_{\min}$ for the input resistance of circuit.

Fig. 1. Parametric capacity $c(t) = c_0(1 + m\cos(\Omega \cdot t))$, $\Omega = 1 rad/s$



Parametric transfer function of the input resistance $Z(s,t)$ of the given circuit has the exact solution in the form:

$$Z(s,t) = \frac{U(s,t)}{I(s)} = \frac{1}{s \cdot c(t)} =$$

$$= \frac{1}{j \cdot w \cdot c_0(1 + m\cos(\Omega \cdot t))} . \quad (4)$$

According to expression (3) we form the objective function:

$$F(c_0, m) = \sum_{i=1}^{23} \sum_{j=1}^{32} \left(M_Z(c_0, m, w_i, t_j) - M_0(w_i, t_j) \right)^2 , \quad (5)$$

where: $M_Z(c_0, m, w_i, t_j)$ - function characteristics, which is a module of the transfer function $Z(c_0, m, w_i, t_j) = \frac{1}{j \cdot w_i \cdot c_0(1 + m\cos(1 \cdot t_j))}$ of circuit when $w = w_i$, $t = t_j$ and $M_0(w_i, t_j)$ - function of goal, which is a module of the transfer function $Z_0(w_i, t_j) = \frac{1}{j \cdot w_i \cdot 1 \cdot (1 + 0.1 \cdot \cos(1 \cdot t_j))}$ of circuit when $c_0 = 1\text{F}$, $m = 0{,}1$ in the points $w = w_i$, $t = t_j$.

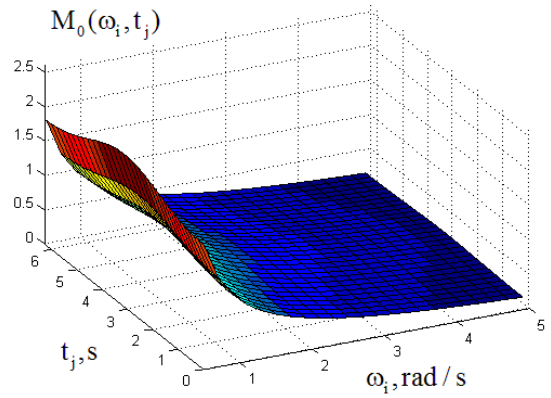


Fig. 2. Module $M_0(w_i,t_j)$ function of goal of parametric capacity

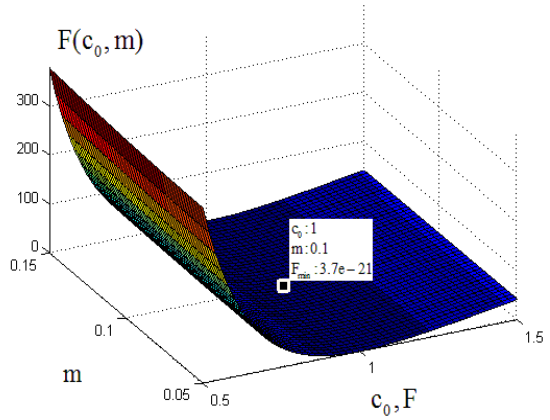


Fig. 3. The objective function $F(c_0,m)$ in the coordinates c_0 and m

On fig.2 shown a graphic view of module $M_0(w_i,t_j)$ of function of goal for values t_j and w_i selected accordingly within the limits 0.5 – 5 s with a step 0.2 s and 0 - 6.28 rad/s with a step 0.2 rad / s. On fig.3 shown a graphic view of the objective function $F(c_0,m)$ for values c_0 within the limits 0.5 - 1.5 F with a step 0.02 F and values m within the limits 0.05 - 0.15 with a step 0.002 for the same values of t_j and w_i, respectively.

Function of optimization «fminunc» when the initial values $c_0 = 0.6$ F and $m = 0.05$ for the 7 iterations has identified a minimum $F_{\min}$ for $c_0^* = 1$ F and $m^* = 0.1$ is marked on fig.3 by symbol ▣. Functions of optimization «fminsearch» and «patternsearch» with the same initial values of $c_0 = 0.6$ F and $m = 0.05$ have given the same values $c_0^* = 1$ F and $m^* = 0.1$ for 40 and 82 iterations, respectively.

Example 2. Determine the value of c_0^* and m^*, which provide minimum of the objective function $F(c_0,m) = F_{\min}$ for parametric transfer function $Z(s,t) = U_2(s,t)/I(s)$ of single-circuit parametric amplifier of fig. 4. According to FS-method [1,2,4] parametric transfer function $Z(s,t)$ has the form:

$$Z(m,c_0,s,t) = \frac{U_2(s,t)}{I(s)} = Z_0(m,c_0,s) + Z_{-1}(m,c_0,s)\cdot$$

$$\cdot \exp(-j\cdot\Omega\cdot t) + Z_{+1}(m,c_0,s)\cdot\exp(j\cdot\Omega\cdot t)\,. \qquad (6)$$

Fractional-rational expressions $Z_0(m,c_0,s)$, $Z_{-1}(m,c_0,s)$, $Z_{+1}(m,c_0,s)$ are not present due to their cumbersome (they are given in [4]).

According to expression (3) we form the objective function:

$$F(c_0,m) = \sum_{i=1}^{5}\sum_{j=1}^{11}\left(M_Z(c_0,m,w_i,t_j) - M_0(w_i,t_j)\right)^2, \quad (7)$$

where: $M_Z(c_0,m,w_i,t_j)$ - function characteristics, which is a module of the transfer function:

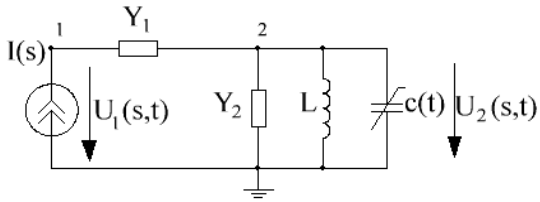


Fig. 4. Single-circuit parametric amplifier. $c(t)=c_0(1+m\cdot\cos(4\cdot10^8\pi t))$ F, $I(s)=10^{-4}\exp(j\cdot2\cdot10^8\pi t-\pi/4)$ A, L = 253.3 nH, Y_1 = 0.25 S, Y_2=0.4 mS

$$Z(m,c_0,w_i,t_j) = Z_0(m,c_0,w_i) + Z_{-1}(m,c_0,w_i)\cdot$$
$$\cdot\exp(-j\cdot4p10^8\cdot t_j) + Z_{+1}(m,c_0,w_i)\cdot\exp(+j\cdot4p10^8\cdot t_j)$$

of circuit when $w = w_i$, $t = t_j$ and $M_0(w_i,t_j)$ - function of goal, which is a module of the transfer function:

$$Z(w_i,t_j)_0 = Z_0(w_i) + Z_{-1}(w_i)\cdot\exp(-j\cdot4p10^8\cdot t_j) +$$
$$+Z_{+1}(w_i)\cdot\exp(+j\cdot4p10^8\cdot t_j),$$

of circuit when: c_0=10 pF, m=0.05 in the points $w = w_i, t = t_j$.

On fig.5 shown a graphic view of module $M_0(w_i,t_j)$ of function of goal for values w_i and t_j selected accordingly within the limits $1.7\cdot p\cdot10^8$ $-2.5\cdot p\cdot10^8$ rad/s with a step $0.02\cdot p\cdot10^8$ rad/s and 0 $-5\cdot10^{-9}$ s with a step $0.05\cdot10^{-9}$ s. On fig.6 shown a graphic view of the objective function $F(c_0,m)$ for values c_0 within the limits $9\cdot10^{-12}$ $-11\cdot10^{-12}$F with a step $0.02\cdot10^{-12}$F and values m within the limits $0.001-0.1$ with a step 0.001 for the same values of t_j and w_i, respectively.

Function of optimization «fminsearch» when the initial values $c_0 = 0.9\cdot10^{-11}$F and $m = 0.01$ for the 57 iterations has identified a minimum $F_{\min}$ for $c_0^* = 1\cdot10^{-11}$ F and $m^* = 0.05$ is marked on fig.6 by symbol ▣. Function of optimization «patternsearch» under the same initial values of $c_0 = 0.9\cdot10^{-11}$F and $m = 0.01$ for 758 iterations has given the same values $c_0^* = 1\cdot10^{-11}$F and $m^* = 0.05$. By function «fminunc» result does not obtained.

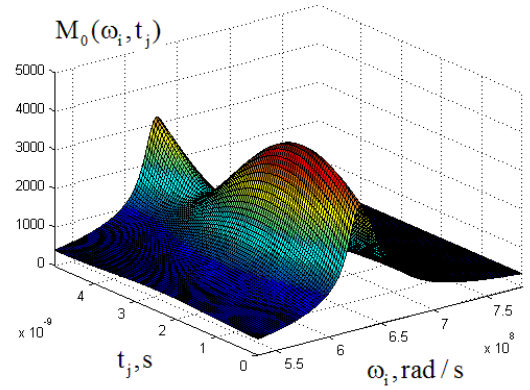


Fig. 5. Module $M_0(w_i,t_j)$ function of goal of single-circuit parametric amplifier

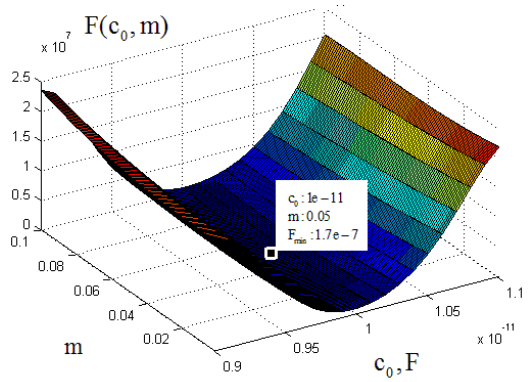


Fig. 6. The objective function $F(c_0,m)$ in the coordinates c_0 and m

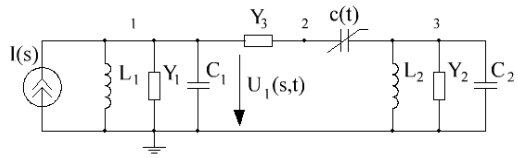


Fig. 7. Double-circuit parametric amplifier.
$c(t)=c_0\cdot(1+m\cdot\cos(597.146\cdot10^6\pi t))$ F , $I(s)=10^{-4}$ $\exp(j\cdot2\cdot10^8\pi t+\pi/4)$ A, L_1 = 36.70795 nH, L_2= 9.312609 nH, Y_1 = 0.1 mS, Y_2=0.1 mS, Y_3=0.5 S,C_1=68 pF, C_2=68 pF

Example 3. Determine the value of c_0^* and m^*, which provide minimum of the objective function $F(c_0,m)=F_{\min}$ for parametric transfer function $Z(s,t)=U_1(s,t)/I(s)$ of input resistance double-circuit parametric amplifier of fig. 7. According to FS-method [1,2,4] parametric transfer function of input resistance $Z(s,t)$ has the form:

$$Z(m,c_0,s,t)=\frac{U_1(s,t)}{I(s)}=Z_0(m,c_0,s)+Z_{-1}(m,c_0,s)\cdot$$

$$\cdot\exp(-j\cdot\Omega\cdot t)+Z_{+1}(m,c_0,s)\cdot\exp(j\cdot\Omega\cdot t)\,. \qquad (8)$$

Fractional-rational expressions $Z_0(m,c_0,s)$, $Z_{-1}(m,c_0,s)$, $Z_{+1}(m,c_0,s)$ they are given in [4].

According to expression (3) we form the objective function:

$$F(c_0,m)=\sum_{i=1}^{5}\sum_{j=1}^{6}\left(M_Z(c_0,m,w_i,t_j)-M_0(w_i,t_j)\right)^2, \qquad (9)$$

where: $M_Z(c_0,m,w_i,t_j)$ - function characteristics, which is a module of the transfer function

$$Z(m,c_0,w_i,t_j)=Z_0(m,c_0,w_i)+Z_{-1}(m,c_0,w_i)\cdot$$

$$\cdot\exp(-j597.146p10^6t_j)+$$

$$+Z_{+1}(m,c_0,w_i)\cdot\exp(+j597.146p10^6t_j)$$

of circuit when $w=w_i$, $t=t_j$ and $M_0(w_i,t_j)$ - function of goal, which is a module of the transfer function

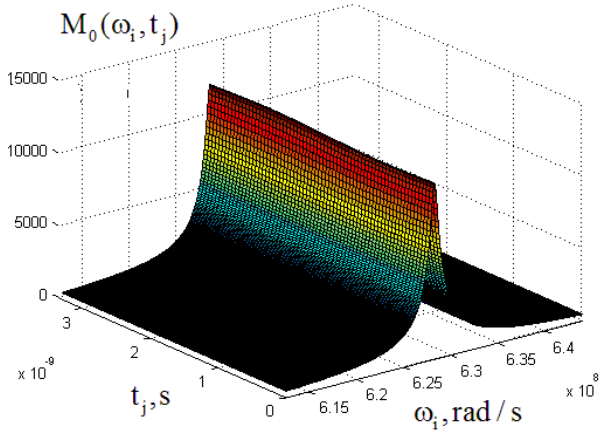


Fig. 7. Module $M_0(w_i,t_j)$ function of goal of double-circuit parametric amplifier

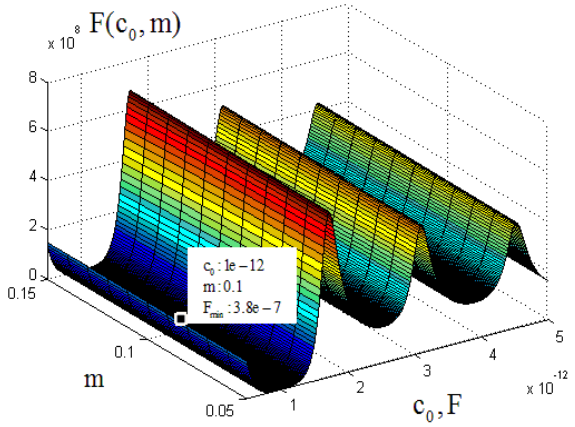


Fig. 8. The objective function $F(c_0,m)$ in the coordinates c_0 and m

$$Z_0(w_i,t_j)=Z_0(w_i)+Z_{-1}(w_i)\cdot$$

$$\cdot\exp(-j\cdot597.146\cdot p\cdot10^6\cdot t_j)+$$

$$+Z_{+1}(w_i)\cdot\exp(+j\cdot597.146\cdot p\cdot10^6\cdot t_j)$$

of circuit when:

c_0=1 pF, m=0.1 in the points $w=w_i$, $t=t_j$.

On fig. 8 shown a graphic view of module $M_0(w_i, t_j)$ of function of goal for values w_i and t_j selected accordingly within the limits $1.95 \cdot p \cdot 10^8 - 2.05 \cdot p \cdot 10^8$ rad/s with a step $0.0005 \cdot 10^8$ rad/s and $0 - 3.35 \cdot 10^{-9}$s with a step $0.05 \cdot 10^{-9}$s. On fig.9 shown a graphic view of the objective function $F(c_0, m)$ for values c_0 within the limits $0.5 \cdot 10^{-12} - 5 \cdot 10^{-12}$F with a step $0.01 \cdot 10^{-12}$F and values m within the limits $0.05 - 0.15$ with a step 0.01 for the same values of t_j and w_i, respectively.

Function of optimization «fminsearch» when the initial values $c_0 = 1.2 \cdot 10^{-12}$F and $m = 0.15$ for the 160 iterations has identified a minimum $F_{\min}$ for $c_0^* = 1 \cdot 10^{-12}$F and $m^* = 0.1$ is marked on fig.9 by symbol ▣. Function of optimization «patternsearch» under the same initial values of $c_0 = 1.2 \cdot 10^{-12}$F and $m = 0.15$ for 524 iterations has given the same values $c_0^* = 1 \cdot 10^{-12}$F and $m^* = 0.1$. By function «fminunc» result does not obtained.

CONCLUSIONS

1. Frequency symbolic method of analysis allows solving optimization task of designing of parametric linear circuits in the frequency domain based on use of the frequency symbolic transfer functions which are approximated by trigonometric polynomials of Fourier, particularly in complex form.

2. Surfaces of the objective function the case of linear parametric circles formed from transfer functions, which, in turn, are represented surfaces, because they contain two (not one, as in the case of linear circuits with constant parameters) of the independent variables - complex variable s and time t.

3. For all the above examples used function of optimization of MATLAB 7.6.0, in particular, «fmi-nunc», «fminsearch» and «patternsearch» define minimum of objective functions in the same values of the variables s and t, although for different number of iterations.

4. Maximum values of variables i and j objective functions in the examples above are different, because every time were defined by practical possibilities by MATLAB 7.6.0 on a computer with a processor AMD TurionX2 Dual Core Mobile RM-76 2.30 GHz and operative memory 3.00 Gb.

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Sales channels selection for small industrial enterprises based on qualitative-quantitative characteristic criteria

N. Shpak, T. Kyrylych

Lviv Polytechnic National University, e-mail: dida_05@ukr.net

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Abstract. In the article, the qualitative and quantitative criteria to compare and evaluate separately direct and indirect sales channels for small industrial enterprises are systemized; the diagnostics of such channels is carried out for concrete enterprise, the application of graphical radar method for comparative analysis is substantiated, the use of the radar method is improved taking into account the weight function of characteristic criteria, the mechanism of diversification of sales channels for a small industrial enterprise is proposed.

Key words: small industrial enterprise; sales channel; characteristic criterion; method of radar; weight function; sales channels selection.

INTRODUCTION

The selection of optimal combination of sales channels is the topical and many-sided problem. Activity of a small business enterprise is closely related to decision-making on sales channels selection. In many instances such a decision is made by intuition or using personal contacts of owners or employees of a firm. This approach often results in profit deficiency and imperfect use of firm's potential as well as the potential of distribution intermediaries. The subject of the article is connected with considering the characteristic criteria for the selection and comparison of direct and indirect sales channels, the methods for their estimation and forming the mechanism of decision-making on the use of sales channels.

ANALYSIS OF THE RECENT RESEARCH AND PUBLICATIONS

Each sales channel can be classified by a list of characteristic criteria which reflect a level of producer profit and a level of collaboration with distribution intermediaries. Investigations of this problem were carried out by leading national and foreign scientists. [7] considers methodical approaches to estimation of activity of a distribution channel and singles out the organizational and economical mechanisms of distribution process management; the logical content of such management is revealed by its structure elements (the functional and providing subsystems). J.-J. Lambin, R. Chumpitaz and I. Schuiling [15] considered market-oriented management strategy and underscore that the increasing complexity of the competitive environment demands new approaches and the use of new mechanisms in formulating strategy of an enterprise [15]. Describing the principles of marketing, [12] stress the twofold goal of marketing strategy: to attract new customers by promising superior value and to keep and grow current customers by delivering satisfaction. D. Jobber and G. Lancaster analyze different kinds of customers in order to help achieving and understanding of buyers' thinking and organize the selling distribution accordingly [10]. A.A. Thompson and A.J. Strickland establish the tree of strategy-making tasks and underline competitive capabilities of an enterprise [19]. M.A. Hitt, R.D. Ireland and R.E. Hoskisson emphasize that strategic competitiveness is achieved when an enterprise successfully states and implements a value-creating strategy being an integrand and coordinated set of activity designed to exploit core competences and gain a competitive advantage [8]. A.T. Coughlan, E. Anderson, L.W. Stern and A.I. El-Ansary shows how to design, develop, maintain and manage effective relationships among worldwide marketing channels to achieve sustainable competitive advantage by using

strategic and managerial frames of reference [3]. They emphasize that distribution channels are critical elements of business strategy. S. Shpylyk singles out the theoretical-methodical regulations and suggestions concerning the order of sales activity management of an enterprise taking into account intensification of existing relations with customers and using the system approach. O.M. Provolotska reveals the theoretical and methodical aspects of improving product sales management in the context of modern marketing by investigation of a situation in internal and external environment under evaluation of competitive capacity of domestic industrial enterprises. The paper of O.A. Bilovodska is devoted to determination of forms of marketing interaction between participants in distribution channels; the author presents classification of marketing relationship in collaboration and in conflicts in channels and investigates the methods aimed at study, estimation, diagnostics, analysis and resolving of conflicts in distribution channels of innovation production [1, 16, 17].

Investigations of V.F. Hamaliy, S.A. Romanchuk and I.V. Fabryka are directed to increase of sales activity effectiveness and profitability of an enterprise; the authors have developed the general sales strategy of an enterprise – integration of two strategies in the framework of the general strategy of intensive growth: the strategy of deep penetration into a market, which lies in increase of sales of existing goods at existing markets, and the development strategy – development of sales of new goods for existing customers [6].

According to L. Gorchels, E. Marien and C. West, competently built distribution channels give rise to large competitive advantage [5]. The authors consider the main principles of distribution channel management. They suppose that the strategy of penetration into market, which accounts for such principles as well as the demands of customers and channel partners and is developed with taking into account new technologies and segmentation of distribution channels, ensures the success of an enterprise. The practical and pragmatical approach of the leading scientist and professor of University of Warwick P. Doyle and his co-author P. Stern is revealed by different aspects of modern strategical business management and marketing as well as by giving many pieces of practical advice necessary for decision-making on marketing and strategy development [4]. They propose to distinguish economic and non-economic factors for choice of distribution intermediaries. The integrated approach to sales department management proposed by P. Winkelmann is characterized by interrelations between all the departments of a firm [20]. He considers marketing activity as a basis for integration of business processes of a company and illustrates his own elaborations by examples from experience of world leading companies.

A wide variety of views and approaches to classification of criteria for selection of distribution intermediaries inherent to studies of national researchers results from ambiguity and non-coordination of their practical use possibilities. Studying this problem, foreign researchers take into account foreign conditions of company management, making contracts between a producer and a distribution intermediary, etc. The approach to selection of sales channels proposed in our article eliminates these shortcomings.

THE AIM OF THE RESEARCH

The aim of this research is to single out the qualitative and quantitative criteria for comparison of direct and indirect sales channels, estimation of their weights and forming on the basis of this elaboration the mechanism of decision making about merits of their use and combination.

MAIN RESULTS OF THE RESEARCH

Small industrial enterprises are more responsive to crisis processes and are more subjected to negative consequences of such processes. At the same time, a crisis can stimulate the development of an enterprise and promote a search of alternative business methods. One of such methods is diversification of marketing activity resulting in product sales. In this case, a small industrial enterprise defines the main goals, tasks and distribution types, singles out existing and potential sales channels and makes decision about their use and rearrangement.

Based on results of analysis of literature, our own elaboration and practical activity of small industrial enterprises, we systemize the qualitative and quantitative criteria to compare and evaluate separately direct and indirect sales channels. Table 1 presents qualitative and quantitative characteristic criteria of direct sales channels by the example of the private joint-stock company “BROTEP-ECO”. For example use of criteria we introduce the weight of each criterion (see Table 1, column 3). The sum of weights is equal to 1. For comparison of the sales channels and mathematical substantiation of this process the absolute values of characteristic criteria are scaled proportionally according to the 10-point evaluation scale (see Table 1, columns 8–10) and are corrected by the weights (see Table 1, columns 11–13). Table 2 presents the qualitative and quantitative criteria of comparison between the actually used (distribution network and specialized supermarkets) and potential (wholesale market) indirect sales channels of PJSC “BROTEP-ECO”. There are much more criteria than for direct sales channels which results from less control and less access to intermediary information. The weight of each criterion is shown in column 3 (see Table 2), the sum of weights is equal to 1. The number of points obtained by each indirect sales channel according to the 10-point scale is presented in columns 8–10 and is corrected by the weight in columns 11–13 of Table 2.

Table 1. Qualitative and quantitative characteristic criteria of comparing the direct sales channels of PJSC "BROTEP-ECO" *

N	Characteristic criteria of direct sales channel selection	The criterion weight	Calculation recommendations	Actual value of characteristics of a direct channel			The number of points of each direct sales channel (according to a 10-point grading scale)			The number of points of each direct sales channel corrected by the weight		
				ES*	FS*	EC*	ES*	FS*	EC*	ES*	FS*	EC*
1	2	3	4	5	6	7	8	9	10	11	12	13
			Qualitative characteristics									
1.	Territorial coverage	0.08	Total population of settlements, where production is presenting / Population of Ukraine	0.37	0.2	0.3	3.7	2	3	0.3	0.16	0.24
2.	The number of visitors	0.05	The leading direct sales channel gets 10 points, the points of other sales channels are calculated proportionally to the leading channel	5 000 visitors	7 000 visitors	8 500 visitors	5.9	8.2	10	0.3	0.41	0.5
3.	Using period	0.05	The number of months in use / The number of months of company existence	0.7	1	0.5	7	10	5	0.35	0.5	0.25
4.	SWOT-analysis	0.11	The sum of strengths and opportunities positions / The sum of weaknesses and threats positions. The direct channel which gets the maximum value obtains 10 points, the points of other channels are calculated proportionally to the leading channel	0.9	1.7	1.4	5.3	10	8.2	0.58	1.1	0.9
5.	Competence and professionalism of management personnel	0.11	Independent experts interview top-management representatives of direct sales channels forming the expert opinion according to a 10-point grading scale	-	-	-	5.7	9.3	7.6	0.63	1.02	0.84
6.	A level of service and a level of production presentation by sales personnel	0.08	A secret shopper evaluates sales personnel according to a 10-point grading scale	-	-	-	9.2	8.1	8.7	0.74	0.65	0.7
			Quantitative characteristics									
7.	Year turnover of a direct sales channel	0.2	The direct sales channel having the largest total production turnover gets 10 points. The points of other sales channels are calculated proportionally to the leading channel	42 000 UAH	57 000 UAH	64 000 UAH	6.6	8.9	10	1.32	1.78	2
8.	The average velocity of commodities circulation from producer to consumer	0.09	The direct sales channel having the shortest period of production delivery from producer to consumer gets 10 points. The points for other channels are calculated subtracting 0.5 point for every additional day	At once	At once	3 days	10	10	8.5	0.9	0.9	0.77
9.	Markup rate	0.1	The direct sales channel having the lowest markup rate gets 10 points. Points for other channels are calculated subtracting 0.5 point for additional 5 % of markup rate	42 %	33 %	15 %	7.5	8.5	10	0.75	0.85	1
10.	Increase of sales volume	0.13	The direct sales channel having the largest increase of sales volume gets 10 points. The points of other sales channels are calculated proportionally to the leading channel	7 %	12 %	16 %	4.4	7.5	10	0.57	0.98	1.3

**Notation conventions in Table 1: ES – Exhibition Sales; FS – Firm Shop; EC – Electronic Commerce*

Table 2. Qualitative and quantitative characteristic criteria of comparing indirect sales channels of PJSC "BROTEP-ECO"

N	Characteristic criteria of indirect sales channel selection	The criterion weight	Calculation recommendations	The actual values of characteristics of an indirect channel			The number of points of each indirect sales channel (according to a 10-point grading scale)			The number of points of each indirect sales channel corrected by the weight		
				S*	DN*	W*	S*	DN*	W*	S*	DN*	W*
1	2	3	4	5	6	7	8	9	10	11	12	13
			Qualitative characteristics									
1.	Territorial coverage	0.05	Total population of settlements, where production is presenting / Population of Ukraine	0.42	0.56	0.7	4.2	5.6	7	0.21	0.28	0.35
2.	Consistency between a target consumer of intermediary and a target consumer of producer	0.05	Independent experts give the number of points according to a 10-point grading scale	-	-	-	5.7	6.3	4.9	0.29	0.32	0.25
3.	Using period	0.02	The number of months in use / The number of months of company existence	0.2	1	-	2	10	0	0	0.2	0
4.	SWOT-analysis3	0.05	The sum of strengths and opportunities positions / The sum of weaknesses and threats positions. The indirect channel which gets the maximum value obtains 10 points, the points of other channels are calculated proportionally to the leading channel	0.6	2.3	1.7	2.6	10	7.4	0.13	0.5	0.37
5.	Competence and professionalism of management personnel	0.04	Independent experts interview top-management representatives of indirect sales channels forming the expert opinion according to a 10-point grading scale	-	-	-	7.7	5.9	8.1	0.31	0.24	0.32
6.	A level of service and a level of production presentation by sales personnel	0.03	A secret shopper evaluates sales personnel according to a 10-point grading scale	-	-	-	3.7	8.6	7.9	0.11	0.26	0.24
7.	Elasticity, efficiency and accommodation of an indirect sales channel in nonstandard situations	0.01	The number of nonstandard situations solved positively for the producer / The total number of nonstandard situations	0.6	0.7	-	6	7	0	0.12	0.07	0
8.	The date of the last purchase	0,01	The dates of the last purchase are compared. The indirect channel with the latest purchase gets 10 points. The points for other channels are calculated subtracting 0.5 point for each month before	7.08. 2013	17.06. 2013	-	10	8	0	0.1	0.08	0
9.	Quantity of the last purchase	0,01	Quantities of the last purchase are compared. The indirect channel with the largest quantity of the last purchase gets 10 points. The points of other channels are calculated proportionally to the leading channel	210 units	795 units	-	2.6	10	0	0.03	0.1	0
10.	Duration of intermediary activity	0.02	Duration of intermediary activity is compared. The leading indirect channel gets 10 points; the points of other channels are calculated proportionally to the leading channel	3.4 yr	1.5 yr	5 yr	6.8	3	10	0.14	0.06	0.2
11.	Existence and quality of marketing strategy	0.04	Independent experts give the number of points according to a 10-point grading scale	-	-	-	7.3	8.5	8.6	0.29	0.34	0.34
12.	Participation in joint promotion	0.02	The part of costs of producer in joint promotion is compared with that of intermediary. The channel for which the part of costs of producer is the lowest gets 10 points. The points of other channels are calculated proportionally to the leading channel	55 %	24 %	30 %	7.5	10	9.4	0.15	0.2	0.19
13.	Frequency of joint promotion	0.02	Intermediary with the largest frequency of promotion gets 10 points. The points of other channels are calculated proportionally to the leading channel	7 times per year	15 times per year	14 times per year	4.7	10	9.3	0.09	0.2	0.19
14.	Quality of promotion	0.02	Independent experts give the number of points according to a 10-point grading scale	-	-	-	6.9	9.4	8.8	0.14	0.19	0.18

1	2	3	4	5	6	7	8	9	10	11	12	13
15.	Existence and quality of review of branch markets for indirect sales channel	0,02	Independent experts give the number of points according to a 10-point grading scale	-	-	-	5.4	7.8	7.3	0.11	0.16	0.15
16.	The date of the last investment in fixed assets	0,01	The dates of the last investment in fixed assets are compared. The indirect channel with the last investment gets 10 points. The points for other channels are calculated subtracting 1 point for each year before	2009	2010	2009	9	10	9	0.09	0.10	0.09
17.	Financial losses, dates and reasons of merchandise return	0,01	The indirect channel having no returns gets 10 points. The points for other channels are calculated subtracting 1 point for each return	-	2007.	-	10	9	10	0.1	0.09	0.1
18.	Ecological compatibility of commodity circulation	0,01	Existence of ecological modes of transport and the use of rendering plant facilities are estimated. The indirect channel having at least one of the abovementioned items gets 10 points	-	-	-	0	10	10	0	0.1	0.1
19.	Elasticity in decision making	0,02	Marketing Department and Sales Department give the number of points according to a 10-point grading scale	-	-	-	6.3	7.4	8	0.13	0.15	0.16
20.	Image, professionalism and reputation	0.01	Independent experts give the number of points according to a 10-point grading scale	-	-	-	8.2	7.6	7	0.08	0.08	0.07
			Quantitative characteristics									
21.	Total year turnover of the indirect channel	0.03	The intermediary with the largest total year turnover gets 10 points. The points of other channels are calculated proportionally to the leading channel	116000 UAH	180 000 UAH	150 000 UAH	6.4	10	8.3	0.19	0.3	0.25
22.	Year turnover of producer production of indirect channel	0.11	The intermediary having the largest year turnover of the producer production gets 10 points. The points of other channels are calculated proportionally to the leading channel	6 910 UAH	5320 UAH	0	10	7.7	0	1.1	0.85	0
23.	A part of turnover of producer production in total turnover of indirect channel	0.02	Turnover of producer production / Total turnover of the intermediary. The indirect channel having the largest ratio gets 10 points. The points of other channels are calculated proportionally to the leading channel	0.09	0.03	0	10	3.3	0	0.2	0.07	0
24.	The average velocity of commodities circulation from producer to consumer	0.02	The intermediary having the shortest period of production delivery from producer to consumer gets 10 points. The points for other channels are calculated subtracting 0.5 point for every additional day	3 days	8 days	5 days	10	7.5	9	0.2	0.15	0.18
25.	Markup rate	0.04	The indirect sales channel having the lowest markup rate gets 10 points. The points for other channels are calculated subtracting 0.5 point for additional 5 % of markup rate	48 %	40 %	20 %	7.5	8	10	0.3	0.32	0.4
26.	Increase of total sales volume	0.05	The intermediary having the largest increase of total sales volume gets 10 points. The points of other sales channels are calculated proportionally to the leading channel	5 %	19 %	10 %	2.6	10	5.3	0.13	0.5	0.27
27.	Increase of sales of producer production	0.07	Data from last two years are compared. The intermediary having the largest increase of sales of producer production gets 10 points. The points of other channels are calculated proportionally to the leading channel	14 %	7 %	0	10	5	0	0.7	0.35	0
28.	Increase of sales of analogical production	0.02	The intermediary having the least increase of analogical production gets 10 points. The points for other channels are calculated subtracting 0.5 point for additional 5 % increase	23 %	12 %	5 %	8.5	9.5	10	0.17	0.19	0.2
29.	Exact time payment for shipped production	0.05	The intermediary having no debts (during last year) gets 10 points.. 0.5 points are subtracted for each debts month	6 months	9 months	0	7	5.5	0	0.35	0.28	0
30.	The quantity of credit debt	0.05	The intermediary having the least credit debt gets 10 points. 0.5 point is subtracted for each additional 1000 UAH	4 500 UAH	5 000 UAH	0	10	10	0	0.5	0.5	0
31.	Discount for production	0.04	The intermediary having the lowest discount gets 10 points. 0.5 point is subtracted for each additional %	5 %	2 %	0 %	9.8	9.9	10	0.39	0.4	0.4
32.	Freight charges	0.03	The intermediary having the lowest freight charges gets 10 points. 0.5 point is subtracted for each additional 1000 UAH	10 000 UAH	4 000 UAH	7 000 UAH	7	10	8.5	0.21	0.3	0.26

** Table 2: S – Specialized Supermarket; DN – Distribution Network; W – Wholesale Market*

The comparative analysis of sales channels will be carried out by the improved radar method. The classical radar method [11, 13, 18] consists in building a circle with a radius equal to the maximal value of all the criteria (in the classical radar method the maximal value of a criterion equals to 10 conventional units) and a graphical cyclogram at radial axis of which the criterion value is marked (the number of axes is equal to the number of criteria). The marks at the radial axes are connected creating a polygon which area is determined as follows:

$$S_{\text{P}} = \sin\left(\frac{2p}{n}\right)\left(a_1 * a_2 + a_2 * a_3 + a_3 * a_4 + \right.$$
$$\left. + \mathbf{K} + a_{n-1} * a_n + a_n * a_1\right), \quad (1)$$

where: S_{P} is an area of polygon created by connection of marks at the radial axes of a circle with a radius of 10 conventional units; n is the number of characteristic criteria; a_i is the value of the ith criterion.

Comparison of sales channels is carried out according to the integral index Y which is calculated as:

$$Y = \frac{S_{\text{P}}}{S_{\text{C}}}, \quad (2)$$

where: S_{C} is an area of a circle with a radius of 10 conventional units.

The larger is the index Y, the more profitable is the sales channel for an enterprise.

Next we build the graphical illustration for direct (Fig. 1 and 2) and indirect (Fig. 2 and 4) sales channels separately because different characteristic criteria have been introduced for direct and indirect sales channels. The classical radar method assumes that the weights of all criteria for comparison of sales channels are the same, but in practice such conditions are not fulfilled. Hence, this method needs improvement taking into account the criterion weight. Such innovation permits revealing advantages and weaknesses of each sales channel. We propose to introduce the criterion weight (the sum of weights is equal to 1) and to plot at the radial axes not the absolute value of a criterion but its value corrected by its weight. Such an improvement allows us to judge more precisely about priority of the sales channels based on their qualitative and quantitative characteristics. Accounting for this modification, Equation (1) takes the form:

$$S^*_{\text{P}} = \sin\left(\frac{2p}{n}\right)\left(a_1 * g_1 * a_2 * g_2 + a_2 * g_2 * a_3 * g_3 + \right.$$
$$+ a_3 * g_3 * a_4 * g_4 + \mathbf{K} +$$
$$\left. + a_{n-1} * g_{n-1} * a_n * g_n + a_n * g_n * a_1 * g_1\right), \quad (3)$$

where: g_i is the weight of the ith criterion.

Now comparison of the sales channels is carried out according to the modified integral index Y^* which is calculated as

$$Y^* = \frac{S^*_{\text{P}}}{S^*_{\text{C}}}, \quad (4)$$

where: S^*_{C} is an area of a circle with a radius which equals to the maximum value of all weighted criteria ($r = \max(a_i * g_i)$).

Usually, a small industrial enterprise employs a little number of direct and indirect sales channels (in fact, PJSC "BROTEP-ECO" uses three direct and two indirect channels; a wholesale market appears as a potential sales channel). This allows us to use the radar method presenting the graphical interpretation of all direct channels in one figure and of all indirect channels in another. For clearness of the proposed modification we solve the problem of comparison and selection of direct and indirect sales channels by two methods (the classical method and the improved one). Graphical interpretation of comparison of direct sales channels of PJSC "BROTEP-ECO" using the classical radar method and the improved radar method is shown in Fig. 1 and 2, respectively.

The vertices of polygons in Fig. 1 approach to the best value (10 conventional units), whereas in Fig. 2 such a tendency is observed only at the 7th vertex of the polygon "Electronic Commerce" which corresponds to the 7th criterion. This is due to taking into account the criterion weight for each sales channel. For express-diagnostics of sales channels the classical radar method will be less labour-intensive, but introducing the weight of criterion for comparison of sales channels permits giving more precise estimation and potentially ensures the profit increase for a small industrial enterprise due to optimal distribution of production between distribution channels.

Graphical interpretation of comparison of indirect sales channel of PJSC "BROTEP-ECO" using the classical radar method and the improved radar method is shown in Fig. 3 and 4, respectively.

Table 3 presents the results of modeling the polygon areas for direct sales channels as well as the values of integral indexes using the classical and improved radar methods.

As it is clear from the results given above, the integral index determined by the classical radar method gives grounds to state that firm shops have the leading position in comparison with other sales channels. According to the improved radar method, exhibition sales occupy the first place with small preference in comparison with firm shops. Hence, using the improved method which is more exact and takes into account the weight of each characteristic criterion, singled out for direct sales channels, we will consider exhibition sales as the most profitable direct sales channel for PJSC "BROTEP-ECO", the second place is occupied by firm shops, and electronic commerce occupies the third place.

Table 4 presents the results of modeling the polygon areas for indirect sales channels as well as the values of integral indexes using the classical and improved radar methods.

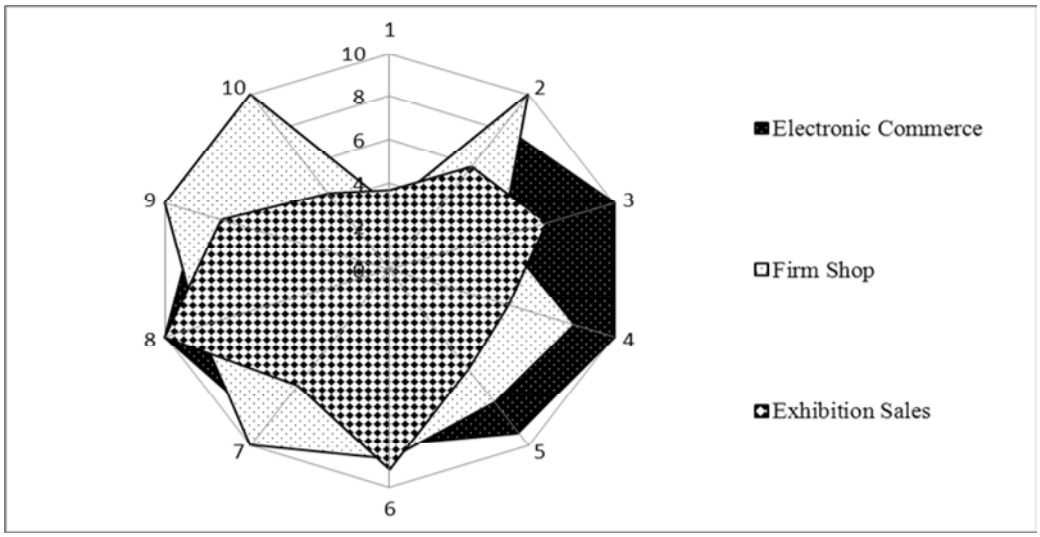

Fig. 1. Graphical interpretation of estimation of PJSC "BROTEP-ECO" direct sales channels using the classical radar method

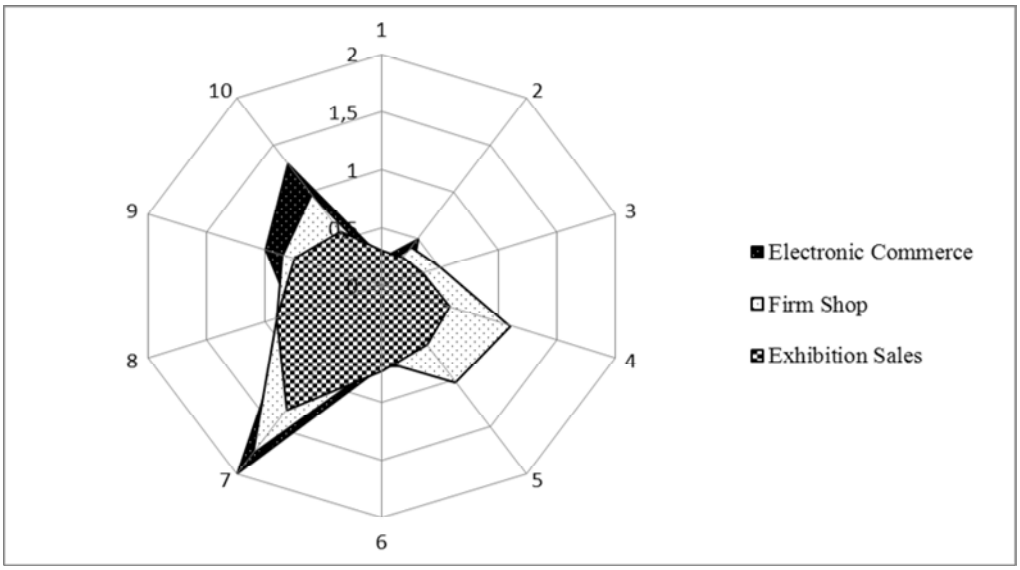

Fig. 2. Graphical interpretation of estimation of PJSC "BROTEP-ECO" direct sales channels using the improved radar method

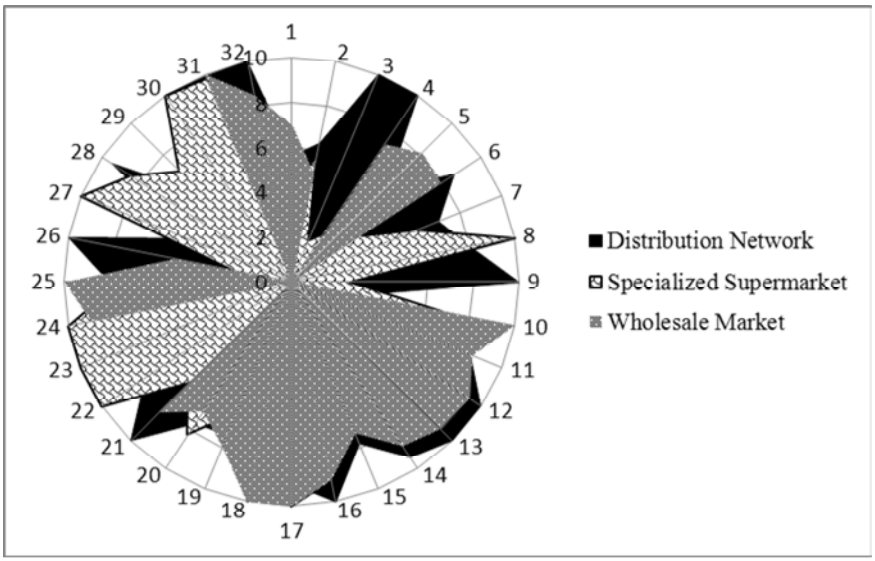

Fig. 3. Graphical interpretation of estimation of PJSC "BROTEP-ECO" indirect sales channels using the classical radar method

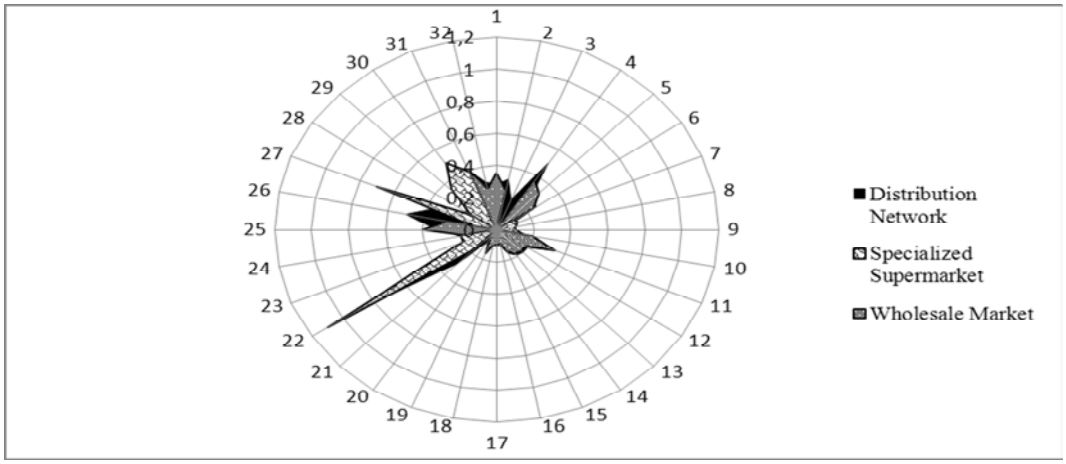

Fig. 4. Graphical interpretation of estimation of PJSC "BROTEP-ECO" indirect sales channels using the improved radar method

Table 3. The integral indexes for direct sales channel of PJSC "BROTEP-ECO"

N	The metod name	An area of the circle (conv. units)²	An area of the polygon "Electronic Com-merce" (conv. units)²	An area of a polygon "Firm Shops" (conv. units)²	An area of a polygon "Exhibition Sales" (conv. units)²	Integral indexes (Y, Y^*)		
						Electronic Commerce	Firm Shops	Exhibition Sales
1.	The classical radar method	314	127.46	203.16	186.96	Y=0.406	Y=0.647	Y=0.595
2.	The improved radar metod	12.56	1.37	2.09	2.1	Y^*=0.109	Y^*=0.116	Y^*=0.117

Table 4. The integral indexes for indirect sales channel of PJSC "BROTEP-ECO"

N	The method name	An area of the circle (conv. units)²	An area of the polygon "Special-ized super-market" (conv. units)²	An area of the polygon "Distribution Network" (conv. units)²	An area of the polygon "Wholesale market" (conv. units)²	Integral indexes (Y, Y^*)		
						Special-ized super-market	Distribution network	Whole-sale market
1.	The classical radar method	314	144.11	203.33	130.36	Y =0.46	Y =0.65	Y =0.42
2.	The improved radar method	3.8	0.17	0.21	0.1	Y^* =0.04	Y^*=0.06	Y^*=0.03

The integral indexes of indirect sales channel of PJSC "BROTEP-ECO" for the classical and improved radar methods show a coincidence of channel ranking: the distribution network is the leading channel, the second place is occupied by specialty supermarket, and the wholesale market occupies the third place.

The process of decision making concerning direct and indirect sales channel is complicated and laborious, it cannot restrict itself only to singling out the characteristic criteria for comparison and evaluation of the generalized characteristic index. There is a need to use the wider and more comprehensive approach. As a result of generalization of studies presented in the literature [2, 9, 14] and of our own elaboration we form the stage-by-stage mechanism of diversification of sales channels for a small industrial enterprise (Fig. 5).

Diversification of sales channels for small industrial enterprise has been formed as an integrated structured mechanism which action has the immediate connection with the mission and aims of an enterprise, marketing strategy and financial, production, management, personnel and other problems. Such an approach before the stage of analysis of existing distribution mechanism allows us to eliminate the strategical mistakes and to present the best view of business intention of small industrial enterprise and of a level of its realization. Taking into account the type of distribution is also closely connected with aims and mission of an enterprise. Under conditions of crisis it is desirable to revise the distribution type by change of a target consumer making production more accessible (for example, using exclusive or selective distribution type). Characteristics of a target consumer and research of public opinion concerning priority of buying production from different sales channels are the fundamentals of strategical marketing activity and have the significant influence on the selection of sales channels. Stage 7 and stage 8 of the proposed mechanisms are presented in this paper in detail.

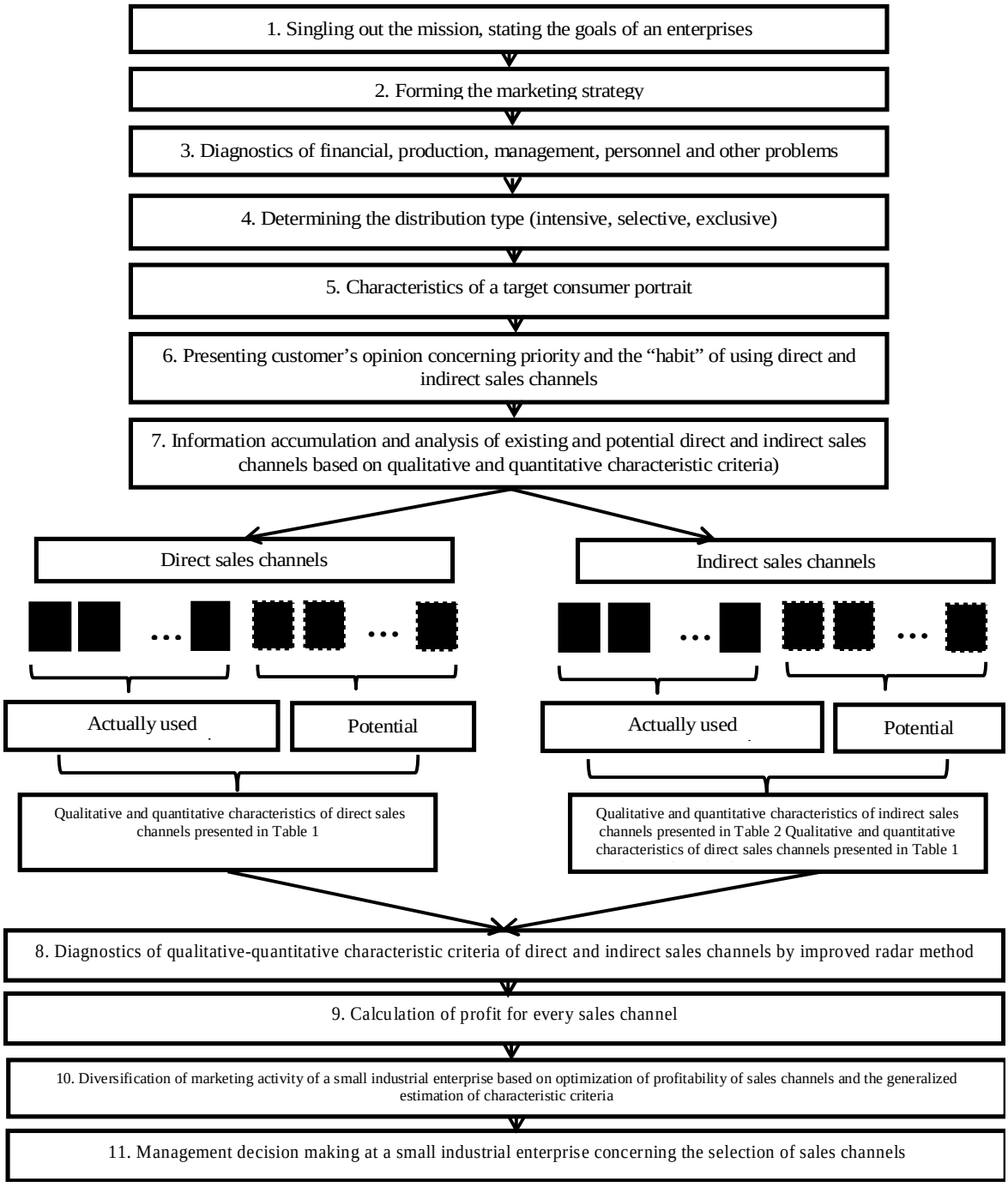

Fig. 5. The mechanism of diversification of sales channels for small industrial enterprise

CONCLUSIONS AND PROSPECTS OF FUTURE RESEARCH

Because of small amounts of production, small industrial enterprises prefer one or two sales channels. Such an approach results from prolonged practice of their existence and from the lack of integrated mechanism which allows for estimating, comparing and singling out the most profitable existing and potential sales channels. In the present article, this problem has been solved in part owing to consideration and estimation of the qualitative and quantitative characteristic criteria for direct and indirect sales channels separately, forming recommendations on initial information gaining.

The proposed mechanism of diversification of sales channels for small industrial enterprise will be an important contribution into practical activity of an enterprise concerning the selection of sales channels. The presented elaboration will serve as the basis for future study concerning diversification of marketing activity of a small industrial enterprise based on optimization of profitability of sales channels and the generalized estimation of qualitative and quantitative characteristic criteria.

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Strategic solutions of business innovation-driven growth mainstreaming

N.V. Smolinska

Lvivska Polytechnica National University, e-meil: smolinska-n@ ukr.net

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Abstrakt. The method of development of the business innovation capacity and corporate culture level evaluation, that allows identification of this level growth or deterioration within the specific period of time, is the key problem of the article. The data received permit to work out the matrix "the level of corporate culture vs. the level of innovation capacity" of the business in order to reveal the business' position in this matrix and select the innovation-driven growth strategy of this business.

Key words: development, innovation capacity, corporate culture level evaluation, management solutions.

INTRODUCTION

The business innovation-driven growth is the key factor of crisis recovery of the country's economy. On the current level of the country economic development, innovation is thought to be the main mean of preservation and enforcement of the business' market share. The experience of the world advanced nations proves that the countries, which encouraged innovation-driven growth, gained economic success. The problem of innovation-driven growth solution depends on both the state's innovation policy and efficiency of innovation resources use as well as intensity of innovation management. When solving this problem, one should pay special attention to scientific background of innovation-driven growth strategy of industrial businesses. The modern economic science does not give any ready-made clues as to formation of innovation-driven growth strategy of business development, although there is some basis for it.

MATERIALS AND METHODS

The strategy in the management theory is understood as a model of actions and a set of techniques, which facilitate for businesses the achievement of their development goals. It is the compound program, which helps the business management adequately use the potential and resources of the company for achievement of their goal. The trend development selection begins with setting goals and tasks of development within the company mission. The corporate culture due to its internal force is aimed at supporting the business in its goal achievement, being part of the total system of the company development strategy.

As far as the innovation capacity of the company guarantees its competitiveness, the corporate culture boosts innovation potential development due to specific micro-climate formation. That is why, at the point of the company strategy development, misalignment of the development strategy and corporate culture could be the wrong option

We suggest the matrix "the level of corporate culture vs. the level of innovation capacity", constructed on the basis of two characteristics: the level of economic potential of the company and the level of corporate culture of this company, in order to evaluate and adopt the management decisions as to the boost of innovation-driven growth..

The notion of the innovation capacity of the company is based on the complex of factors and their characteristics. From the point of mathematic modeling, it is based on aggregate markers that completely reveal the elements of structural and economic aspects of the company capacity. The system of markers for innovation capacity evaluation forms the following four elements: set up of production, organization of work, economic efficiency of results, innovation-driven growth funding [1, 2, 3, 4].

The aggregate indicator of the innovation capacity of the company (g) is calculated with this formula [5]:

$$g = \sum_{j=1}^{m} b_j \left[\sum_{i=1}^{n_j} p_{ij} \left(\sum_{k=1}^{s} a_{k_{ij}} m_k(x_{ij}) \right) \right], \qquad (1)$$

where: j – index of the group of markers, $j=1,m$; i – index of the indicator inside the group, $i=1,n_j$; n_j – number of indicators in group j i; b_j – gravity of group j; p_{ij} – gravity of indicator i of group j; $m_k(x_{ij})$ – meaning of k membership function of indicator i of group j; s – number of junctures, $s=5$; $a_{k_{ij}}$ – juncture k of marker i in group j ($k=1,s$), which value for markers that indicate the marker growth corresponding to the characteristics improvement is calculated by the formula:

$$a_{k_{ij}} = 0,1 + 0,2 \cdot (k-1). \qquad (2)$$

For markers that indicate the marker growth corresponding to the characteristics deterioration, the value is calculated with the formula:

$$a_{k_{ij}} = 0,9 - 0,2 \cdot (k-1). \qquad (3)$$

The rule of the company level of innovation capacity identification G on the basis of the aggregate indicator g, calculated with the formula (1), is represented in Table 1.

Table 1. Business innovation capacity levels classification

Interval of meanings g	Classification of the parameter levels G	Degree of evaluation confidence (membership function)
$0 \le g < 0,35$	Very low (Vl)	$m_1 = 1$
$0,35 \le g < 0,45$	Very low	$m_1 = 10 \times (0,45 - g)$
	Low (L)	$m_2 = 1 - m_1$
$0,45 \le g < 0,5$	Low	$m_2 = 1$
$0,5 \le g < 0,6$	Low	$m_2 = 10 \times (0,6 - g)$
	Average (A)	$m_3 = 1 - m_2$
$0,6 \le g < 0,65$	Average	$m_3 = 1$
$0,65 \le g < 0,75$	Average	$m_3 = 10 \times (0,75 - g)$
	High (H)	$m_4 = 1 - m_3$
$0,75 \le g < 0,8$	High	$m_4 = 1$
$0,8 \le g < 0,9$	High	$m_4 = 10 \times (0,9 - g)$
	Very high (Vh)	$m_5 = 1 - m_4$
$0,9 \le g \le 1,0$	Very high	$m_5 = 1$

The model uses the junctures of the standard five-level indistinct 01-classification code a_k, which are abscissas of maximal values of correspondent membership functions on 01-carrier, on one hand, and on the other hand, are evenly distant from each other on the 01-carrier and symmetrical as to the 0,5 juncture. These points act as scales when aggregating the markers systems on the level of their qualitative states.

The results of the investigation can be put in the basis of alternative models of formation of the company innovation-driven growth implementation. These findings can also help to determine the improvement directions of the present level of the company innovation capacity.

As for the research of the second matrix parameter, the total level of the corporate culture, we suggest the method that includes the questionnaire "evaluation of the level of the business corporate culture". Characteristics correspond to our goals, specifically, authenticity of research, objectivity (mathematic analysis of the data received helps to average the diversity of individual ideas, as a result, we receive the objective information) and credibility of information received with the help of anonymous forms.

In order to identify problematic places of corporate culture of the companies, the author suggested calculating average markers, taking into consideration four elements of the company corporate culture: CEO's management qualities and style, social and psychological climate , information and communication exchange, motivation and labor ethics [6,7,8,9,10].

The next stage could be determination of the necessary selection volume (to be representative) for receiving credible result, when we know the distortion value $\Delta = 0,05$, which should be considered as inessential. Then we start determining of the standard distortion μ, and later, numerical selection.

Determine the sufficient minimum of selection, which would represent the basic qualities of the general aggregate at the given distinctiveness:

$$n = \frac{t^2 * pq * N}{N * \Delta^2 + t^2 * pq}, \qquad (4)$$

where: $\sigma^2 = pq = 0,5 * 0,5 = 0,25$

When $t = 2$, with probability belief $P = 0,954$, calculate the amount of selection on the basis of the target audience of the respondents, i.e., whether they are high-level, mid-level or low-level management of the following companies.

The three-point response scale was used for evaluation. If the respondent gives the positive answer to the question ("yes"), it is evaluated with 1 point, in case of doubt ("sometimes"), 0.5 points and if the question completely opposes his vision ("no"), 0 points.

The level of corporate culture is determined on the basis of correspondence of the total number of received responses to the number of respondents. The maximum meaning (max) shall be 1, the minimum shall be 0. According to the form, one respondent can give 25positive answers, which is the biggest possible sum of points.

As soon as the questionnaire is completed, the data are downloaded into the computer. To find the level of corporate culture, calculate the average meaning of each question:

$$\overline{X} = \frac{\sum X}{n}. \qquad (5)$$

The total meaning of average quantities of each of the questions, divided by 25 (b is the number of

questions asked), as a result, allows finding the level of the company corporate business:

$$R_{OK_1} = \frac{\sum \overline{X}}{b} \ . \quad (6)$$

For convenience of comparison and further research transfer the scale of measurement from 1 to zero. The scale below (with reference to Fishburne scale) reveals the further level of the corporate culture:

[1 - 0,90] – very high,
[0,89 – 0,75] – high,
[0,74 – 0,50] – average,
[0,49 – 0,35] – low,
[below 0,34] – very low (with deterioration tendency).

Calculation of quadratic factor of variation (V_σ) in order to reveal uniformity of the population researched, i.e. the level of corporate culture of the company will permit summarizing of the research results. If the factor is more than 33%, it means that the population is not uniform by the researched aspect, whereas the average meaning of this factor is not typical.

The following data, regarding evaluation of the innovation capacity, have been received from the companies researched: PJSC «Konveyer» and PJSC «Zolochivskyi Radiozavod» H (g) = 1 have the low level of innovation capacity; JV LLC «Sferos-Electron» C (g) = 0,53 and B(g) = 0,47 – high level and LLC "LEONI Baering Systems UA Gmbh» H (g) = 0,06 i C (g) = 0,94 average level of innovation capacity.

In the process of the corporate culture research the following results have been received: LLC "LEONI Baering Systems UA Gmbh» - 68,4; JV LLC «Sferos-Electron» - 70,4; PJSC «Konveyer» - 53,7; PJSC «Zolochivskyi Radiozavod» - 54,6. The quadratic factor of variation is lower than the overriding criterion, which is characterized by the average level of the corporate culture in the companies concerned, average staff unity, sharing of established values, norms and rules of behavior by the majority of employees, concurrence of goals of the employers and their employees. As far as PJSC «Zolochivskyi Radiozavod» and PJSC «Konveyer» are concerned, this index can sometimes exceed the overriding criterion (33%), which can be explained by lack of knowledge about the situation and the corporate culture from the side of some employees with a big turnover rate, in which case the population can be considered as non-uniform while the average results achieved are not typical.

The selection of the company innovation-driven growth direction is based through its correspondence to specific factors (criteria), with the following major ones: the goals of the company, recourse basis sufficiency (integral estimation of funds sufficiency, material resources, personnel, information, etc.), and level of the corporate culture. Accordingly, the following directions of the company innovation-driven growth are included in correspondence with the company position in the matrix “the level of corporate culture vs. the level of innovation capacity”, which contains three sectors: Field A- the most attractive one, the growth strategies are recommended for the company development. The corporate culture strategy should be aimed at team integration and its needs satisfaction;

Field B – the company has to develop its corporate culture in order to lessen the level of the employees’ resistance either to innovation or to corporate structure changes, which are potent to take place when the integration is present. It is recommended to use integration strategies of the company development. In order to reinforce the level of the corporate culture, it is worth using the strategy, aimed at the integration, control and function stability;

Table 2. Directions of the innovation-driven growth of the business

Levels of innovation capacity and corporate culture of the company	Evaluation of the constituent level	Directions of the company development
Very low	0 ≤ IC < 0,35 0 ≤ OK < 0,35	- search for investors or production diversification; - outsourcing implementation; - change of the business style; - staff changes.
Low	0,35 ≤ IC < 0,5 0,35 ≤ OK <0,5	- new considerable financial input; - consideration of the merger or takeover option; - search for new distribution area; - change of the personnel policy.
Average	0,5 ≤ IC < 0,75 0,5 ≤ OK< 0,75	- change (enforcement) of the company technical basis; - development and implementation of the new innovation projects; - creation of favorable climate for the whole personnel capacity revealing ;
High	0,75 ≤IC< 0,9 0,75 ≤OK< 0,9	- takeover of the other companies (competitors) with high intangible assets; - improvement of the existing corporate culture and enforcement of both internal and external image of the company.
Very high	0,9 ≤ IC≤ 1,0 0,9 ≤ OK≤ 1,0	- the company occupies the leading position and can provide any strategy of its development.

Source: the author’s research

Field C – means that developing the corporate culture, the level of innovation capacity can be increased. The subsidiary enterprise option, which would deal with PTI (Process technology and innovation), should be considered. It would be the proper thing to use strategies of diversification here;

Field D – is the signal for the company to think about essential changes of their corporate culture and use the innovation outsourcing. It should be mentioned that these indexes range can be acceptable on one level of the company development and unacceptable on the other level. For the company on the juvenile level or the level of growth,the rate of 0.5 for the corporate culture and innovation capacity is more than satisfactory.

Possible strategies of the business innovation development with different combinations of the company level of readiness for innovation and corporate culture organization are represented in Table 2.

The businesses can provide their sustained development only due to the timely formulated strategy, which should take into consideration different development options.

CONCLUSIONS

The overall attention to the strategy formation grows constantly, as the competition intensifies and requires fast and adequate reaction for the market condition change. It accentuates the need of the new methods of the company's strategy formation both in terms of complex and verified processes inside the company and in terms of external surrounding and integration of the functional strategies into the single strategy of the company development.

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