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Building a performance factors model for a new design dust collector

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Abstract. The factors hierarchy performance model for a new design dust collector is developed. In addition to ordering the factors by importance of their influence, this model allows further separation of dependent (internal) components to identify the degree of weakening or strengthening of the source factor.

Key words: hierarchy model, linguistic variables, dust collector.

MATERIAL AND METHOS

Every year brings new developments in science and technique, modern technologies and different researches are perfected, but in spite of the positive side, there is a negative one: contaminants increasingly affecting the environment is increased the polluted atmosphere. Atmospheric air is the most important life-supporting environment, which consists of mixture of gases and aerosols of the ground layer of atmosphere created during the Earth evolution. Protection of atmospheric air including ozone layer is the crucial issue of ecology today.

Most people spend 80-95% of their time in office premises. An important factor in their life quality is air. According to the latest statistical estimation the office premises air is 100 times more polluted than the air outdoors.

The principal reason of air contamination in offices are chemical compounds which have got inside. More than 100 compounds can simultaneously be in the air of office premises, including: vapors of lead, cadmium, mercury, copper, zinc, phenol, formaldehyde, in concentrations which most frequently exceed GDK once or twice.

They are:

– poisonous fumes and particles from cleansers used in office premises; their concentration is 1000 times higher than in the open air;
– bacteria, viruses, spores of fungi and mould; fine dust particles smaller than 10 microns, invisible for an eye, practically unseen and constantly hanging midair including dust borne mites and products of their vital functions, which belong to the strongest allergens;
– products of vital functions of man (150 types of chemical matters) and home animals; tobacco smoke and 3600 chemical matters in it;

In the indoor premises the air of which is not exchanged, one litre of air holds up to 300 thousand particles of dust, of 0.5 micro size. From them only 75-80 thousands go back into an environment with exhalation, and more than 200 thousands remain to set in the organism of man, and more precisely - in his bronchial tubes and tracheas! Taking into account that the volume of inhalation makes about 1.5-2 liters of air, it is simple to count that each time we inhale, our respiratory system absorbs about 400 thousand particles of dust and vapors. And everybody processes approximately 7-9 thousand liters of air daily in the quiet state and 6-8 times more in the state of physical activity. Consequently, our respiratory system must somehow "deal" with more than 30 million particles of dust and vapors. Let us remind once again, that in the environment of polluted air toxins are found as well as soot, pulverized grains, spores of fungi, bacteria, microbes, including the disease ones, an enormous list of harmful chemical matters and, finally, home dust. [2,4] Every type of these particles of dust can turn into vapor to become an allergen. Even if these particles do not cause a toxic effect (the mucus shell of bronchial tubes is only irritated mechanically), they remain there for a long time. It is well known that for miners, for heavy smokers, the bronchial light is intensively painted in black color. But also people on average have the black pigment in bronchial lights, even if they never went down in a mine and never smoked.

According to the latest data of statistics there has been a drastic growth of number of pulmonary diseases, al-

lergy and decline of immunity, dynamic growth of deaths, from spastic conditions, chronic bronchitis and asthma.

ANALYSIS OF LATEST RESEARCH WORKS

A lot of technological processes in different fields of industry are accompanied by emissions to the atmosphere of the dust of those materials which are applied in technological processes. For the decline of harmful emissions to atmospheric air, all sorts of dust-catcher devices are set on their sources.

From the large variety of the latter, the widest distribution was enjoyed by cyclones and filters.

The dust aggregates (dry cyclones) with the mechanical method of filtration of air are used for the cleaning of polluted air from the medium-sized particles of different types of dry dust.

The following basic work tasks were in the last years of industry:

– Development of the existing and introduction of new facilities for the cleaning from the emission dust of vent systems and technological processes.
– Conducting researches for taking the inventory of sources of contamination and development of norms for the maximum possible emissions of harmful matters to the atmosphere.
– Research work and development of the operating systems of ventilation for dust removal and promotion of the increase of efficiency of their work.

It is accepted to divide dust catchers for providing of degree of the gas (air) cleaning from dust into: rough, middle and thin.

Rough dust catchers catch particles the size of which exceed 20 microns, middle-over 10 microns and thin - the size of which is below 10 microns. Such classification can serve only for a rough estimate, because efficiency of cleaning from dust depends not only on the sizes of particles but also their physical, chemical and morphometric properties, and it is related to that the same cleaning process can give different results for the dust of different materials.

The purpose of work is the creation of a tool for cleaning of air from dust on a new type of principle in which the considerable increase of efficiency of cleaning is arrived at from dust dispersion and diminishing of hydraulic resistance and sizes.

STATEMENT OF TASK

For many years authors have engaged in the dust collector's development for air cleaning from pollution for various industries [1-10]. A common shortcoming of many famous dust collectors constructions [1] is a significant reduction in their performance caused by the need of their frequent replacement, due to breaks from the high temperature of dust and gas flow, as well as the deterioration of the aerodynamic flow characteristics due to the same reason - high temperature of dust and gas flow, which moves within it. A new design dust collector with heat exchanger (Fig 1) was developed, in which dust and gas stream pre-cooling before entering the apparatus extends its life and improves hydrodynamic and aerodynamic working environment, which in its turn leads to increasing its efficiency and reducing hydraulic resistance [9].

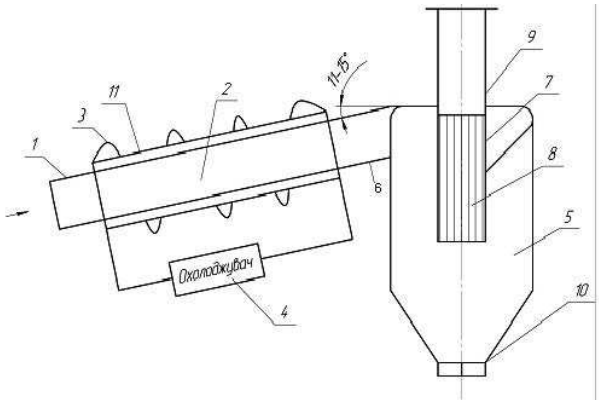

Fig 1. Dust collector with a heat exchanger: 1 - inner tube heat exchanger, 2 - heat exchanger; 3 - coil 4 - cooler, 5 - cylindrical-conical dust collector's body, 6 - tangential inlet pipe;7 - jalousie separator, 8 - jalousie, 9 - exhaust pipe, 10 - dust outlet pipe, 11 - outer tube of heat exchanger

In the process of designing dust collector with a heat exchanger the factors were determined that affect its efficiency. For the heat exchanger those are: hydraulic resistance, dust median diameter, inlet diameter, inlet angle, coolant temperature, type of cooling substance, length of the pipeline, design features of coil. For dust collector: hydraulic resistance, dust median diameter, inlet diameter, inlet angle, casing diameter, dust exit tube diameter, purified air tube diameter, angle of cone, design of jalousie separator. The significance of influence of certain factors on the efficiency of dust collecting was described. It is possible to determine the degree of importance of a particular factor separately, without other side effects. Trying to summarize the data so far formally captures the result, even if it had been proven with factual material [19, 20].

Interestingly, from our point of view, and important in terms of predicting the effectiveness of the proposed design could be studies that use the methods of the previous effect determination of the set of selected factors on the efficiency of the dust collector. An analysis of the nature and methods of various factors proved the need for factors hierarchy model development, which, besides ordering most important influence on the performance of the machine, also enabled further division into subordinate (internal) components to identify the degree of weakening or strengthening of causing factor. Formulation and solution of such problems requires identifying the most complete set of generalized factors, establishing peer reviews of intercommunication in the selected information environment [18]. Let the combination of

such factors be some set Z = {z1, z2, …, zn }. From this set we select a subset of the most significant factors. To illustrate, mathematical notation of factors is provided with their mnemonic names and summarized in Table 1.

Table1. List of factors of efficiency of work of dust collector and their denotation

Mathematical denotation	Name	Mnemonic name
z1	hydraulic resistance	GO
z2	median diameter of dust	MD
z3	diameter an entrance to the union coupling	VP
z4	angle of slope an entrance the union coupling	KN
z5	diameter of corps	DK
z6	diameter to the union coupling of output of dust	DP
z7	diameter to the union coupling of the cleared air	OP
z8	corner of taper of corps	KK
z9	construction of jalousie dust collector	ZHV

Subset of factors z and possible interactions between them is presented in the form of a directed graph (Fig. 1), in the vertices of which are published subsets z_i, arcs connecting adjacent pairs of vertices (z_i, z_j), for which the relationship is defined. It points to the dependence of one factor on another.

Table 2. Dependency Matrix of the initial graph vertices on relationships between factors

		1	2	3	4	5	6	7	8	9
		GO	MD	VP	KH	DK	DP	OP	KK	ZHV
1	GO	0	0	1	1	1	1	1	1	1
2	MD	0	0	0	0	0	0	0	0	0
3	VP	0	1	0	0	0	0	0	0	0
4	KN	0	1	0	0	0	0	0	0	0
5	DK	0	1	1	1	0	0	0	0	0
6	DP	0	1	1	0	1	0	0	1	1
7	OP	0	1	1	0	1	0	0	0	1
8	KK	0	1	0	0	1	0	0	0	0
9	ZHV	0	1	0	1	1	0	0	0	0

Using matrix A, construct a distance matrix. We form a binary matrix (I + A), where I - the identity matrix. As a result, distance matrix must satisfy the condition:

$$(I+A)^{k-1} \leq (I+A)^k = (I+A)^{k+1}.$$

Practically its construction is simplified to fill Table. 3, similar to the above, binary elements of which are defined by the following rule:

1 – if j is available from i,

0 – in another case.

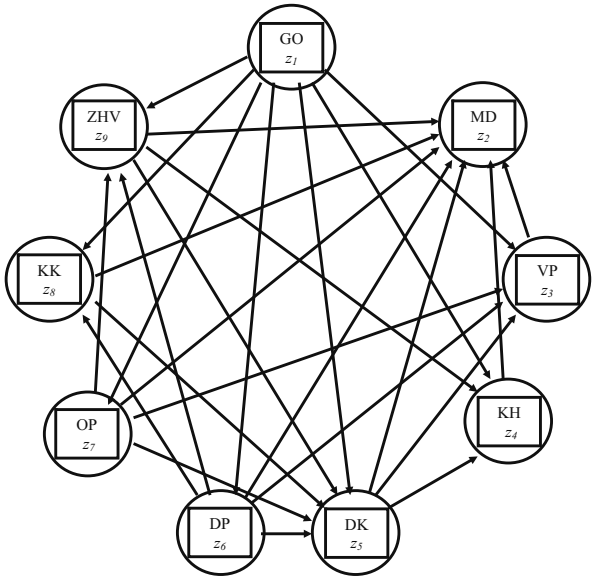

Fig. 2. Output graphic model of the relationship between factors determining the efficiency of dust collector

Based on the graph, a binary matrix A is constructed, accordingly, for the set z_1 [12].

For convenience, the matrix A with 9 × 9 elements dimension was put in Table 2, with information line added as well as the column with mnemonic factors' names.

Table 3. Matrix initial graph heights from relationships between factors

		1	2	3	4	5	6	7	8	9
		GO	MD	VP	KH	DK	DP	OP	KK	ZHV
1	GO	1	0	1	1	1	1	1	1	1
2	MD	0	1	0	0	0	0	0	0	0
3	VP	0	1	1	0	0	0	0	0	0
4	KH	0	1	0	1	0	0	0	0	0
5	DK	0	1	1	1	1	0	0	0	0
6	DP	0	1	1	1	1	1	0	1	1
7	OP	0	1	1	1	0	0	1	0	1
8	KK	0	1	1	1	1	0	0	1	0
9	ZHV	0	1	1	1	1	0	0	0	1

Vertex z_j is achieved from vertex z_i, if in the graph (Fig. 1) there is a path that leads from the vertex to the vertex of z_j. This peak is called achievable. Denote a subset of these nodes through S (z_i). Similarly, vertex z_i is the predecessor of vertex z_j, if it reaches its peak. Let the set of vertices predecessor form a subset of P (z_i).

The final section of subsets of reachable vertices and the predecessors is the subset:

$$R(z_i) = S(z_i) \cap P(z_i), \quad (1)$$

vertex which is not achieved from any of the remaining vertices of z1 determinates the priority level of the factors hierarchy attributed to these vertices. An additional condition for this is to ensure equality.

$$P(z_i) = R(z_i). \quad (2)$$

Implementation of the above set of actions gives the first level (the lowest in terms of importance to study the impact process) of factors hierarchy. To determine it on the basis of the previous, a matrix is constructed.

Table 4. Iterative table for the first hierarchical level factors formation

i	$S(z_i)$	$P(z_i)$	$S(z_i)\cap P(z_i)$
1	1, 3, 4, 5, 6, 7, 8, 9	1	1
2	2	2, 3, 4, 5, 6, 7, 8, 9	2
3	2, 3	1, 3, 5, 6, 7, 8, 9	3
4	2, 4	1, 4, 5, 6, 7, 8, 9	4
5	2, 3, 4, 5	1, 5, 6, 8, 9	5
6	2, 3, 4, 5, 6, 7, 8, 9	1, 6	6
7	2, 3, 4, 7, 9	1, 7	7
8	2, 3, 4, 5, 8	1, 6, 8	8
9	2, 3, 4, 5, 9	1, 6, 7, 9	9

The second column of Table 4 - numbers of single elements for corresponding rows of reach matrix, third - numbers of single column elements for the matrix.

Equality (2) is performed for the 1st factor - hydraulic resistance of dust collector (GO).

According to the hierarchy analysis method [16], this factor belongs to the lowest level of the factors that determine the efficiency of the dust collector. Then, from Table 4 line 1 is removed, and in the lines 2-9 number 1is removed. We will get Table 5, which is the basis for calculating the second iteration of finding factors numbers that determine the next level of the hierarchy.

Table 5. Iterative table to form the second hierarchical level factors

i	$S(z_i)$	$P(z_i)$	$S(z_i)\cap P(z_i)$
2	2	2, 3, 4, 5, 6, 7, 8, 9	2
3	2, 3	3, 5, 6, 7, 8, 9	3
4	2, 4	4, 5, 6, 7, 8, 9	4
5	2, 3, 4, 5	5, 6, 8, 9	5
6	2, 3, 4, 5, 6, 7, 8, 9	6	6
7	2, 3, 4, 7, 9	7	7
8	2, 3, 4, 5, 8	6, 8	8
9	2, 3, 4, 5, 9	6, 7, 9	9

In the second iteration the equation (2) is performed for the factors with numbers 6 and 7, indicating a place that hold dust exit tube diameter (DP) and purified air tube diameter (OD) of dust collector among the factors that determine the effectiveness of its operation. These factors determine the next level of the hierarchy. Then, from Table 5 lines 6 and 7 are removed, and in 2-5, 8 and 9-th line - numbers 6 and 7 , thus obtaining Table. 6.

Table 6. Iterative table to form the third hierarchical level factors

i	$S(z_i)$	$P(z_i)$	$S(z_i)\cap P(z_i)$
2	2	2, 3, 4, 5	2
3	2, 3	3, 5	3
4	2, 4	4, 5	4
5	2, 3, 4, 5	5	5

The third iteration gives us the next hierarchical level of future model. From Table 6 we see that this level will be formed by two factors - the cone shell angle (CC) and the jalousie separator design (WO). From Table 7 we can determine the fourth hierarchical level of the model that is constructed.

Table 7. Iterative table to form the fourth hierarchical level factors

i	$S(z_i)$	$P(z_i)$	$S(z_i)\cap P(z_i)$
2	2	2, 3, 4, 5	2
3	2, 3	3, 5	3
4	2, 4	4, 5	4
5	2, 3, 4, 5	5	5

From Table 7 we can see that the next level will be 5 the factor - the diameter of the shell (DC).

Table 8. Iterative table to form the fifth hierarchical level factors

i	$S(z_i)$	$P(z_i)$	$S(z_i)\cap P(z_i)$
2	2	2, 3, 4	2
3	2, 3	3	3
4	2, 4	4	4

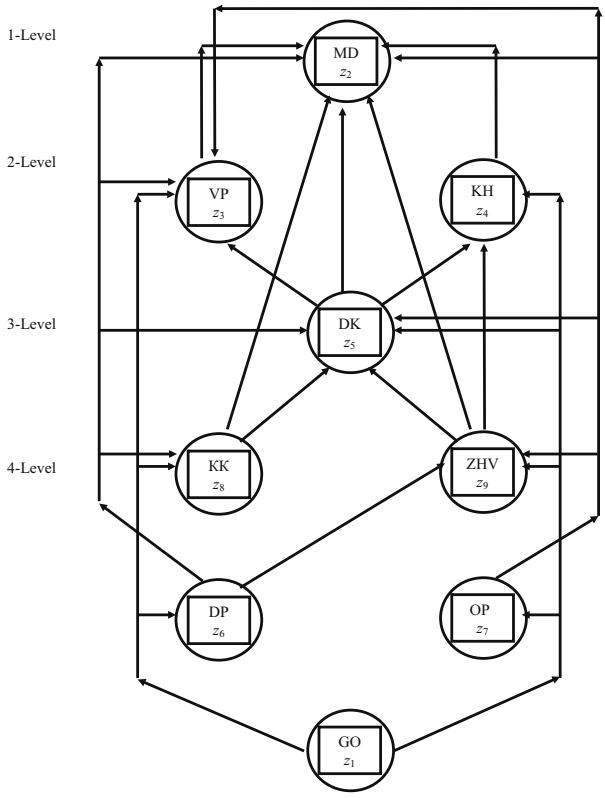

Fig. 3. Model of factors hierarchy that determines efficiency of the dust collector

CONCLUSIONS

It should be noted that the result of inclusion of selected factors to the appropriate hierarchical level is objective in so far as its validity is provided by using known principles of the theory of system analysis, modeling theory, research and solving problems methodology. The appearance of concrete barriers at some level depends on established links between them, given in the original graph (Fig. 1). Their numbers and substances change will cause the resulting modification of the model. If each of the factors will be evaluated by some number or will be given appropriate weighing priority of factors on the efficiency of the dust collector, then, as follows from Fig. 2, the weight factor will correspond to the number of hierarchy levels. However, the priority of factors on the efficiency of the new design dust collectors is of the relative size and can be changed depending on the expertise measurements of the impact factor on the investigational process. As a result, probabilistic performance factors hierarchy model of the developed device is synthetised, and on its basis in the first approximation, the model of priority factors influencing the efficiency of the new design dust collector. The results, in our opinion, may be subject to adjustment during these studies.

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Competition as a strategy of enterprise functioning in the ecosystem of innovations

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Abstract. The article deals with the problem of providing the innovation activities of Ukrainian enterprises based on the competition strategy in the market of innovations. It describes new trends in the interaction of innovative process participants in competition and cooperation in competitive environment. The main results of the marketing studies of innovative activity of Ukrainian enterprises and their cooperation are given. The principles of competition as a form of interaction in the ecosystem of innovations are explained.

Key words: ecosystem, ecosystem of innovation, business environment, strategy of enterprise, cooperation, competition

INTRODUCTION

Rapid growth of complexity and turbulence of business environment, increase of the competition and consumer demands, fast development of information and communication technologies are changing the conditions in which enterprises function and require improvement of their management practices. Turbulence in business causes significant changes. Under such conditions, old-fashioned way of doing business becomes out-of-date, and business environment is filled with spontaneity and risks. There is one interesting fact: business environment calls for significant changes in the very process of doing business. This especially relates to the continuous process of introducing innovations to business.

These conditions increase the importance of the innovative environment, which, in its turn, becomes the source of management practice development and generates progressive knowledge, first-hand experience and contributes to the adaptation of enterprises to external environment. This is accomplished by providing strategic information, supporting implementation of organizational changes and professional development of management authorities. Hence, on the one hand, external business environment requires choosing optimal forms of co-existence of enterprises in business environment; on the other hand, it requires developing and mastering innovations in order to achieve competitive advantages in the market.

The subject of the present study is contradictory nature of interaction of innovative process participants in competition and cooperation in competitive environment. The aim of the article is the investigation of the essence and constituent parts of the competition in high-tech markets as well as the principles of competition as a form of interaction, investigation of the dynamics of the innovation activities of the enterprises and the concept of cooperation in the market of innovations.

NATURAL APPROACH TO ECONOMICS AS A SCIENCE

Over the last decades in economics, great attention is drawn to the natural approach to science, which becomes more and more popular. Natural approach is grounded on the fact that interpersonal relations of the people inside organizations are a part of the large processes that are going on in nature. Radical changes in external environment stipulate the need for changes in basic concepts in the framework of the main scientific theory – paradigm. In this case we refer to the transformation of the management paradigm. According to the theory of famous scholar T. Kuhn [8], described in detail in his work entitled "The Structure of the Scientific Revolution", the paradigm shift means "…comparing of two paradigms with the nature as well as comparing one paradigm to another one…".

According to some scholars [18], applying terminology pertaining to nature in non-traditional spheres of its application, as is the case with management contributes to better understanding of the phenomena and creates the possibilities for seeing the facts on the background

of wide range of processes. This terminology creates certain analogies between the processes going on in nature, technology, and inside the organizations. Let us take, for instance, organizational structure. Organizations with strictly hierarchical structure are like mechanical systems, i.e. mechanisms, in which each of the elements has its own place and performs its own, detailed and strictly determined function. On the other hand, flexible organizations that easily adjust to changing conditions of the environment are called organisms. Both types of analogies determine the key features of a certain type of organizational structure.

A psychologist J.F. Moore from Harvard University in his book "The Death of Competition" [10] (J.F. Moore, 1996) has introduced the notion of "ecosystem of entrepreneurship". In nature, ecosystem is a complex group of interdependent living beings (flora, fauna, insects, micro organisms) and non-living elements (ground, water, climate), which are constantly interacting with one another and take advantage of this interaction on a definite territory. By analogy with nature, an ecosystem in market economy is described as a complex group of companies, customers, suppliers, competitors and distributors that influence the business of individuals, groups, and partners, and take advantage of that interaction. In the customers' ecosystem market activities (investments, joint product developments, market communications, logistics, and transactions) are performed and controlled not so much by suppliers as by consumers [9].

AN ECOSYSTEM OF INNOVATION: ITS ESSENCE AND MAIN PARTICIPANTS

The basis of key competencies has to include the whole value chain – from suppliers to consumers. Therefore, foreign scholars in their works more and more often treat enterprise as an open system that seeks additional, external means needed for its development and creation of sustainable advantages in competition somewhere outside its boundaries. To be more particular, in this case we are dealing with the following modern concepts of partner integration to innovative activity: leadership platform; integrator's strategy; a model of open innovations; value network; learning organization; hyperlinked organization.

Developing the theory of G. F. Moor, American scholar Ron Adner [1] introduced the notion "ecosystem of innovation" and explained it as the forms of cooperation, in the framework of which organizations unite their individual offers into integrated decisions, ready to be used by a consumer in the market. The use of information technologies greatly reduces expenditures for communication and coordination of actions, therefore, innovation ecosystems became the foundation of the enterprise growth strategies. Strategies that are based on ecosystems are implemented in different sectors, such as: polygraphic services for industrial markets, financial services, production of materials, logistics, etc. However, this trend is the strongest in the high-tech markets. Excellent examples of the enterprises following this strategy are such companies as: Intel, Nokia, SAP, and Cisco. Well-established functioning of these companies' ecosystems allowed them to create value that would not be possible to be created by any of these companies on its own, even by the most powerful ones.

Different market participants are functionally connected to each other by information flow through influence and economic consequences for creating demand (directly or indirectly) for goods and services. They form complex network of cooperation and competition. Consumer ecosystem functions in the framework of strictly determined macro marketing environment and can be almost completely modified as a result of the appearance of technological innovation. This was the example of digital technological revolution in the photography, when as a result of tough competition digital picture-taking turned to become a global digital industry with new possibilities of taking pictures, developing and storing them, and the emergence of new competitors that previously existed in the markets of electronics and entertainment (Sony) and computer industry (Hewlett-Packard).

In the ecosystem of innovation there are involved different market participants that are usually members of the chain supply. This regroups all stages of production starting with the purchase of raw materials, their processing, collecting and ending with their selling to the final customer. All these activities are performed in the global traditional and online markets. Graphically, the ecosystem of innovations may be represented in the form of interaction between key participants in the global market, as shown in Figure 1. As it is shown in Figure 1, the ecosystem of innovations is formed first and foremost of the forces, analyzed in detail by Michael Porter: direct suppliers, producers – direct competitors, final customers, suppliers of the substitute goods. The ecosystem is also greatly influenced by various middlemen: trade, marketing, logistical, financial ones.

In industrial markets it is important to take into consideration possible influence made by the so-called influential people, which do not belong to the category of consumers or users. However, their advice should be always taken into account when making the final decision concerning the purchase of the innovation. These influential people include engineering companies, independent designers, experts, architects, consulting companies, and in pharmaceutical sphere – doctors. In social market economy great influence on business is made by contacting audiences of the innovation ecosystems, such as the mass media, trade unions, organizations for protection of animals, consumer protection organizations, etc.

Facilitators are groups of suppliers in traditional and online markets, which attempt creating the relevant market infrastructure and guarantee the safety of market operations. In the traditional market facilitators are represented by banks, customs offices and tax services. In the online market the role of facilitators is performed by the providers of the Internet and agencies, providing the relevant services via the Internet, including the information middlemen.

Therefore, the business environment under investigation allows us to study all the relations and dual nature of strategies in the relations of enterprises as market participants in the ecosystem of innovations.

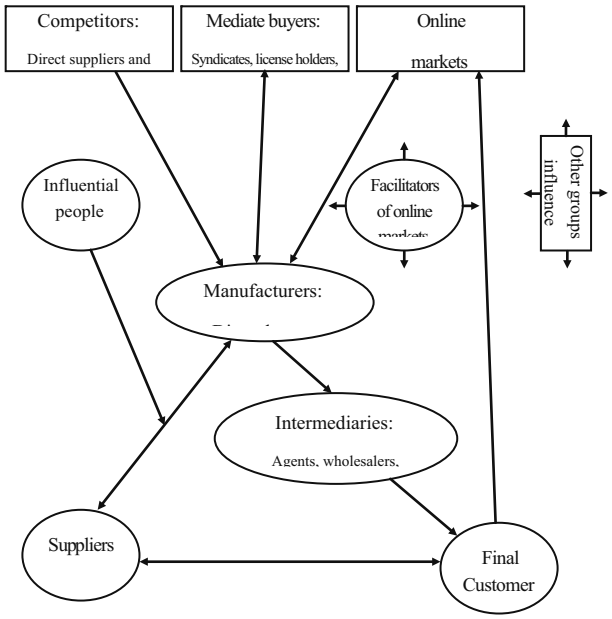

Fig. 1. Key players in the global market and limit innovation ecosystem

Source: *Market-Driven Management: Strategic and Operational Marketing // Jean-Jacques Lambin, Ruben Chumpitaz and Isabelle Schuiling// Second Edition. –N.-Y.: PALGRAVE MACMILLAN, 2007.* - 76

COOPERATION AND COMPETITION IN THE MARKET OF INNOVATIONS

Functioning in competitive environment, every enterprise chooses its own competition battle strategy and has to take strategic decisions concerning its conduct in relation to its competitors. Modern competition is more than a "product against product" or "efficiency against inefficiency", it is "non-linear" innovation against "linear" one [14]. Competition battle strategy or competitive strategy is the totality of interrelated actions, aimed at achieving sustainable competitive advantage in order to secure for an enterprise a beneficial market position, leaving behind its competitors.

Some of the most studied strategies in scholarly literature and the ones that are most widely used in strategic management practices are confrontational strategies. They represent direct competitive battle using a variety of instruments such as: commercial spying, building strategic maps of competitors, matrix of competitive advantages, etc. Other strategies that are quite often mentioned in literature are the strategies of cooperation and mutual agreements between market participants. This is so-called "side-by-side" competing, which has been analyzed in detail by M. Porter in his book "Competitive Strategy" [11].

In order to restrict or avoid direct confrontational contest, enterprises seek other places of differentiation, new positioning, try to attract new clients etc. In mature markets, however, in a long-term period of time, these innovations do not provide significant increase in sales volume. Sometimes there may be observed the phenomenon of "cannibalism", when the products of one group "consume" the products of another group. The scholars Chan Kim and Renee Mouborgne in the book "Blue Ocean Strategy" [3] figuratively refer to the competitive markets as "red oceans" filled with blood of their competitors, ready to destroy one another. In the "red ocean" there are strictly defined market boundaries and principles of the work in sectors are the same for all participants. Products of the competitive companies have similar qualities, and the differences between them quickly disappear as a result of time and benchmarking.

To oppose the existence of "red oceans" Chan Kim and Renee Mouborgne have developed a special "*blue ocean strategy*". This was the result of the study of over thirty sectors of the economy over the last hundred years. In order to avoid the competition the scholars advocate creating the "blue oceans" – new ideas and markets. The "blue ocean" – does not consist of technological innovations, it is first and foremost the result of successful strategy and careful management decisions. It represents a free niche of the market, which is created by an enterprise. This niche encompasses unsatisfied needs of different groups of customers; focuses on key criteria of making choices and evaluating the product; and is oriented at attracting customers from various markets.

Conducting of innovative activity does not only mean confronting other competitors, but it also presupposes cooperation with other market participants, first of all, with consumers, suppliers, middlemen, and other influential groups.

Challenges and possibilities set by the modern market, can be too high to be accomplished by one enterprise on its own. Therefore, the key for success is to transform market partners that are passive market participants into active ones. Let us analyze some of modern examples of cooperation in innovative activity, as illustrated in the book by K. Prahalad and V. Ramaswamy [12]. As per initiative of InnoCentive, pharmaceutical company Eli Lilly attracted the skills of more than 8 thousands of scientists to solve the scientific problems, related to different complexity of medicine. Though Lilly is spreading its research and development basis, using the competencies outside the boundaries of the company, it carefully controls all the processes.

Sony created the remote control Play Station for operating system Linux. Having equipped Linux software with tools necessary to develop Play Station programs, Sony is coopting competencies of the consumers and spreading the Play Station as the main platform in the sphere of entertainment. (Contrary to Eli Lilly, which controls the development of its own products by attracting scientists, who are not employed by the company, Sony attracts consumers directly for the development of its platform).

The positive side of the cooperation is revealed under information and technological revolution conditions. In competitive policies of the globalization era there can be traced interactions between market participants aiming at reaching different types of economic efficiency: allocation efficiency (efficiency of allocating resources in alternative means of their use), production efficiency (optimizing the size of the factory and the company), dynamic efficiency (efficiency of the sector as a constantly developing structure; innovations implementation, which reduces expenses; development of incentives to invest).

This is the way, as American scholar Ron Adner suggests, how an "ecosystem of innovation" is formed. The fact of existence of cooperation, however, does not imply the absence of competition and vice versa. Complexity of the task is that we need to understand each of these terms not only as separate phenomenon, but also treat them as their own opposites [1].

In the attempt to emphasize the peculiarity of the market economy, i. e. the "competition or cooperation" dilemma, scholars A. M. Brandenburger from Harvard University and B. G. Nalebuff from Yale University have developed the theory of "co-competition" or competition [2]. According to these scholars, in business there is no fatal predetermination of success of some companies and failure of others, because many participants can get a certain kind of benefit. In this context, the scholars suggested applying the theory of games, which, in their opinion, will give the possibility for making flexible combinations: change the participants at will, modify values of the business participants, determine the rules and tactics of the game, its framework and scale.

For example, well-known automotive companies follow the competition strategy, flexibly using strong sides of both opposite concepts under different tasks. Hence, Volkswagen is constantly contesting Ford in the attempt to occupy the compact cars market share. On the one hand, fierce competition leads to increase in aggressiveness towards the enterprise's competitors. On the other hand, these enterprises are united in other industrial sectors of the market, for example, in the development of the full-size car models [17].

Alliance as a form of partnership in innovative activity is peculiar mostly to the companies working in the pharmaceutical field. Over the period since 1997 to 2002 more than 20 largest world pharmaceutical companies formed over 1,500 alliances with various biotechnical companies. According to the data published in the "Pharmaceutical Executive" journal and released in May, 2004 by "Strategic Decisions Group", which is a consulting company, 40-50 % of products that are in the stage of their development used to be licensed ones and more than a half of total prescription medicine that is best sold is being developed or is being sold by several companies. As it has been proved by studies, alliances allow companies to reduce up to 15 % of their current expenditures, cut their expenses in developing similar medicine, and increase the research potential in general. Moreover, companies benefit from such forces as capital increase, access to additional credit lines, reducing similar divisions existing in different companies [16].

Competition strategy (which is the combination of cooperation and competition strategies) is used in working with trade middlemen (for example, in the process of new product development and its introduction to the market, in trademark policies, in direct market sales).

MARKETING STUDIES OF INNOVATIVE ACTIVITY OF UKRAINIAN ENTERPRISES AND THEIR COOPERATION

Marketing studies have been carried out in the framework of the Department of Organizational Management of Lviv National Polytechnic University in correspondence with the government-funded theme DB/LANTS "Innovative Enterprise Management Processes in Value Chains" (government registration number 0110U001094, approved by the order of the Ministry of Education and Science of Ukraine № 686 as of July 22, 2009).

In order to estimate the dynamics of the innovative potential development of the enterprises in national economy, the results of the conducted survey in certain groups (such as items 2 and 3 of the present study as shown in the Table 1), were compared to other studies, similar in structure.

Those studies included "The Study of the Strategic Forces of Innovative Environment in Western Region" and "The Study of Innovative Potential of National Industrial Enterprises", accomplished in 1999 and 2002, respectively.

In order to calculate the representative sample we used the methodology of selective observation theory, according to which optimal representative sample value is calculated according to the formula $n = \frac{V_x^2 \times t^2}{V_\Delta^2}$, where V_x – is the coefficient of variation of the feature; t – is the level of trust; V_Δ – is the coefficient of variation of marginal deviation. Coefficient of variation of marginal deviation is $V_\Delta = 5$ and level of trust 0,954 → t = 1,96. According to the previous observation of the sample, the coefficient of variation of the feature for this particular sample equals $V_x = 0{,}21$. Consequently, optimal representative sample value is:

$$n = \frac{(0,21)^2 \times (1,96)^2}{(0,05)^2} \approx 68 \text{ (enterprises).}$$

Comparison of the parameters obtained from marketing studies is shown in the Table 1. The number of organizations that participated in the survey can be considered quite representative of the tendencies on the whole. Let us analyze the survey results and its dynamics at each of the stages of the survey in different periods.

Table 1. Comparison of the Parameters Obtained From Marketing Studies

Characteristics of the study	The study of the strategic forces of innovative environment in Western region	The study of innovative potential of national industrial enterprises	The study of the barriers in innovative activity development and possibilities to increase its efficiency
1. General sample size	92 respondents	141 respondents	84 respondents
2. Coefficient of variation of the feature for the sample of this study	0,25	0,25	0,21
3. Maximum deviation of the sample	10 % with the possibility 0,95	5 % with the possibility 0,954	5 % with the possibility 0,954
4. Optimal sample size	*74 respondents*	*96 respondents*	*68 respondents*
5. Period of data collection	*March –June, 1999*	*February-May, 2002*	*May-October, 2010*
6. Place of data collection	*Offices of industrial enterprises, situated in Lviv oblast and in Kyiv*		
7. Method of data collection	personal survey		
8. Means of data collection	questionnaire	questionnaire	questionnaire
9. Structure of the study	Identification of factors contributing to success or failure of innovations as implemented by the organizations under study	1. Identification of factors contributing to success or failure of innovations as implemented by the organizations under study 2. Investigation of the main types and directions of innovative activity of the enterprises, identification of the sources of innovation supply and means of financing the innovations.	Collection of general data related to the functioning of the enterprise. Evaluation of the innovative activity of the enterprises and their research and development work. Evaluation of the effectiveness in implementation of innovations. Evaluation of cooperation and relations with partners.

Source: results of the author's own research

The results of the survey prove the fact of importance of formation and implementation of innovative potential of the enterprise. This contributes to developing sustainable competitive advantages in the market, attracting consumers, and consequently, achieving increase in efficiency of the enterprise and its goals. In general, innovative potential of industrial enterprises is constantly developing in dynamics, which requires carrying out its systematic analysis and monitoring.

In comparison with 1999 and 2002, in 2010 there has been observed positive dynamics in the following directions:

– increase in the number of innovation active enterprises;
– increase in the number of organization and management innovations;
– increase in the role of organizational factors in market introduction of successful innovations;
– decrease in negative influence of taxing in market introduction of innovations.

Negative dynamics can be observed in the following areas:

– low quality level of innovation activity of the enterprises;
– increase in the gap between science and production;
– lack of external sources of financing the innovation activity, which his proved by the fact of increase in financing using internal sources of the enterprises and reduction of financing using credits;
– decrease in scientific and technical levels of national industry and lack of highly-qualified human resources in the labour market;
– considerable decrease in innovation activity of well-established partner relations in creating value chain of innovation and decrease in the intentions to improve this situation;

In the course of the survey the respondents were asked to assess their partner relations with other market participants, such as suppliers, scientific institutions, competitors and financial establishments, choosing one of the following answers: well-established cooperation; planning of establishing cooperation; no plans to establish cooperation; not known. The results of the survey are presented in the Table 2.

The priority in establishing partner relations in 2012, as in the previous years, was given to suppliers (81 %). Only 18 % of the respondents are closely cooperating with scientific and educational institutions – these are mainly the enterprises that either have research and development departments in their subdivisions or those that closely cooperate with the relevant subdivisions of higher educational institutions. For instance, companies offering architecture services are actively cooperating with the departments of architecture, building or geodesy.

Nonetheless, around three quarters of the enterprises that participated in the survey are planning to establish close relations with scientific institutions in the near-

Table 2. The presence of cooperatives and partnerships (percentage of respondents, %)

Cooperation with the	Established close cooperation in the years		It is planned to establish close cooperation in the years		Not planned establishment of close cooperation in the years		Do not know yet
	2002	2012	2002	2012	2002.	2012	2002
Suppliers	84	81	–	14	–	5	16
Universities and scientific organizations	35	18	23	21	15	61	27
Rivals	38	29	8	9	23	62	31
Finance organizations	61	31	4	23	15	46	20

Source: results of the author's own research

est future. The most uncertain are the relations of the respondents with their competitors, as according to the study, less than a third of the enterprises that participated in the survey have partner relations with their competitors (29 %), and 62 % of the respondents do not plan cooperating with competitors, which is proved by the application of active confrontational strategies in competition in the national market. Competition strategies in the majority of cases are not used by Ukrainian enterprises.

CONCLUSIONS

In order to achieve success and sustainable competitive advantages in the market, enterprises have to develop, understand, and introduce innovations to the market. Modern market is a complex system of relations between companies, buyers, suppliers, competitors, and distributors that influence the business of individuals and groups, as well as partners that benefit from one another. In the ecosystem of innovations market activity (investments, joint product development, market communication, logistics, and transactions) are performed and controlled not so much by suppliers as by consumers. In order to develop and understand innovations an ecosystem of innovation is formed. It engages different market participants that are usually part of the economy sector supply chain incorporating all stages of production starting with the purchase of raw materials, their processing, collecting and ending with their selling to the final customer. Enterprises in the ecosystem while pursuing their own goals, can compete and cooperate at the same time, and this phenomenon has been described in the foreign literature as "co-opetition".

The results of the marketing study accomplished by the author of the present article were conducted in the framework of research corresponding to the government-funded theme DB/LANTS "Innovative Enterprise Management Processes in Value Chains" and prove low level of cooperation in innovation activity. Moreover, there has been traced a tendency towards reduction in cooperation and loss of trust to almost all potential market partners, this especially concerns scientific and financial institutions. Nevertheless, modern competitive environment requires from entrepreneurs mastering new approaches to competing in the market. One of the possibilities is to create new market space in order to avoid face-to-face competition and establish constructive relations with competitors, which would contribute to increase in efficiency of functioning in the market through implementation of effective innovative projects and programs. In this case we speak about alternative approaches to changing the competitors' behaviour, which can be revealed in dual character of competition strategy. Implementation of the competition strategy, i.e. cooperation with competitors simultaneously contesting with them (for example, in different functional spheres, market sectors, in different countries) gives the companies the possibility to flexibly use strengths of the opposite competitive concepts while solving various tasks.

Efficiency of the innovation processes of enterprises can greatly increase on condition of cooperation and partnership with other market participants, first of all, with suppliers, middlemen, users, especially at the early stages of innovation implementation. Therefore, tracing successful examples of cooperation in Ukrainian market of innovations and thorough investigation of methods and techniques used in this process, will be the subject of our further studies.

In functioning of the ecosystem there rises the issue of synchronizing the efforts of its main participants that are involved in the process of creating and introducing the innovation to the market. The mechanism coordinating the efforts of all ecosystem participants as well as the problem which organization in particular has to assume the role of the coordinator, have not been much researched in literature on innovation issues. This will also be the subject of author's further studies, particularly in the framework of research carried out by the staff of the Department of Organizational Management of Lviv National Polytechnic University in correspondence with the aforementioned government-funded theme DB/LANTS "Innovative Enterprise Management Processes in Value Chains".

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Analytical instruments of management development of industrial enterprises

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Abstract. In this article the modern analytical instruments of management development of industrial enterprises are analyzed taking into account the values of their financial-economic indexes and the level of potential. The modern methods of evaluation and analysis of development of enterprises are considered and analyzed. The indirect method of evaluation of the level of development of enterprises is offered taking into account the level of its potential and middle growth of gross receipt rate. The areas of development of enterprises are graphically presented as well.

Key words: analytical instruments, management development, evaluation of development, indirect method of evaluation, system of evaluation indexes.

INTRODUCTION

The necessity of management development by objectives appears before industrial enterprises in unsteady economic conditions [3] taking into account the dynamics of environment that lead to the problem of choice of adequate analytical instruments. A construction of the system of indexes' analysis and evaluation of the level of enterprise's development is an actual and top priority task. Increase of the amount of indexes according to multi-criteria approach results in creation of the system of indexes, each one objectively represents an action of separate factor on development of enterprise. Establishment of integral estimation with a limited amount of indexes meets a range of problems: establishment of relative ponderability of indexes; choice of type of indexes; taking into account the action of the law "mono-bi-poly" in the process of generalization and transformation of the system of indexes; comparison of values of indexes of different measurement (natural, cost, labour, absolute, relative, middle etc.) and forming an overestimation etc.

It is obviousl that the method of evaluation of level development of enterprises must contain the least of indexes in the system of analysis and evaluations, including indexes of dynamics that will provide objectivity of estimation, evident character of interpretation of numerical values of indexes and comfort of operation.

Many works of domestic and foreign scientists such as B. Andrushkiv, M. Bakanov, M. Barankevych, V. Gerasymchuk, P. Drucker, A. Zagorodnii, O. Melnyk, R. Kaplan, M. Korobov, O. Kuzmin, D. Norton, I. Oleksiv, M. Porter, Ye. Raievniva, Zh. Ryshard, M. Tymoshchuk, J. Schumpeter etc. are dedicated to development of various instruments of management development of industral enterprises. However, there is no unambiguous idea of expediency of the use of this or that method, model or system of indexes. Because of this, there is a necessity of forming universal effective analytical instruments of management development of industrial enterprises.

ANALYTICAL INSTRUMENTS

In scientific literature [19] it is marked that it is possible to consider evolutional and progressive types as basic types of development, that lead to qualitative, quantitative and structural changes. In unsteady economic conditions development of enterprises depends on the dynamics of commodity market, the conjuncture of which is continuously changing [22], which influences the qualitative and quantitative descriptions of their development. Thus, for the indexes of rows of dynamics with the help of which the results of industrial and economic activity of enterprises is analysed, high variation of their levels is typical, so far as development of subjects of management is not instant, but it is a continuous process of quantitative and qualitative changes in their activity [17]. Melnyk L.G. has the same idea and he marks that development is not always connected only with positive changes, as it is accompanied by a chance and vagueness [12].

In connection with the above-mentioned it is possible to come to the conclusion, that action of "gold rule of economy" according to the dependence between the rates of change of indicators of development of enterprises, spreads to the economies that are developing in an evolutionary way [8, 11, 14]. The dependence:

$$T1>T2>T3>T4>T5>T6>T7>1, \quad (1)$$

where: $T1 \div T7$ – rates of profit's change, circulating assets, income from realization, costs of assets, fixed assets, cost price of output, quantity of workers in most cases cannot serve as a criterion or norm of comparison, as far as saltatory development is not accompanied by the proportional change of qualitative and quantitative parameters of enterprises in force of inertion of production as an economic system. Not by chance in the works of Melnyk O.G. [13] it is marked that the dynamics of individual indexes of development for a certain period can substantially differ as to volume and aspiration.

At the evaluation of level of development of enterprises it is possible to use the following instruments of analysis and management development of enterprises [18]: SWOT- analysis, STP- analysis, GAP- analysis, strategic Porter's model, matrix of BKG, matrix of "Mak-Kinsi" etc.

Modern systems of indicators of management and evaluation of development of enterprises are noteworthy to compare and they are widely inculcated on domestic enterprises (Table1).

In spite of existence of the already worked out systems and models in unsteady economic conditions there is a requirement in the universal and a reliable instrument of analysis and evaluation of the level of development of enterprises.

INDIRECT METHOD

The ground of choice of the system of indicators of evaluation the level of development of enterprises is

Table 1. Comparing systems of indicators of evaluation of development of enterprises

System of indexes	Characteristic	Advantages and disadvantages
Tableau de Bord [10]	Evaluation of productive and financial aspects of the state concordantly to the hierarchical system of indicators for every enterprise.	Advantage is a presence of having a special purpose and functional indexes with clear reason and consequence connection. Disadvantage is not regulated quantity of indicators that is not adjusted to the existent system of account and accounting.
Balanced Scorecard [9]	An evaluation of development of enterprises according to 4 prospects(finances, clients, internal processes, studies and development) that have reason and consequence intercommunications and formalize strategy of enterprise.	Advantages are the uses of financial and not financial indexes with a limited amount of them (not more than 25), presence of retrospective and prognosis indicators, intercommunication with strategy. Disadvantages are policriterian system that leads to difficulties in determination of key indexes for a separate enterprise and unadjustment to the existent standards of account of industrial and economic activity.
Model of L.S. Maisel [16]	An evaluation of development of enterprises is according to 4 directions (finances, clients, internal processes, human resource) that formalize strategy of enterprise	Advantage is introduction of prospect of human resource that plays one of qualificatory roles in activity of enterprise. Disadvantage is modification of the balanced system of indexes on the basis of out-of-date resource approach.
Performance Pyramid R. Lynch., C. Cross [16]	Evaluation of efficiency on the basis of 10 blocks(strategy, finances, market, satisfaction of consumers, innovation and studies, productivity, quality, time of delivery, productive cycle, defect) with clear hierarchy of management levels.	Advantage is the development of blocks of indexes for every hierarchical level of management of enterprise with a limited amount of indicators 1-2 on each aim. Disadvantage is the absence of reason and consequence connections and intercommunication with the system of account and accounting.
Model EP2M –Effective Progress and Performance Measurement (C. Adams, P. Roberts) [1]	Evaluation of 4 spheres of activity : management and realization of strategy of development; increasing of efficiency of activity; strengthening of power of proprietors and independence of workers; maintenance of consumers and market.	Advantages are analyses of indexes as an internal enviroment and an external environment as well, orientation on forming corporate culture. Disadvantages are policriteriation and absence of clear regulation of universal indicators for enterprises.
Model of stakeholders [7]	An orientation of activity of enterprise is on the grouped target audiences and satisfactions of their expectations.	Advantage is taking into account expectations of groups of influence for the best achievement of aims of enterprise. Disadvantage is contradiction of stakeholders (investors, proprietors, workers, creditors and others like that), that results in lobbying of short-term interests instead of long-term development.
Prism of efficiency [15]	A model includes the evaluation of pleasure and payments of stakeholders taking into account additional elements(strategy, processes, possibilities)	Advantage is combination of model of stakeholders and balanced system of indexes of Kaplan-Norton with all their features. Disadvantage is forming the group of indexes for every stakeholder that leads to a big ammount of indexes and complication of their analysis.

Table 2. Distribution of respondents after priority of basic indexes of level of development of enterprises

Indexes of level of development of enterprises (research objects)	Amount of people who were asked and order in which they specified indexes											
	1	2	3	4	5	6	7	8	9	10	y_i	y_i^2
1. Gross receipt	23	19	21	16	8	4	2	1	1	1	293	85849
2. Profitability of products	9	6	14	14	13	12	9	7	7	5	488	238144
3. Capital productivity	21	17	10	12	16	9	5	3	2	1	354	125316
4. Specific gravity of products on an export	5	13	7	14	15	10	14	10	6	2	495	245025
5. Increase of workplaces	4	2	4	4	7	13	10	13	18	21	695	483025
6. Market share of products	2	1	3	7	4	10	10	13	21	25	734	538756
7. Operating charges	14	11	12	6	9	9	8	13	7	7	488	417316
8. Market value of enterprise	3	11	8	8	11	13	16	17	6	3	546	298116
9. Level of management of personnel	5	6	5	6	7	9	12	12	19	15	646	238144
10. Innovativeness of products	10	10	12	9	6	7	10	7	9	16	541	292681
Total	96	96	96	96	96	96	96	96	96	96	5280	2962372

**Note:* it is expected by an author on the basis of undertaken studies.

expedient to carry out on the basis of research of experts' opinions. Domestic industrial enterprises are general totality in the process of research of factors of influence on the level of development of enterprises. The spatial sign of general totality is a western region of Ukraine and branch sign is a sphere of industry. The units of analysis, in other words the elements of selective totality, that is the subject to study, serve as an administrative link and specialists that are straight or mediate related to the management of development of industrial enterprise.

A questionnaire is selected as research instrument in the process of analysis of factors of influence and evaluation of ponderous character of indexes of development of industrial enterprises. There are certain tasks of marketing research, that are presented in a questionnaire in form of questions: exposure of factors that substantially influence the development of enterprises; determination of reasons of increasing or inhibition of level of development; establishments of indexes, that represent the level of development best of all. The method of expert evaluation is used with the aim of establishment of the most ponderable factors and indexes of level of development of industrial enterprises. For realization the evaluation the group of experts was formed, it consisted of 96 experienced specialists of industrial enterprises, who graded ponderous character of indexes of development of enterprises (after the slump of grades).

Correlation of respondents of three levels of management during questioning was proportional. The terms of representation of the group of experts were maintained according to an educational level, experience of labour, competence etc.

Basing on own scientific researches [4-6, 20], the base system of indexes of evaluation of level of development of enterprises is formed, it consists of: gross receipt; profitability of products; capital productivity ratio; specific gravity of products on an export; increase of workplaces; market of products share; operating charges; market value of enterprise; level of management of personnel; innovativeness of products.

Each of selected indexes characterizes the certain verge of development of enterprise - the indexes of efficiency allow to estimate activity of enterprise on the whole (gross receipt, profitability of products, capital productivity), the indexes of products expose the level of science (the innovativeness, operating charges, specific gravity of products is on an export), the indexes of the management system show the level of management of an enterprise (the level of management of personnel, increase of workplaces), the indexes of the market positioning characterize the present state of an enterprise at the market in relation to others (market of products share, market value of enterprise). Distribution of respondents after priority of basic indexes of level of development of enterprises is given in table 2.

For the evaluation of the generalized measure of coordination of opinions of experts we will use coefficient of concordance (W), that is calculated on a formula:

$$W = \frac{12 \cdot \mathrm{S}}{n^2 \cdot \left(m^3 - m\right)}, W \in (0;1), \; S = \sum_{i=1}^{n} y_i^2 - \frac{\left(\sum_{i=1}^{n} y_i\right)^2}{m}, \quad (2)$$

where: S is deviation of sum of squares of grades of every object of research from the middle arithmetic square of sum of grades; n is an amount of experts ($n=96$); m is an amount of indexes($m=10$); y_i is a sum of grades; and i is a research object ($i \in 1, m$).

Even at the subzero value of coefficient of concordance ($W=0,228$) in the conditions of far of experts its statistical meaningfulness is confirmed by χ^2 - Pirson's criterion, the value of which is calculated on a formula:

$$\chi^2 = n \cdot (m-1) \cdot W = 96 \cdot (10-1) \cdot 0,228 = 196,9. \quad (3)$$

The tabular value of Pirson's criterion is determined taking into account the level of meaningfulness and degree of liberty (m - 1). For α=0,05 and degree of liberty is 9 we will get χ^2_{tabl}=16,9. As $\chi^2 > \chi^2_{tabl}$, then a condition is executed and it is possible to assert about the presence of the concerted opinion of experts at grading of indexes of development of enterprise.

Thus, from experts' opinion the most ponderable index of level of development of enterprises is a gross receipt. It can be explained that a gross receipt is directly connected with three indexes from the formed system of indexes of development, in particular, with a market share of products (expressed through the volume of products at the market), market value of enterprise (a gross receipt in a number of methodologies is a key index for the calculation of market value) and part of products on an export.

An index of capital productivity is the second after ponderous character index of level of development, as it is connected with two indexes from the formed system of indexes of development, in particular, with profitability(economic end-point) and innovativeness of products (through the cost of capital assets and change of volume of the realized products). The cutting of operating cost is also one of important indexes of development that is confirmed by the received sum of grades. It is necessary to mark that in the conditions of continuous development or unprofitable activity of enterprises the indexes of charges of production have certain advantages at the evaluation of level of development comparatively with the indexes of profitability, and it found its reflection in the estimations of experts. In opinion of experts other indexes represent the level of development of enterprises in less degree, as an increase of workplaces, taking into account influence of scientific and technical progress, cannot serve as the index of level of development, and level of management of personnel influences on the development of enterprises in a way, but from the point of view of evaluation this index is rather indefinite

The received results of questionnaire are an information base for realization of further researches in direction of forming the system of indexes of entry-level (gross receipt, estimation of the level of potential) and working out an analytical instrument of management development of industrial enterprises, and it will provide obviousness of interpretation of their numerical values and comfort of operating.

The level of potential is the very moment (in certain moment of time) estimation of the possibility of achievement of the set aim at existent resource limitations in a changeable environment. The value of indexes of effectiveness of industrial and economic activity of enterprise can be interpreted as estimations of the level of realization his potential. Indexes that serve as the indicators of economic effectiveness of functioning of enterprise are rather fully described in scientific works [2, 21].

The volume of gross receipt is taken to the number of the most used indexes of effectiveness of activity of enterprise, that is stipulated by both informative availability of this index, the value of which is driven to the standard statistical accounting of enterprises, and its economic maintenance - combination of quantitative (amount of production of goods) and qualitative (cost of products) indexes.

It's necessary to mark that time-history of gross receipt characterizes development of enterprise, various factors influence on it - both basic and by chance. With the aim of grant to this index greater firmness and removal of influence of price factor we suggest to examine middle rate change of gross receipt for the last three years in quality descriptions of development of enterprise. Such

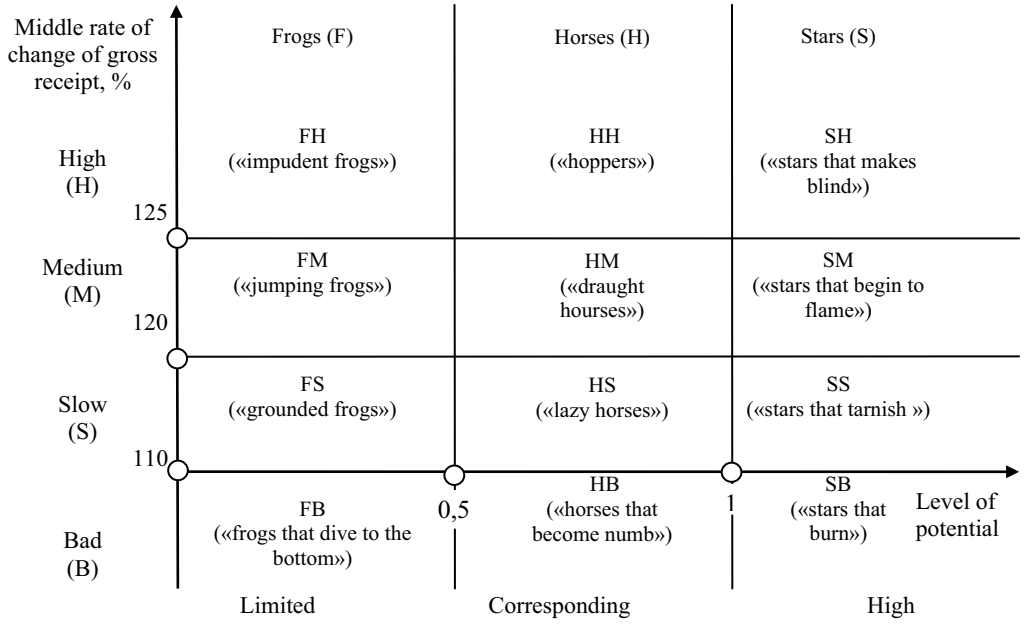

Fig. 1. Graphic presentation of areas of development of enterprises

**Note*: own development

length of sentinel interval in a number of scientific sources is considered the most reasonable [4].

The middle rate of change of gross receipt will be examined as slide geometrical middle, that gives an opportunity to level the dynamic estimation of development of enterprise, in other words to remove the action of casual factors in relation to the parameters of external and internal environment - state of affairs of commodity market, system of taxation, resource providing of enterprise etc.

Establishment of quantitative limits of indexes gave an opportunity to outline clearly the borders of every area of development of enterprise (picture 1). It is understandable that the groups of enterprises, that belong to one class (for the homogeneous enterprises of certain type of economic activity) should follow such quantitative limits.

If to set aside the value of both indexes (middle rate of change, level of potential) for a few years, then we will get possibility graphicly to present direction of development of enterprise in time (picture 2).

CONCLUSIONS

The existent analytical instruments of evaluation of the level of development of enterprises do not satisfy the requirements that concern the methods in unsteady economic conditions. Foreign developments of tool of management development of enterprises (inspite of their efficiency) need adaptation and prove to be not always suitable for application in the domestic economy. Such situation needs development of the cardinal new approach to the management not only the efficiency of activity but also the evaluation of the level of development of enterprises taking into account modern requirements to the construction of the system of indicators.

The indirect analytical method of analysis and evaluation of development of industrial enterprises that is based on the modified matrix of "McKinsey" is marked by the plenitude, objectivity and demonstration of the calculated assessment and it also gives an opportunity to choose the strategy of development reasonably on the basis of analysis of the present state of enterprise and prognosis of the change of its parameters. Such approach is deprived of the necessity for a calculation of integral index, and accordingly - the problems of determination of ponderability of its constituents, elements, simplifies the interpretation of results and its scale. On the basis of values of two indicators of development - middle annual rate of the change of gross receipt and the level of potential development of enterprise, the new approach is offered for understanding both of the development and efficiency of activity of industrial enterprises.

Further researches can embrace the development of bi-criteria conception of forming the concerted system of indicators of development of industrial enterprises.

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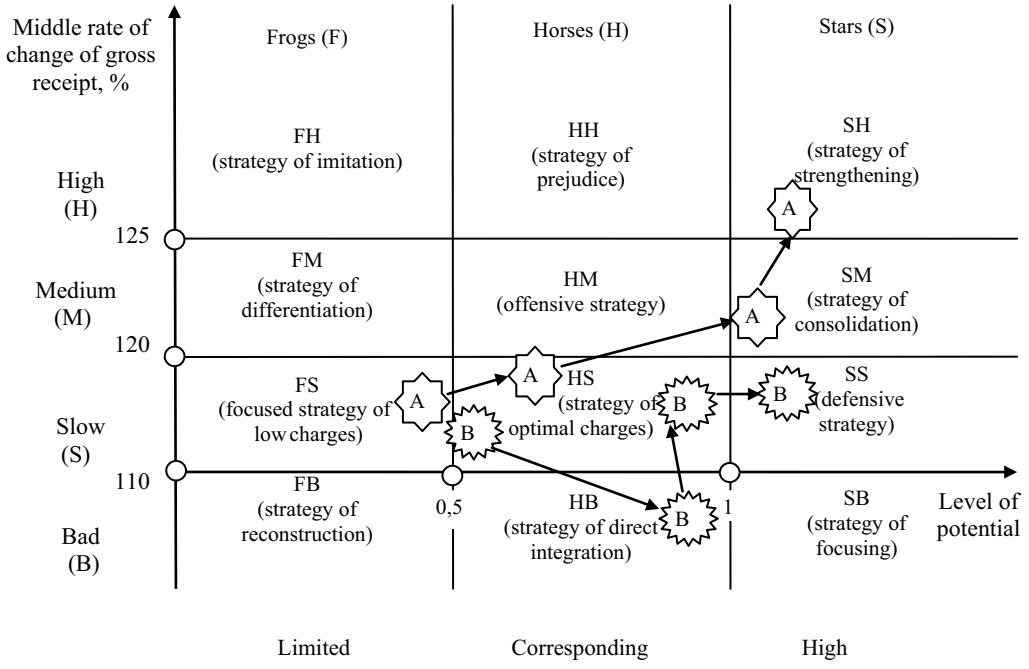

Fig. 2. Graphic presentation of directions of development of enterprises

******Note*: own development; A, B are conditional enterprises; priority strategy of development of enterprises is given to every area.

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Place of Scientific and Technological Production Preparation in the Forming of Enterprise Competitiveness Strategy

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Abstract. The research considers the reasons for the loss of competitiveness of enterprises under its subspecies. Correlation of major functional competitiveness strategies occurred within the limits which implemented measures STPP strategies and higher levels. The influence innovation processes under STPP were considered as part of the production and technological strategies for achieving competitiveness.

Key words: strategy, strategic management, competitiveness, innovation development, scientific and technological preparation of production

INTRODUCTION

In today's business environment the success of the enterprise market is directly related to the upgrade of production, introduction of innovative technologies, the application of advanced scientific developments in practice. These factors are key to strong market positions and positive business results. Therefore, Ukraine is extremely important to the preservation and development of national industrial complex, its focus on meeting the needs of society through product updates, improving its properties based on the significantly improved organization of scientific and technological activities of enterprises and other organizations involved in this activity, and also the introduction of advanced technologies.

Also, the company must constantly look for ways to respond to the demands of the external market environment to gain competitive advantage [21]. The strategy just serves to study competitive advantage to achieve its mission and objectives.

Strategy is the element that connects the requirements of internal and external environments, availability of resources and competitive advantages. Without a strategy, organizations can end up with dispersed resources, and mistaken purposes. Many scientific research (for example [26]) represent the viewpoint that the introduction of the latest production technologies cannot positively affect the performance of the company, if it is not made in accordance with a specific strategy.

Among recent national publications on the issues of competitiveness of enterprises there is the research of R.Fathutdinov [9], D.Maksym'yuk [17], M. Porter [21], O.Kuz'min [16], which considers some management techniques competitiveness of different business entities. Strategies for the development of enterprises was investigated by V. Ponomarenko, O. Trydid, M. Kizim [20], the practical aspects of innovative development of enterprises in Ukraine – by V. Zakharchenko, N. Merkulov, L. Shiryaeva [31].

Despite the comprehensiveness of strategic management research and innovative development in the publications of scientists, still relevant and still incomplete aspects of the relationship measures innovation, realized at the stage of scientific and technological preparation of production (STPP) and strategic management in general, and their impact on competitiveness within the limits of the functional competitiveness strategies in particular.

MATERIALS

The main task of this research is to study the impact of innovation processes under STPP as part of the basic functional strategies for achieving competitiveness and positioning STPP in forming the strategies of enterprise competitiveness.

Strategy forming involves three levels: corporate strategy defines the overall direction of the enterprise, business strategy concerns the business units, and functional define the specific means of achieving competitive advantages enterprise [12].

In general, the publications stated that the formation and importance of certain functional strategies depends on contextual factors such as the scope of the company,

the type of product produced, stage of life cycle, size of company, type of market, etc.

Exploring the relationship with the corporate production strategy, business strategy and other functional, one group of authors considers that corporate strategy directs business strategy, which in turn controls the production strategy. In the research [18] the author states that the production strategy is reactive and subordinated to business strategy. According to [19], production strategy is "projected model of production possibilities, which is formed to improve production capacity and support higher levels of strategy". Analysis of the results of the research [25], conducted in developed economies, represented significant differences in the use and effectiveness of various functional strategies (Table 1).

Table 1. The use and importance of various functional strategies

Functional strategy	The use of the past	Importance in the future	Efficiency in the past
Production (operating)	4,63*	5,24	36,6
Research and development	4,23	4,91	19,8
Marketing	4,22	5,02	15
Human resources	4,2	5,19	21,6
Technological	3,74	4,3	22,4
Organizational	3,36	3,81	6,6
Investment and economic (financial)	3,14	3,91	8,8

* Note. To determine the extent of use in the past used a scale from 1 (not at all) to 7 (great degree of utilization), to assess the importance of the future scale of 1 (not accented at all) to 7 (strong emphasis). Effectiveness was measured by averaging the past number of respondents noted the high efficiency of a particular strategy

From these data it is evident that the most important companies in the past have provided production strategy, somewhat smaller – a strategy for research, development and marketing. For efficient production, strategy as defined in the top positions, then – technological and human resources strategy. So industrial and technological improvements that are made within the limits of the innovation enterprise, most of which is under STPP, have a decisive influence on the competitiveness of enterprises.

Extremely important for the competitiveness of enterprises is to effectively organize their innovation activities, whose main objective is the timely launching of new products and improvement of the existing ones as the rapid development of their production [31].

It is the realization of this objective which aims to provide STPP of enterprises, whose main activities are carried out within the limits of the functional strategies of the company. Enterprises in this regard should always perform innovation, perform complex operations on the preparation and production of new products or the provision of new services, the introduction of new technologies and the adoption of new management solutions that provide reduction of production costs, increase competitiveness compared to competitors, etc. [27].

It should be noted that most measures of innovation under STPP are realized by enterprises within the limits of three main strategies: production (operating), technological investment and economic, although measures within other functional strategies are equally important (Fig.1).

The main purpose of innovative STPP is to provide the enterprise development, made possible by introduction of innovations, namely the production of new products or improvement of products already available, introduction of new construction techniques and technologies or improvement of existing processes, improvement of production management etc. [2, 6]. STPP includes a set of interrelated processes that provide engineering, technological and organizational readiness of the enterprise to release new products through innovative approaches to the

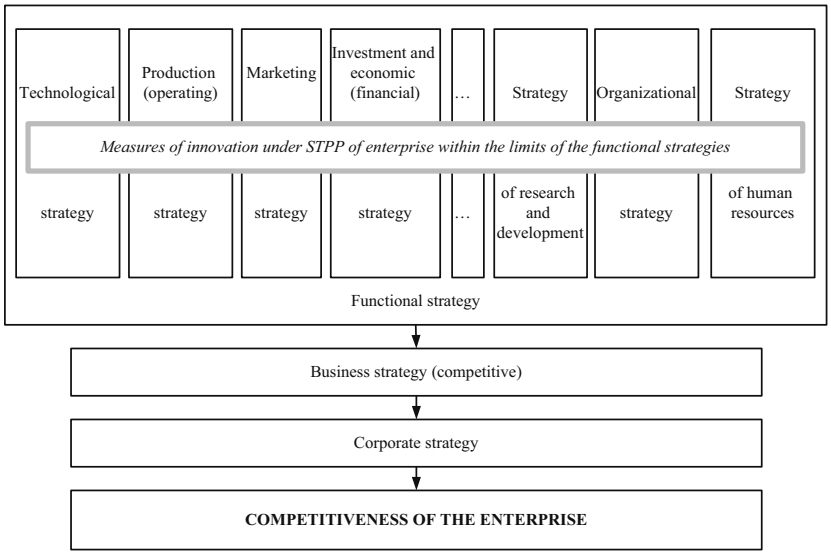

Fig. 1. Place of scientific and technical preparation of production in forming of strategies enterprise competitiveness

organization of the production process [8]. Realization of STPP is not only a wish, but a necessary concept. That is why more and more relevance is attributed to the issues of management STPP, namely to planning, organizing, motivating, monitoring and regulation.

STPP combines the processes of creation and development of new products, it involves a range of related marketing and research, technical, technological and organizational solutions aimed at finding new opportunities to meet the needs of consumers in specific types of products, to deliver products with the required functional properties and to create new and upgrade existing construction equipment, consumer properties of products, technological processes, methods of production management [27].

Already at the stage of scientific and technological preparation of production it is appropriate to analyze and evaluate the risks that the company will face and take them into account when deciding on the stage of STPP during action. Because early detection and consideration of risks in the enterprise activity is the key to the effectiveness of its activities and market competitiveness.

General tendency for risk management at the enterprise level is due to both internal demand and external factors and to the progress in developing methodologies and risk management techniques [14]. Crises can cause significant loss of inner need for risk management at the enterprise. The main external factor that leads to the introduction of risk management at the level of the whole enterprise is that investors, analysts and lenders have recently focused not only on indicators such as quarterly income, and are more interested in assessing the risk exposures of the enterprise, which can lead to loss of income. It is possible to meet their demands only if there is effective risk management at the enterprise level and coverage of information relating to risk management. Another external factor in the development of risk management systems at the level of the entire enterprise is the development of new products transmission risk, such as credit derivatives, and alternative risk financial instruments that allow the end user to choose which risks to keep and which to hedge [17]. Enterprises which have already implemented an integrated approach to risk management, received substantial material benefits, including: increasing business value for shareholders, reducing losses and smoothing the variability of income. They also won the accuracy and completeness of measurement and risk management at the level of the entire enterprise [17].

Thus, a necessary condition to ensure competitiveness in the market is the incorporation of uncertainty in planning its activities through its transformation into a risk, and then - correct plan activities and management decisions in accordance with the expected risk, namely, adapt to the environment of business uncertainty. In fact, "adaptation" – is a process of interaction of the enterprise with environment, during which, when they are in problematic (risky) situations, the company develops and uses mechanisms and rules which eventually have adaptive value.

In the economic publications categories of adaptation and adaptability are distinguished, which essentially differ, though are often incorrectly used interchangeably [15]. In particular, the adaptation - this is part of adaptability and, accordingly, its semantic value is much narrower. Adaptation is commonly understood as the actual level of enterprise adjustment of environmental conditions management, adaptability – the ability to adapt to these conditions. Particularly, I. Ansoff proposed the definition of adaptability that considers it as the ability and motivation to think and act strategically [3]. Therefore, adaptation is a current (present) category, and adaptability – a future (strategic) one. Accordingly, in order to ensure their competitiveness, enterprises need to develop and implement measures to ensure their adaptation to environmental management, which is an integral part of risk generated by uncertainty, as well as the formation of innovation-oriented enterprises adaptability, which act as a strategic factor in their competitiveness. Production and technology strategy is the link between corporate strategy and organizational and technological capabilities of the enterprise and must be consistent with them. This inter-consistency we consider as one of the major paradigms forming the production and technological strategies [28]. However, in the published research, this issue is given very small attention.

Research of strategic management issues rarely affect production. While some publications [29] emphasizes the importance of studying the influence of production strategy for activity results, yet there is not enough empirical research on this issue.

Traditionally, the production is not defined as the means of achieving competitive advantages, but only as the means to increase the effectiveness of enterprise activity[4].

For the first time the need to develop a production strategy was confirmed by W. Skinner [24] in his publication "Production – missing link in corporate strategy". He stresses that the production has the potential to strengthen or weaken the competitiveness of the company.

In coherence strategies, one must also analyze the internal consistency of production purposes, processes, technology, organization and human resources. Any investment or changes in production processes must be consistent with the business purposes, otherwise their ever being effective at the operational level will be futile [11].

The above applies directly to technological strategy. Most of the research has noted the importance of strategic management of technology in the forming of strategy, and only some of them offer specific advice to the leaders of its formation. Besides, many researchers find that technology strategy should be formulated in parallel with and integrated into corporate strategy, but only a few of them have analyzed the benefits of this. In today's highly dynamic market conditions, the role of technology in order to achieve competitiveness is more important than ever. Technology is one of the determinants of global competition.

For a long time goods technology considerations were fragmented,the organization of manufacturing processes and management of technologies were considered as merely tactical. However, during the last two decades technology has become the main strategic resource of equal importance with the other operating components such as marketing, finance, human resources. So, summing up the results of several empirical research, the author [7] concludes that "... to gain a competitive advantage through technology, companies need to manage technology strategically".

According to [23] strategic management of technology includes both the strategic planning and implementation strategies at two levels in the company: in general the corporate or business level to "technologically dependent" firms and functional level within a particular department or the scope of activity (for example research and development).

I. Wilson [30] considers that the technological strategy should at least cover three interrelated areas – product, processes and system development. D. Ford [10] stresses that the technological strategy should be based on policies, plans and procedures to obtain knowledge and capabilities, as well as to manage the last to reach profitability.

The publications of the late 20th century (for example [13, 21, 23]) reflect the effective development of technological possibilities and resources to find a means of creating a strong competitive advantage of the organization.

Integrating management of technologies in strategic planning involves much more than just considering technology in the formation of a strategic plan. For most companies the type of people who manage technology differs significantly from those engaged in strategic planning as to their vision and orientations. In their research [5], the authors conclude that in small technology-oriented firms, technological and corporate strategy are generally interrelated. In the initial stages of company development it is technology-oriented. This strategic planning is generally informal and the emphasis is on flexibility in research and development.

P. Abetti [1] proposed a classification of companies depending on the impact of technology on their corporate strategy and formed three main models of influence: a) the technology can be an element of reactive strategic approach; b) it can proactively influence the strategic planning process; c) it can determine corporate strategy as a whole.

Also the importance of technology is being determined as it is being integrated into the strategic planning process. The authors [13] think that the relationship of corporate strategy and technology must be highly dynamic and interactive. They describe the nature of this interaction in three models: a) the current strategy uses and capitalizes current technology; b) the current strategy cultivates future technology; c) the current technology determines the future strategy.

The first model focuses on direct coordination of selected corporate strategy and current technological capabilities of the company. The second recognizes the efforts to continually align technology and current strategy will lead to the accumulation of technologies with much more future potential than it is required to meet current needs. According to the third model, the current efforts of the company's technological development will affect the perception of the leadership of future strategy. According to the authors [13], the choice of model will depend on the stage of technological evolution of the company and the role played by the leaders of technological services in the forming of corporate strategy.

THE RESULTS AND DISCUSSIONS

Considering the analyzed scope of internal and external factors influencing innovation processes under STPP within the limits of functional strategies on activity of enterprises, it is appropriate to consider their impact on the competitiveness of enterprise in four aspects: 1) "technological capacity" - the ability of enterprise in a particular time by using existing equipment and technology to ensure technology works with STPP to ensure competitiveness in the market; 2) "human resources capacity" - the professional suitability of employees to perform STPP aimed at ensuring competitiveness of enterprise in the market in a certain extent; 3) "financial capability" - matching financial condition requirements for effective implementation STPP; 4) "compliance with market conditions" – an objective need for partial or complete renewal of business caused by changes in market conditions, a weakened market position of the enterprise and the need to improve its competitiveness.

Exploring the factors that influence the activity of enterprises, we can affirm that in order to ensure the competitiveness of enterprises there should STPP focus on ways to address the causes of its loss. The list of selected reasons for loss of competitiveness according the subtypes is presented in Table 2.

To ensure the effective development of innovative enterprises ensuring their competitiveness, we recommend to follow the implementation of the following STPP concept: 1) formulation purposes of STPP enterprise; 2) selection of exercise STPP areas that meet the stated purposes; 3) formation of applications in selected STPP areas; 4) identification of uncertainties and evaluation of enterprise adaptation to their effect at the adequate STPP stage; 5) selection of STPP considering adaptation to the conditions of uncertainty; 6) development of a plan for implementation of the selected STPP application with the influence of uncertainties; 7) implementation STPP; 8) implementation of special STPP plan in case of impact of additional uncertainties; 9) monitoring the compliance of STTP implementation plan and whether it matches the set targets.

CONCLUSIONS

The research examines the impact of innovation processes under STPP as part of the production, technological and other functional strategies to achieve competitive-

Table 2. Reasons for competitiveness loss

Subtype of competitiveness	Reason for competitiveness loss
Technological capacity	Inconsistency of the technical equipment required by the enterprise with the existing types of products requiring new functional properties
	Additional demand in engineering and technology for the creation and development of new products
	Depreciation and need for updating at the stage of creating new structures technology
	High production risks
Human resources capacity	Lack of qualification of employees and additional need for specialists to ensure the creation and development of new products
	Dishonesty of production personnel at the stage of creating new structures technology
	Mismatch qualifications suitability of employees at the stage of improvement of consumer properties of products
	High level of organizational risk
Financial capability	Low operating activities, innovation, unstable financial condition, which requires improved methods of production management
	Lack of financial resources for innovation in the development and assimilation of new products
	High levels of investment risk
Compliance with market conditions	High dynamic of market, innovation of competitors, competition, low government support for innovative enterprise development through the establishment and development of new products
	Unstable demand for enterprise products that require the provision of existing types of products required by new functional properties
	High level of innovation risks

ness in four aspects, as well as the place of innovation processes under STPP in the overall system of enterprise strategies and relationship with the strategies of higher levels.

In further research innovative measures will be specified and organized under STPP, within the limits of the functional strategies competitiveness and a system created for evaluating the impact of innovative measures under STPP on the competitiveness of enterprises.

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The development of electronic extension service in Ukraine on the international platform

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Abstract. Extension System constantly changes to meet the shifting needs and priorities of the people they serve. By becoming a more relevant, dynamic, and flexible organization, the Extension System can make a greater impact on problems and is taking greater advantage of opportunities brought about by changes in the global economy, the environment, demographics, community and family structures, values, and resources. These have required providing e-Extension service with distance learning, and market opportunities to extension workers and their partners. This paper identified the perspective of the development of e-Extension service in Ukraine on the international platform. Many forms of extension programs in the world, different levels of extension education and its funding possibilities need to provide e-Extension including the knowledge generators, content developers, network providers, learning centers, resource generators, and management experts. E-extension is the basis for evolving worldwide new technologies for effective development of E-extension system in Ukraine.

Key words: extension system, e-extension, international platform.

INTRODUCTION

The new Century with its globalization, consolidation, integration and other worldwide challenges are changing the extension system, making it become a more focused, client-driven, and flexible organization.

The mission of Extension is continually changing to adjust to the new conditions for agriculture and the rural economy. The global, national, and local economies, the natural resources environment, demographics, and community and family structures, values and available resources are all factors in these changes. Extension Services also differ more locally than in the past, depending upon the level of infrastructure and the availability of competitive sources of knowledge, the economy, priorities for development, and developments of within complex of knowledge generation and delivery systems. It is important to know that fully private extension is not feasible, even for commercial agriculture [1, 2].

The changing priorities for agriculture and rural development have in turn changed the "centre of gravity" for Extension, which is coming to be more focused on people and institutions and where partnerships and engagement are more important characteristics of its operations. One factor that has changes is the availability of information, now much more universal than in the past, and from many organizations that serve agriculture and rural development.

Extension education worldwide are also facing numerous challenges including increasingly limited resource, keeping up with advances in information and other technologies, remaining aware of and responsive to clientele, and outreach programs [3, 4]. Although the scale of the problems and the local conditions vary across and among regions, there are remarkable similarities in the fundamental nature of these challenges. The realization that these are shared challenges, combined with a political and economic climate that lends itself to the lowering of national barriers, conducive to global networking and cooperation in extension [5].

Over time, Agricultural Extension Systems have tended to develop strategies that involve various forms of co-payment for services. Charging fees for service is an important source of revenue in many public Extension Services. Farmers and other clients pay a portion of the cost for strategy but more based on refined concepts of public and private goods and services.

Government organizations also may provide resources on a contract basis or through grants and contracts. Many countries (The Netherlands, Germany, Britain, New Zealand and the United States) began a cost-recovery/fees approach by the end of the twentieth century. In some cases, this process has led to the emergence of fully private Extension Services – private consulting firms, agencies, and

institutions that provide their services to farmers for a fee. The so-called privatization of Extension Services has shown success when multiple actors such as government agencies, universities, nongovernmental organizations, international agencies and donors, as well as producers, workers, consumers, and private business work together.

The Extension Services also tend to have a wider range of programs, such as: agricultural and natural resources; business and industry; rural communities; families and household orientated services; 4-H youth development; continuing education and communication services. This broadening of the Service results in more and different kinds of partners, and in fact a completely different way of thinking about the organization of the Extension service [6].

The Internet has become the largest library of the world. There are millions of people in the world using the Internet now. Well-designed educational approaches that apply technology appropriately will stimulate active learning, critical thinking and problem solving [7]. The challenge for extension is to be successful in using on-line technology transfer and just-in-time learning. Extension must act quickly to form strategic alliances within and outside the university system to partner effectively in hardware, software, and skilled personnel and to supply in-service training for professional personnel.

The e-Extension is capable of achieving effective linkages by connecting geographically dispersed people and develop communication, managing large volumes of data, and rapidly collecting, processing and dispersing information in a variety of forms. It consists of two fully-integrated and interdependent components: the human and the technological [8]. The human component consists of a network of policy-makers, research and extension workers, academics, NGOs and farmers, committed to collaboration, communication and supporting agricultural producers. The technological component includes the tool which allows members of the network to communicate and develop, share, store, retrieve and disseminate information. It relies on the network of people to contribute, update and create knowledge and information.

MATERIALS AND METHODS

The purpose of the study was to describe e-Extension as programs, new technologies transfer, and education system in the world to provide accurate, up-to-date information for use anytime, anywhere. The study addressed the following objectives:

1) To describe the extension system in Ukraine.
2) To work out a conceptual model of e- Extension in Ukraine.
3) To show the perspective of development of e-Extension.

Ukraine is now an independent country in Eastern Europe and is one of the largest of the European countries. Ukraine has “black soil”, of the richest type in the world. About 40 % of the world‘s black-earth soils are concentrated there. Grains, sugar, sunflower seeds, and livestock products play a significant role in Ukrainian trade [9].

In new democratic Ukraine, the role of the Extension Service has become clear and more important. Agricultural Extension is being increasingly recognized as an organization that can help people and communities solve problems and improve their lives by improving agricultural productivity; creating new products; protecting animal and plant health; promoting human health and nutrition; strengthening children, youth, and families; revitalizing rural life; and maximizing the effectiveness of the use of limited resources [10, 11].

Extension services in Ukraine have recently began to develop more on a regional level. The first support for the development of Extension services came from joint projects with donor agencies and grant founders. International Extension Projects started from Western Ukraine where the first Regional Extension Centres were created. These regional centres focused on local agricultural and rural development problems and opportunities and worked with the local organizations as partners [1].

Extension Services or so called Agricultural Advisory Services have been created in all regions of Ukraine. There are 69 certificated Advisory Centres at the districts of Ukraine (Figure 1).

Figure 1 illustrates the model of Agricultural Extension System in Ukraine. As the model shows, agricultural extension in Ukraine has three levels: national, regional and local level.

The Government of Ukraine provides a funding for social advisory service programs. The advisory service has an Extension Coordination Department under Ministry of Agricultural Policy and Food of Ukraine and National Association of Agricultural Advisory Services of Ukraine, and develops its service through Advisory Services with different organizational and legal structures.

There are thee level organizations that are in the creation process now: National Centre of Ukraine Agricultural Extension, Regional Agricultural Extension Services and District Departments.

A new Law of Ukraine “About Agricultural Advisory Services” that was adopted on June 17, 2004, and stipulates that Agricultural Extension will encompass a number of actions and methods, directed to the satisfaction of households plots and farmers needs, needs of household partnerships and other agricultural enterprises of all forms of ownership and management, and also peasant population needs in improvement of knowledge level and practical skills in keeping profitable housing.

Extension Service needs qualified specialists-advisers who are professionals in consulting activity. In 2001, the first Department of Extension Education in Ukraine was created at the National University of Life and Environmental Sciences of Ukraine (NUBiPU). The result has been the creation of educational programs for all of the agricultural Universities of Ukraine in such courses as: “The Bases of Agricultural Extension”, “Consulting Management”, “The Organization of Extension Service”.

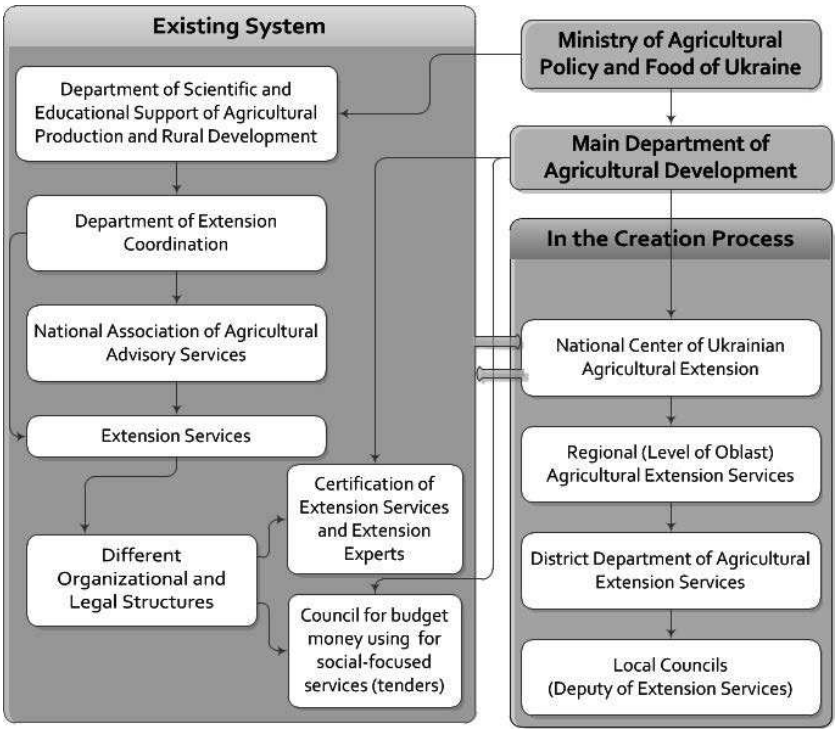

Fig. 1. The Model of Agricultural Extension System in Ukraine

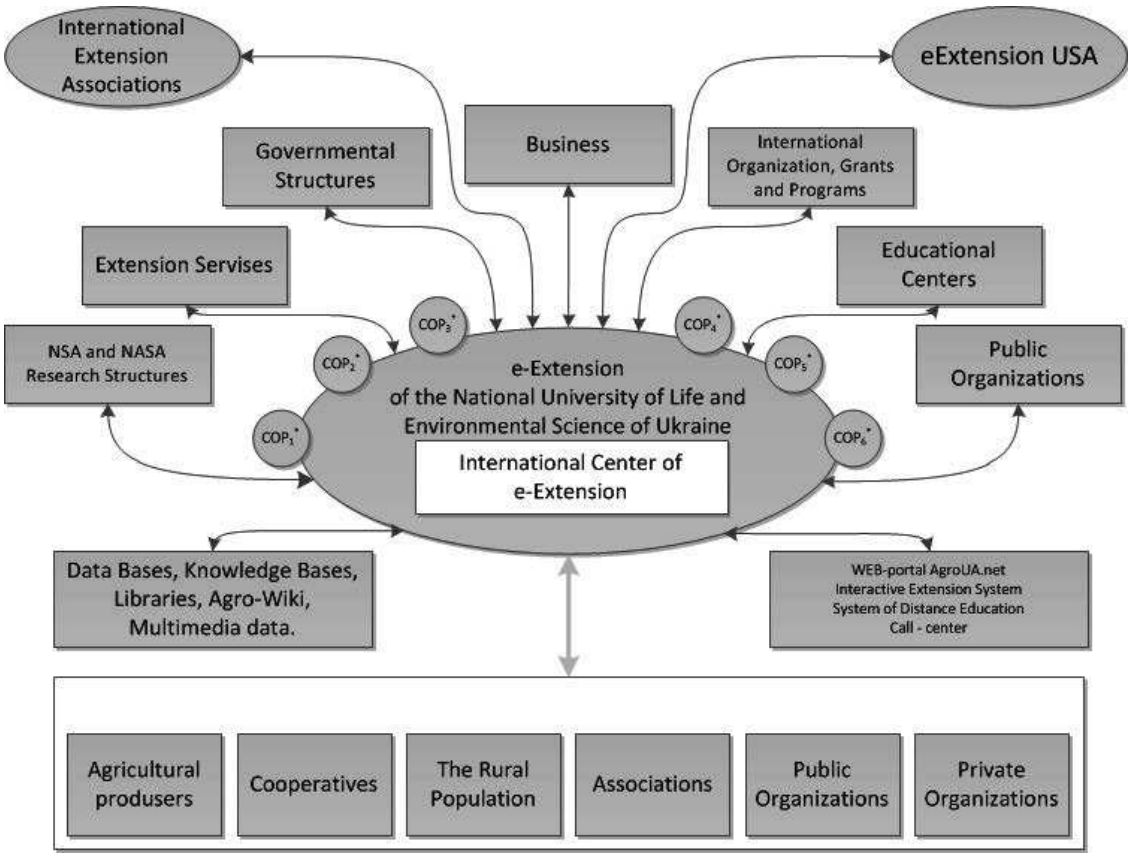

Fig. 2. The Model of e-Extension in Ukraine

* Community of Practices by interests (forestry, planting, horses its.)

In 2012 the Department NAUU opened a new specialization – "Extension Services in Agriculture" for Master Students. For this aim new courses such as "The Organization of Education in Extension", "Public Relations", "PR in Extension", "The Planning of Extension Practices Programs in Rural Area", "Modern Methods of Research" and etc. have been organized and are being taught [12, 13].

The Department also organizes professional preparation of advisers and expert-advisers to certification for Extension activity through the development of distance education and worked out some of Business schools for current questions of our days such as "Agricultural Green Tourism", " The Basic of Organic Production System", " To Use a New Technologies in Planting", "Land Consolidations" and others. This shows the demand for Extension Services that are broader than agriculture [14, 15, 16].

Ukraine's strategy today is to create electronic Extension (e- Extension) System. The best model for this e-Extension System is a dynamic model designed to function in a market economy, with public, private, donor and state sources of funding and interactive approach to make decision in extension [17, 18].

Figure 2 illustrates the model of e-Extension in Ukraine. E-Extension expects to establish Communities of Practice (COP), experts and specialists who will consult and teach by interests (forestry, planting, horses its.). The main team of each COP includes representatives from extension services, governmental structures, business, international organizations, grants and programs, educational centres and public organizations, research institutions. COPs deal with: educational programs, curricula, syllabi, and methods for training and retraining experts, advisers, farmers, and other individuals; developmen of communication services and continuing education; database and data knowledge, innovations; distance education; constant and efficient cooperation with programs, projects, organizations, and universities from different countries.

E-Extension is based at NUBiP of Ukraine where International e-Extension Centre is organized. Technical platform of e-Extension has been worked out by Education and Research Institute of Information and Telecommunication Support of Agricultural and Environmental Branches of Economy of NUBiP of Ukraine.

E-Extension becomes a national Internet-based information and education network that provides accurate, up-to-date information for use anytime, anywhere. It will use technology and new organizational processes, enhance accessibility, quality, breadth and depth of information and foster collaboration within the COPs, reduce duplication [19].

E-Extension will cooperate with e- Extension USA [19] and International Extension Associations. Users of e- Extension will be farmers and agricultural producers, cooperatives, the rural population, associations, public and private organizations teachers and others. To support viable COPs an Interactivity consulting system CONKA was worked out [20].

CONCLUSIONS

The development of a market economy system in Ukraine moves forward in increase in the number of farmers and the appearance of new forms of agricultural business entities. All of this has been accompanied by increasing problems and opportunities in the social, cultural and educational development of the rural population.

Ukraine's strategy in this environment is to create its own Extension System. The main role in this will be played by electronic Extension service that with collaboration across the globe is being challenged to consider their impact, relevance, and effectiveness. The most important factor for e-Extension development in the future is the people involved in the decision-making process. Equally important is a clear understanding of what e-Extension is. All people, not just a few, must be able to think for a living, adapt to changing environments, and to understand the world around them.

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Modelling techniques for rational management decisions considering innovative risk

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Abstract. The article is devoted to the problems of development of theoretical and practical recommendations for the improvement of rational decision modeling process considering innovation risks. Based on the review of domestic and foreign techniques to management decision based on consideration of the risk factor, the basic theoretical flaws and practical difficulties faced by Ukrainian enterprises were systematized. In the article the methodical approach was accepted to making rational management decisions based on consideration of options - the current assessment of innovative risk, its future level and managers' propensity for risk.

Key words: innovative risk, rational decision-making.

INTRODUCTION

It is well known that economic growth of Ukraine to the level of developed European countries is possible on condition of activation of innovation such as the development of knowledge-based and competitive innovation and active implementation in practical economic activity. However, this process is accompanied by a number of risks both those common to all entities and the specific ones, that arise during the implementation of innovations. These risks are not only hinder the progress of the innovation in the real economy, but are defining reasons for making management decisions in terms of innovation. Note that the successful functioning of any organization is also determined by the quality and timeliness of rational decision-making that is especially actual for enterprises innovators. Ensuring a stable and effective innovation in economic activity should, primarily, be based on reliable estimation of innovative risk and, on this basis, the taking of rational management decisions.

In the modern changing environment, the current evaluation of innovative risk and predicting its level does not provide reasonable grounds for a successful reaction to it. Accordingly, there is a need to review and improve approaches to evaluating and predicting innovation risk, taking into account the multidimensional nature of the phenomenon and its dynamic changes. Predictions, which objectively evaluate innovation risk and forecast scenarios of its development, provide reliable information for making rational decisions.

Today, the decision-making manager is facing a number of obstacles, namely uncertainty of the environment, rapid changes in business principles, existence of significant influences such as macro risks and unpredictable internal risks, the complexity of predicting the future picture of reality, taking into account the interests of stakeholders, information insufficiency and impropriety, limited technical and technological support for analyzing the situation. That is why, during making decisions, the manager must take into account the large number of conditions such as the situation of the enterprise as a whole and the state of innovation as well as the risks that accompany it. Under such circumstances, the manager is facing an extremely difficult task. On one hand - the development of alternative solutions that meet all of the possible scenarios of risk and take into account the possibility of the company, and on the other - reasoning and choosing the most rational management decisions. The situation is complicated by the fact that even in challenging situations the manager must ensure the efficient and uninterrupted operation of the enterprise and minimize the impact of his own subjectivity.

Under these conditions, there is an objective need for the development and substantiation of the method of election of rational management decisions with multiple alternatives, which will be based on the simultaneous consideration of all the options such as innovation risk, and features such as activities or subjective characteristics of the manager, and optimize management decisions from the point of view of effectiveness and usefulness. Thus, the purpose of the article is improving methodical approach to modeling rational management decisions considering innovative risk.

LITERATURE REVIEW

Current state of management science in Ukraine and in the world is characterized by seating for new approaches to modeling rational decision-making process. That is why, this research author is primarily drawn to fundamental results, namely based on the theoretical, methodological and practical results related to management decisions, innovation management, risk management, received by both domestic and foreign scientists. V. Abchuk, M. Bakanov, I. Balabanov, V. Vasiliev, O. Kuzmin, A. Sheremet [2,8,15] focused attention on the fact that under modern conditions the basic requirement to management decisions is its focus on the profitability and efficiency of the whole enterprise contributed to the development of management science. However, scientific researches do not give appropriate attention to solving the problem of selection of rational management decisions of multiple alternatives considering risk factors and propensity of managers to take risky decisions. Not enough attention is paid to formalizing and structuring the process itself and the grounds of rational decision-making.

Significant contribution to the research of problems of existence of innovation risk and risk management company, made the following domestic and foreign scientists as A. Alhin, J. Balabanov, I. Blank, A. Vasyurenko, V. Vitlinskyy, D. Voronkova, M. Vnukova, P. Grabovoy, V. Granaturov, L. Gohberg, S. Illyashenko, T. Klebanov, G. Kleiner, O. Kuzmin, M. Lapusta, A. Morgenstern, F. Knight, J. Neumann, C. Redhem, B. Raysberh, L. Tepman, E. Utkin, R. Fathutdynov, J Schumpeter [1-16] and others. These and other researchers in his works investigated the nature of the category of "risk" classified innovative risks, developed methods for evaluating and predicting levels of risk, model risk management decision-making and so on. However, under conditions of dynamic phenomena and processes accompanying activities of companies limited time factor, a significant effect of subjective human factor, there is a need to provide a comprehensive assessment of the risks of innovation, forming optimal set of response measures based on the selection scenario risk events and making rational management decisions aimed at proper response to identified risks.

Analyzing the work of the above-described scientists it may be summarized that:

- insufficient attention is paid to the generalization and systematization of risk factors with substantiated separation of the defining reason;
- methods of quantitative evaluation of innovative risk and planning response measures to them are insufficiently substantiated. In particular, there is a need for developing a method of risk assessment which, unlike the existing ones, would be based on consideration of multilateral parameters of the phenomenon to which most of the conditions of development of innovation by Ukrainian enterprises are tied;
- to evaluate decision alternatives, usually classic criteria are used: Wald, Bayes, Laplace, Savage, Hurwitz, Hodges-Lehmann focused on the minimum, maximum or average value of performance evaluation and criteria. Hurwitz and Hodges-Lehmann required that subjects objectively assessed the probability of occurrence of certain risks that are not always objective. Therefor further study is required on the possibility of using complex mathematical models which should adequately reflect the multidimensional nature of innovation risk and multipurpose nature of rational management decisions;
- there is need for further research and improvement of the theoretical and methodological tools to account for the propensity to take risky decisions;
- foreign methods and practical methodologies developed as separate entities and public institutions are highly specialized, often relating to a particular point and type of operation and certain types of risk;
- foreign scientists have formulated a set of classical, modern approaches for assessing behavioral dispositions to risk and decision making under uncertainty. However, the domestic industrial sector is characterized by specific original features that prevent the use of foreign instruments. That is why, there is need for tools developed to evaluate propensity of managers to take risky decisions, which would take into account both personal and professional features.
- There is need for further research on the grounds for making rational management decisions under the influence of innovation risk.

These and other drawbacks in the national and international scientific opinion form the need for scientific research towards improving the modeling of rational management decisions based on innovative risk.

METODOLOGY OF MODELING TECHNIQUES FOR RATIONAL MANAGEMENT DECISION CONSIDERING INNOVATIVE RISK

The existence of a substantial list of risks which are typical innovation is one of the major factors hindering the progress of the entities and forces managers to give up the introduction of the various innovations. At the same time, business conditions make it impossible to perform rational decision-making based on information about the current condition of the company, the state of innovation, information about the possible loss or rely on experience and intuition of the manager.

In such difficult conditions, which exacerbated the influence of a number of risks there are difficulties and conflicts between developed theoretically grounded approaches and practical implementation. The theoretical foundation of rational management decisions in innovative risk means that you must take into account all factors that affect the development and innovation, specific risk factors, other characteristics of the individual decision-making. In practice, usually it is either impossible to

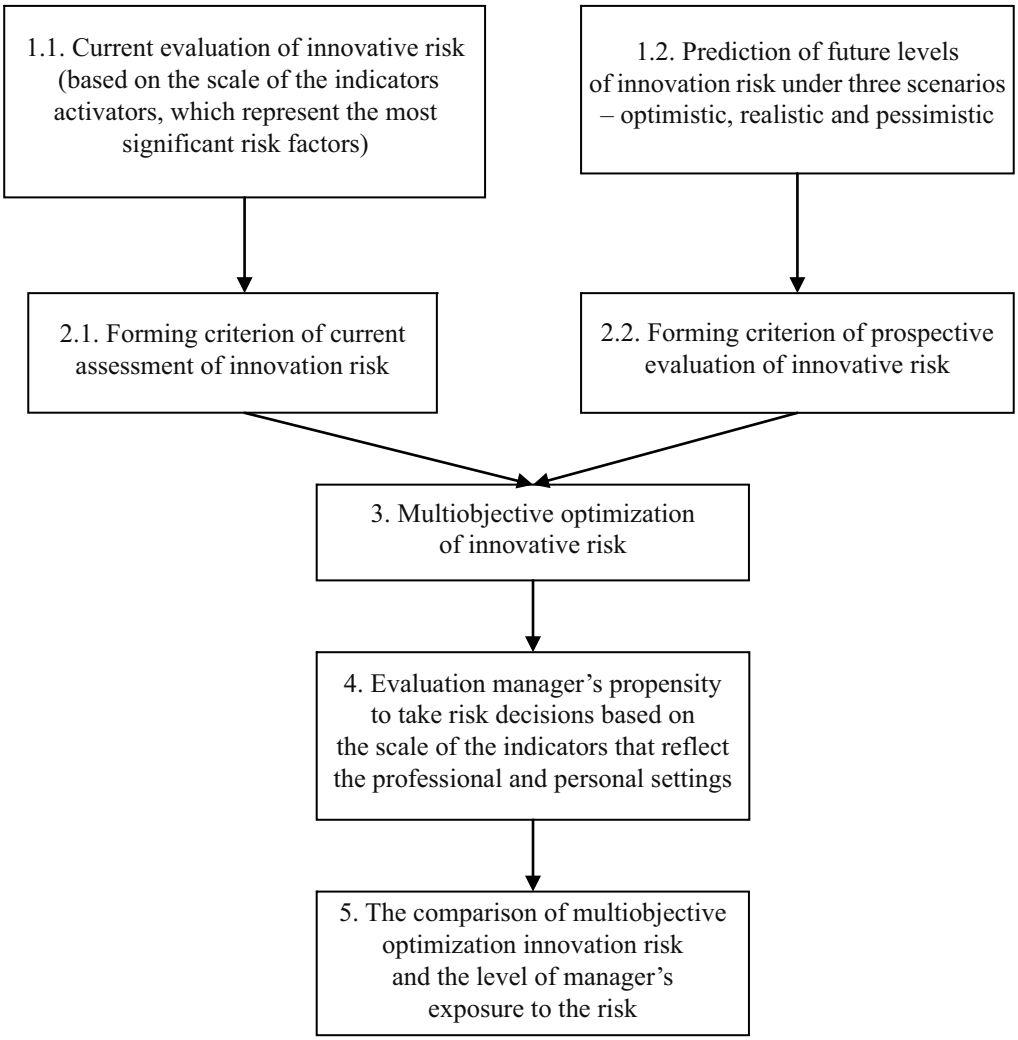

Fig. 1. The sequence of process modelling rational management decision

implement or results in significant loss of funds and time. So research on the effect of the proposed approach will try to formalize all the necessary parameters for making rational decisions to ensure practical feasibility of the results.

The question of rational decisions should be solved in the context of maintaining the completeness of information regarding the impact of the set of risk factors and the use of scientifically mathematical models.

Considering the above-mentioned facts, the need is for updated modelling acceptance of rational management decisions aimed at the adequate response to innovative risk. To ensure rational decision-making requires a clear outline of the reasons for election of such decisions with multiple alternatives. Rationale and development of these bases underlie improvement of the modelling of rational management decisions based on innovative risk (Figure 1).

Proposed authored provisions to improvement of decision-making based on innovative risk are:

1) objective evaluation of the level of innovative risk:
   - ongoing evaluation of innovative risk based on the scale of the key indicators-activators;
   - prediction of risk events based on defining performance-activators and, taking into account the possible scenarios of risk events (pessimistic, realistic and optimistic scenarios);
2) propensity evaluation of manager to take risky decisions:
   - evaluation of professional parameters manager;
   - evaluation of personal characteristics;
3) comparison of the level of innovation risks (the current and projected approach) and the level of propensity risk manager to take decisions.

These points are the criteria of optimality of rational management decisions and serve the formalization and modeling.

CONCLUSIONS

Thus, the advantages of the proposed approach to modeling rational management decisions based on innovative risk are:

1) rationality of decisions based on complete and objective information on specific features of innovation risks:

- complexity of the elaboration innovations - the current criteria for evaluating the risk level is functionally dependent on the parameters of elaboration innovations, the parameters of the entire enterprise and reflect the defining characteristics of the most significant risk factors and at the same time take into account the strength of the impact of these parameters for each of the analyzed period;
- considering the dynamic nature of risk events - prospective evaluation criteria are made based on future values of innovation risk levels;
- alternative options for the development of innovative risk - formalization of risk events based on performance-activators, which fully represent the most significant risk factors in three possible scenarios - pessimistic, rational and optimistic;
- preservation of the entire information set the object of research and consideration of the variability and uniqueness of each individual case, which is provided by the use of multi-criteria optimization;

2) leveling influence of the subjective factor of the manager - analysis of personality characteristics, based on the research of his temperament, speed of information processing, reaction rate in critical conditions, etc.;

- ensuring optimality management decisions based on consideration of any number of combinations "risk level - the level of manager propensity to the risk";
- take into account dynamic character, objective-subjective nature of innovation risk and justification of the existence of a causal relationship "risk - the tendency of managers to take risks - the rational management decisions" create conditions for not only additional analytical information to improve innovation but there is standardized pattern that can be applied to any other type of risk and crisis of the whole enterprise.

To summarize should be noted that the results of the proposed methodological approach can be represented in two ways:

– in the narrow aspect research results contribute to the solution of management problems, namely based on the vision of the state of innovation of the whole enterprise formalization manager characteristics that indicate a tendency to take risks and, combining the most important objectives of the enterprise, choose the rational management decisions under the influence of risks;
– in the broadest sense - the findings will contribute to the solution of philosophical problems, specifically ideological and cognitive problems in terms of appropriateness and reasonableness as well as the formalization of all processes and elements of the enterprise, in particular, the behavior of people who make management decisions.

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Transfer potential of innovative enterprise development

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A b s t r a c t. The essence of the concept "transfer potential" is considered in the article. This concept is interpreted as a set of business opportunities on storage conditions of transfer and transmission business partners asset management experience, information, etc. during innovation development programs. Attention is paid also to the logic of building evaluation method transfer potential with using of the set theory.

K e y w o r d s: transfer, innovation potential, profitability, financial stability.

INTRODUCTION

Despite a multitude of patterns of successful enterprise functioning in the framework of innovative structures the theoretical substantiation and methodology of formation and realization of the transfer potential of the innovative enterprises development, particularly those intending to launch a new or join an existing innovative structure, need further investigation. Today, the issues of transfer potential formation and realization have not been formalized as yet which, in most cases, is the reason for a high riskiness of transfer relations formation, difficulty in raising financial resources, irrational managerial efforts in finding and employing increase reserves as well as an increase in the transfer potential realization level of an innovative enterprise. Current theoretical, methodological and applied outcomes in the field of technologies transfer, innovative products, financial resources etc. are characterized by fragmentariness, non-systematic notions about causal and consequential relationships in the formation and application of industrial enterprises transfer potential which, in its turn, demands the elaboration of methodological, conceptual, and applied propositions as to formation and application of the transfer potential of the innovative enterprise development.

RESULTS AND DISCUSSIONS

With no exception, all economic activity entities are participants of transfer[1] relations (Fig.1).

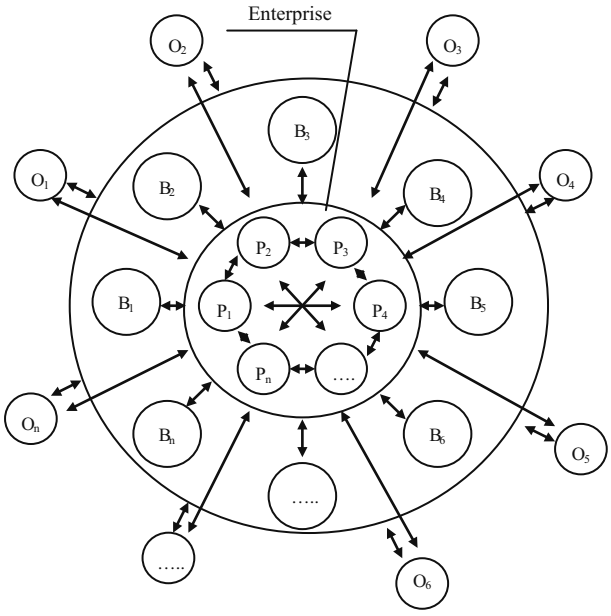

Fig. 1. An industrial enterprise as a transfer relations participant

Notes: conventional designations: P1, P2,…,Pn – structural subdivisions of an industrial enterprise; b1, b2,… - business partners, complete products consumers included; O1,O2…On – bodies of local authorities.

A great many of input and output information flows, financial and material resources, complete products and technologies is the permanent subject of coordination of organizations' economic interests. Today, there is a great

[1] Transfer (Latin *transfer*– move from one place, job, position etc.) the term usually identified with the process of transferring certain assets, skills, knowledge etc. from one economic activity entity to another both at charge and free of charge.

amount of transfer systems which enable legitimate, safe, economically beneficial interaction of economic activity entities. Nevertheless, there is some evidence that the availability of these systems and the information on them is a necessary but not a sufficient condition of an innovative development of organizations [2-4, 6, 8, 18, 19]. The major factors hindering an innovative development of enterprises and limiting their interaction with other economic activity entities result from a low level of the transfer potential of the innovative enterprise development (TPIED)[2].

The lack of the systemic theoretically grounded propositions and methodological instruments of its formation and application results in an underdeveloped market of innovative products and technologies. The rate of innovation commercializing by domestic enterprises is dozens times slower than that in the developed countries. According to the official statistics, no more than 11 percent of industrial enterprises implement innovations in Ukraine, at 60-80 percent in the USA, EU and Japan.

In recent years, alternative sources have provided information on the availability of the innovative potential of industrial enterprises as well as the level of their innovative development. The methods of estimating these parameters differ critically [1, 5, 9, 13]. To avoid subjectivity and fragmentariness at the innovation potential estimation as well as to promote the innovation development of domestic industrial enterprises, the indices adopted to the input and output data of the EU research & innovation scoreboard, particularly those concerning the micro-level, have been employed. The computation of these indices demonstrated that among the total amount of enterprises under investigation the three groups of enterprises can be formed. The enterprises with a high level of both innovation potential and innovation development belong to the first group (*Kredmash* Public Company, *Peretvoryuvach /Transformer/* Public Company, R&D Institute; *MATS* Concern Private Company, *Motor Sich* Public Company, *INTER PET* LLC, *Mining Engines* Private Company). The second group was made up of the enterprises with a high level of innovative potential but a low level of innovation development. Here belong *ViAZ* State enterprise, *Electron* LLC**,** *Lutsk Automobile Plant* Public Company, *Lutsk Bearing Plant* Public Company. The third group covers the enterprises with low levels of both innovation potential and innovation development. These are *Lviv Locomotive Repair Plant* Public Company, *Drohobych Automobile Cranes Plant* Public Company, *Genichesk Machine Building Plant* Public company, *HalytskyAutoPlant* Public Company.

The first and the second groups of the identified enterprises are of major interest. Since the enterprises with relatively similar levels of innovation potential are characterized by different levels of innovation development it is obvious that the traditional parameters of the innovation potential estimation may be, as a rule, non-sufficient and narrow.

Taking the above into consideration, the industrial enterprises have been analyzed according to their transfer potential for an innovative development. This has been preceded by TPIED parameterization considering the following features: transfer objects; means and terms of transfer. The multitude of these parameters can be formally presented in the following way [13,15]:

$$\bigcup P_t^n = \bigcup_{i=1}^{4} x_i \cup \bigcup_{j=1}^{6} y_j,$$

$$x_i \in \bigcup P_t^n \Leftrightarrow \exists \bigcup_{i=1}^{4} x_i \in P_t^n, x_i \in \bigcup_{i=1}^{4} x_i,$$

$$y_j \in \bigcup P_t^n \Leftrightarrow \exists \bigcup_{j=1}^{6} y_j \in P_t^n, y_j \in \bigcup_{j=1}^{6} y_j, \qquad (1)$$

where: $\bigcup P_t^n$ multitude of indexes characterizing TPIED, parts of a unity; n – the total number of indexes characterizing TPIED; $\bigcup_{i=1}^{4} x_i$ – multitude of indexes characterizing the transfer possibilities of the internal enterprise setting, parts of a unity; i – a feature to estimate the transfer possibilities of the internal enterprise setting; $\bigcup_{j=1}^{6} y_j$ – multitude of indexes characterizing the transfer possibilities of the external enterprise setting, parts of a unity; j – a feature to estimate the transfer possibilities of the external enterprise setting.

As shown above, it has been suggested to compute TPIED on the basis of internal and external transfer possibilities identification. Internal enterprise transfer possibilities reflect the indices: transfer objects diversification; communication support of transfer; a guarantee of private property rights to transfer objects; transfer patterns diversification. It is reasonable to estimate transfer possibilities of external enterprise setting by means of indices of: transfer activity of off-shore structures, local innovation structures, venture financial organizations; diversification of financial resources transfer systems; development of advertising-searching transfer systems as well research-technological cooperation; the dependence of innovation commercialization on the intellectual property rights transfer.

A cluster analysis of the aggregate of the enterprises under investigation was carried out as based on the computation of the TPIED indices as well as the identified level of innovative development. The results obtained are shown in Fig.2 [13,15]. Two groups of the enterprises are

[2] TPIED is the aggregate of possibilities of accumulation, on the transfer terms, intellectual property rights, technologies, innovative products, financial and other resources as well as transferring them to consumers, business partners, bodies of local authorities etc. in the framework of the realization of innovation development programs.

presented. One of them is characterized by high levels of transfer potential and innovative development. The enterprises with low levels of transfer potential and innovative development belong to the second group. The consideration of the fact that the innovative potential of both groups is identical makes it possible to claim that the level of the enterprises' innovative development depends linearly on the level of their transfer potential.

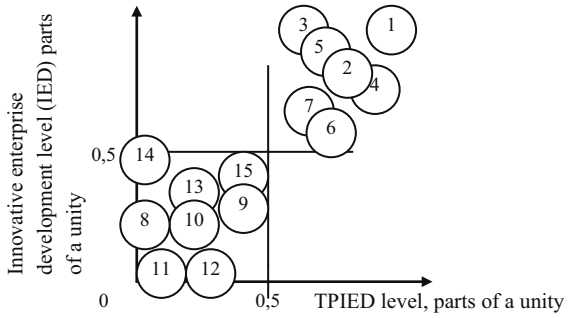

Fig. 2. Constructed clusters

Notes: clusters have been constructed by means of a sphere method formalized by clast_iomorph_trek applied program. Conventional designations: 1)Kredmash Public Company – IED level (0,9),TPIED level (0,98); 2)Peretvoryuvach/Transformer Public Company, R&D Institute – IED level (0,62), TPIED level (0,74); 3)MATS Concern Private Company – IEDlevel (0,87), TPIED level (0,59);4)*Motor Sich* Public Company - IED level (0,59), TPIED level (0,96); 5) I*nterPet*LLC – IED level (0,73), TPIED level (0,69); 6) *Mining Engines* Private Company –IED level (0,52), TPIED level (0,72); 7*) Iveko Motor Sich*LLC – IED level (0,56), TPIED level (0,62); 8) ViAZ State enterprise – IED level (0,29), TPIED level (0,12); 9) *Electron* LLC – IED level (0,36), TPIRD level (0,46); 10)*Lutsk Automobile* Plant Public Company – IED level (0,29), TPIED level (0,35); 11) *Lutsk Bearing Plant* Public Company – IED level (0,12), TPIED level (0,29); 12) Lviv Locomotive Repair Plant Public Company – IED level (0,12), TPIED level (0,44); 13) *Drohobych Automobile Cranes Plant* Public Company – IED level (0,38), TPIED level (0,32); 14) *Genichesk Machine Building Plant* Public company – IED level (0,48), TPIED level (0,11); 15) *HalytskyAutoPlant*Public Company – IED level (0,48), TPIED level (0,47).

The conducted research proved that in the process of TPIED formation and application there may arise some contradictions (liquidity insurance and profitableness of the entities of the innovation development when the expansion of their sources of financing needed; minimization of the expenditures on the innovation activity aimed at employees' motivation increase and information support improvement; retaining the private property right of the enterprise as well as its solvency insurance when the activity expansion demanded; maximization of the total volume of production and sales when the minimization of expenditures on products or technologies modification demanded as well as the possibilities to maneuver a profit share are limited. Their critical analysis demonstrated that all the indices characterizing the above contradictions are constituent elements of the financial stability of the enterprise and investment profitability directed into the innovative enterprise development. These parameters have been proved to be crucial for the development of transfer relations between enterprises. The essential dependence of TPIED on financial stability and investment profitability put into the innovative enterprise development has been grounded by statistical observation during 2007-2011 as well as by computation of the linear correlation index (0,9966). The indices of financial stability and investment profitability put into the innovative enterprise development can be formalized as shown below [13, 15]:

$$\left.\begin{aligned} &\bigcup E_{f_z}{}^n = \bigcup_{i=1}^{2} F_{y_i} \cup E_i, \\ &F_{y_i} \in \bigcup E_{f_z}{}^n \Leftrightarrow \exists \bigcup_{i=1}^{2} F_{y_i} \in \bigcup E_{f_z}{}^n, F_{y_i} \in \bigcup_{i=1}^{2} F_{y_i}, \end{aligned}\right\} \quad (2)$$

where: $\bigcup E_{f_z}{}^n$ multitude of the indices characterizing financial stability and innovation profitability put into the innovative enterprise development, parts of a unity; $\bigcup_{i=1}^{2} F_{y_i}$ – multitude of the indices characterizing the financial stability of the enterprise, parts of a unity; $F_{y_i} = f(O_{vb}, K_y)$, where: O_{vb} – balance currency circulation, parts of a unity; K_y – index of the enterprise solvency, parts of a unity; E_i – investment profitability put into the innovative enterprise development.

The following formula was suggested to estimate the investment profitability, put into the innovative enterprise development [13-15]:

$$E_i = \frac{W_p(1-R_n) - W_k(1+C_V)}{P}, \quad (3)$$

where: E_i – investment profitability put into the innovative enterprise development, parts of a unity; W_p – enterprise assets increase as a result of the realization of investments, hryvnyas; R_n – index of deviation risk at some level of enterprise investment attractiveness (calculated on the basis of the identification level of information completeness, timeliness and objectivity used by the entities of the investment activity), parts of a unity; W_k – expenditures on accumulation resources for investment realization, hryvnyas; C_V – index of variation expenditures on investment realization, parts of a unity; P – volume of invested costs, hryvnyas.

The lack of the aimed impact on TPIED results in the irrational realization of their functions and inefficiency. When planning and organizing the TPIED, motivating creative search and innovation realization, controlling and regulating the TPIED level, enterprises are able to achieve the set goals on the basis of rational and creative application of their own and drawn resources, innovative products and technologies.

TPIED control has an information basis, i.e. it is based on the accumulation, procession and application of the data on TPIED indices value changes and factors affecting them. Achieving the expected values may cause some contradictions. As a result, getting the expected values of some indices managers obtain worse values of other indices. This complicates the innovative develop-

ment program realization and increases the riskiness of TPIED formation and application. The counteraction to these contradictions by means of applying conventional managerial strategies does not provide positive results. TPIED control demands applying the priorities diversification strategy which resists the contradictions following the TPIED formation and application and promotes expected positive indices changes. The priorities diversification strategy should be considered as a functional strategy which is a component of a higher order strategy. Thus, such strategies are to be elaborated on the decomposition basis. The formation of a new or choosing an existing strategy from a number of alternative ones is to consider internal and external enterprise setting factors having an effect on TPIED. These factors, in spite of their certain autonomy, are interrelated. Thus, on the one hand, setting TPIED goals as an internal setting factor is influenced by the tendencies on local, regional and world markets, conjuncture, a competition level etc. On the other hand, market segmentation, the level of demand for a certain product and its price depend on such internal setting factors as the maturity of heuristic managerial systems, the ability of activity entities to develop creative ideas and commercialize innovations promptly adapting communicative, intellectual and other possibilities to the needs and possibilities of consumers and business partners etc. Therefore, the elaboration of TPIED priorities diversification strategy is to consider the interrelations of TPIED internal and external setting factors as well as innovation process phases of the innovative enterprise development program. As a result of the research conducted it is claimed that the innovative development programs at different phases of the innovative process are characterized by different priorities. Thus, at the stage of conducting R&D and research-construction activities the priority is given to their loss-free. At the stage of manufacturing and consuming the priority is given to the maximization of profitability, at the stage of innovation products improvement and modification – a longer life of an innovation product.

The consideration of this feature may promote the acceleration of the invested costs compensation, the decrease in the riskiness of the resources portfolio formation, the timeliness of identifying TPIED level increase resources and the rationality of making managerial decisions on their application,

Table 1 shows the outcomes of the change of transfer potential and innovative development levels at the analyzed enterprises as a result of the realization of the TPIED priorities differentiation strategy.

Thus, the realization of the actions foreseen by the TPIED priorities differentiation strategy in the cross-section of each phase of the innovative process during 2007-2011 provided an additional TPIED level increase which had a positive effect on the IED level increase.

CONCLUSIONS

The application of the priorities differentiation strategy of TPIED realization belongs to the class of under-formalized tasks. The reason is the amount of assumptions of the prospective state of the external setting and uncertainty of the state of the innovative development program realization. To sum up, to achieve the TPIED goals in the structure of the integrated enterprise managerial system it is necessary to set up a local sub-system of information support of the innovative development management. The realization of this task is the most rational on the basis of making decision support systems. But, despite some advantages of these systems, the best results are achieved in the dialogue mode between users and the system. The increase in costs of their total automation is irrelevant. The optimal variant is the realization of measures related with professional training of managers who are good at modern information technologies, methods and patterns employed in the decision making systems since it enables the control entities to correlate algorithms and terms of application set in them. Such an approach will promote the optimization of expenditures on management systems formation and TPIED indices.

Table 1. Outcomes of the change of TPIED and IED levels resulting from the realization of TPIED priorities differentiation strategy

Enterprises	Increase of TPIED and IED levels in the reported period as	
	TPIED	IED
Kredmash Public company	0,01	0,06
MATS Concern LLC	0,05	0,02
Peretvoryuvach (Transformer) R&D Institute Public Company	0,03	0,08
*Element-peretvoryuvach*LLC	0,07	0,04
*Electron*LLC	0,02	0,02
ViAZ State enterprise	0,03	0,08
*Lviv Locomotive Plant*Public Company	0,04	0,07

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Spare parts logistics of automobile enterprises in conditions of module production

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Abstract. The peculiarities of module production of automobile companies are lighted. Research on the role of innovations in automotive development has been carried out. An algorithm of decision making for optimizing logistics costs is presented. The hierarchy of needs in the area of spare parts maintenance is presented. The benefits of partnership relations in the automotive industry are outlined.

Key words: module production, logistics, spare parts, automotive industry, relationship management, cooperation.

INTRODUCTION

Automotive industry in the post-crisis period is usually characterized by a significant change in the policy of market "key players", mainly concentrated on improving the efficiency of production and economic, financial, marketing, logistics of enterprise. Any changes that take place in the existing system should be aimed at improving or correcting errors of functioning. While describing the changes that have taken place in the automotive industry after the global economic crisis of 2008-2009 it is not possible to distinguish the single decisive one, but the fact has to be admitted that the industry has undergone a qualitative change, and moving further in the selected direction we can analyze the key changes [1, 2].

Basically, the structure has undergone significant changes in the market. Part of the enterprises announced bankruptcy, others entered the warehouse more resilient enterprises, created a number of associations. The role and influence of agents of the first and second level was increased, carrying out production of some spare parts and complete units for car assembly enterprises. Competition in the market and aftermarket services has escalated. The increasing role of outsourcing, Internet trading, short product life cycle, increasing the speed and flow of information, formation of joint departments on innovation, the management of certain manufacturing or logistics processes with intermediaries and competitors, increasing consumer awareness and, consequently, increased demands for quality, functionality and service are part of the trends that currently accompany the development after the crisis on the automotive industry.

PROSPECTS FOR THE AUTOMOTIVE INDUSTRY

Activity on any market depends to the presence of certain features and certain barriers. Identifying them enables to identify prospects and set the right ways of doing business. In general, existing barriers, trends and opportunities for business of automobile industry should be considered, taking into account the following factors: political, economic, social, technological, legal and natural [3]. The political include:

- Tax deductions for fuel and road duty,
- Infrastructure development of region, heavily dependent on government policy.

Economic:

- Globalization promotes trade without borders, and thus logistic flows as complex products and certain spare parts for them, their intensity, saturation, structure and nature of the service creates a new paradigm in development,
- The choice of a partner is usually carried out on the basis of cost and quality of its services,
- Enhancing the role of services in packing and sorting that can generate added value and avoid the feeling of mass goods,
- Significant logistic chains pose obstacles to effective, efficient and quality management, and thus reduce their resistance,
- Mergers provide an opportunity to increase market share, access to the new technologies, to achieve economies of scale, reduce the development and release of a new products, etc.,

– The desire of companies to focus on their core competencies promotes outsourcing, which, in its turn, changes the structure of the industry.

Social:

– With the development of consumer awareness, increase of demands for goods and for related services: targeting supply (predefined user), efficiency response to the request, manufacturing and delivery of environmental friendly goods and production, enhancing the role of reverse logistics (increase of the number of goods returns).

Technological:

– Transparency and the ability to control any of the processes that take place in the logistics chain, both on consumers side and directly on the side of logistic chain elements,
– Internet-tailored logistic system,
– New methods of production, assembly and distribution of spare parts [4, 5],
– Using of advanced production materials,

The legal:

– Legislative regulation: the length of the workweek, transportation, level of environment`s impact, the level of innovation activity, etc.

Natural:

– Increase of the volume of CO2 emissions into the atmosphere,
– Growth of the part of reverse logistics under increasing role of utilization,
– The use of finite natural resources, the search for alternative energy sources.

The authors believe that the key "generators" of the development of any industry (including automotive) can be innovations that are designed to solve certain technological, natural, social and other factors and challenges. Figure 1 shows the chronology of the development of innovative technologies used in motor vehicles.

In general, innovation can be divided into two groups - technical (technological) and administrative (non-technological). The technical innovations in logistics today include: radio frequency identification, or so-called RFID technology; integrated information systems between organizations in the supply chain, automatic information systems that builds the optimal route of vehicles (the ability to change the route after the departure from the part); digital administration, which is intended to reduce the time of booking process; integrated systems for processing and transmitting information; modern vehicles with low CO2 emissions into the atmosphere, as well as cars with hybrid and fully electric engines; the use of new models of vehicles for car transportation that are able to increase the number of floors as needed (maximum of 3) and so on. Administrative innovations in enterprises logistics of automobile industry can be summarized as follows: the emergence of logistics operators class 3PL and 4PL, enabling complete on-line control of moving goods from producer to consumer, while providing services for the temporary storage of goods, increasing manufacturers attention to the environmental logistics, implementation of which should be done in terms of administrative innovations, increasing the role of automated warehouses, packing centers, departments for personalization or localization of orders, etc., further development of logistics, based on the principle of "just-in-time» (JIT). Overall, as studies have shown, the number of innovations that were developed as an administrative and technical nature are considerably less than the number of actual implementations (see Figure 2). Therefore, scientific and technical departments are critical to recognize perspectives of this or that development.

There are also a number of innovations that include features of both groups. These include the so-called modular production in cooperation of several companies. For businesses of automotive industry, modular production in the conditions of a continuous search of opportunities to

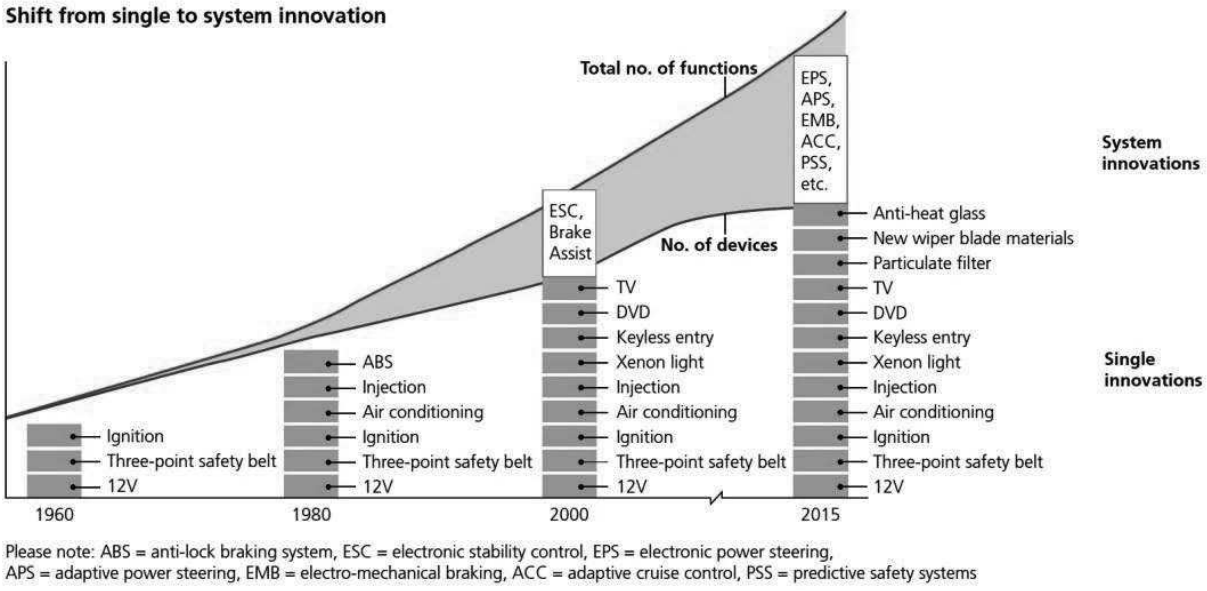

Fig. 1. Characteristics of innovation in automotive industry [6]

optimize costs, trying to meet the growing demands of consumers to the product, is one of the most promising ways of developing in the coming years [7]. The successful implementation of the considered innovation allows for:

– Reduction of the cost of developing new models,
– Speeding up the output of new products on the market (over 30%),
– Reduction of the cost of training staff that performs repair and servicing of motor vehicles,
– Unification of many spare parts in modules that apply to different car models, thus reducing the cost of spare parts to the end user,
– Using a single platform with multiple-choice modules - producing a range,
– Reducing dependence on a single supplier,
– Reducing risks related to natural disasters,
– Effectively management of the disposal.
– In addition to the positive aspects of modular production a number of drawbacks are inherent:
– Difficulty of establishing close partnerships,
– Inability of radical differentiation of developed platform to meet individual customer orders,
– Increasing complexity of designs of some replacement parts,
– Availability of additional costs for testing object models.

The nature of the modularity conditions on every automotive company is specific, but they are united by the presence of a number of modules, certain systems or car parts, the layout of which makes it possible to unify the car.

For example, the company Nissan in the modular production (program "Common modular family Nissan») used four different modules: engine compartment, cabin, front and rear underbody. Combining different variations of these modules allows for the creation of a broad range of cars, including models from the wagon to the hatchback. Options of modules and their combination results are shown graphically in Figure 3.

As seen from Figure 3, the use of multiple versions of a module part allows more dynamic individualization of production process.

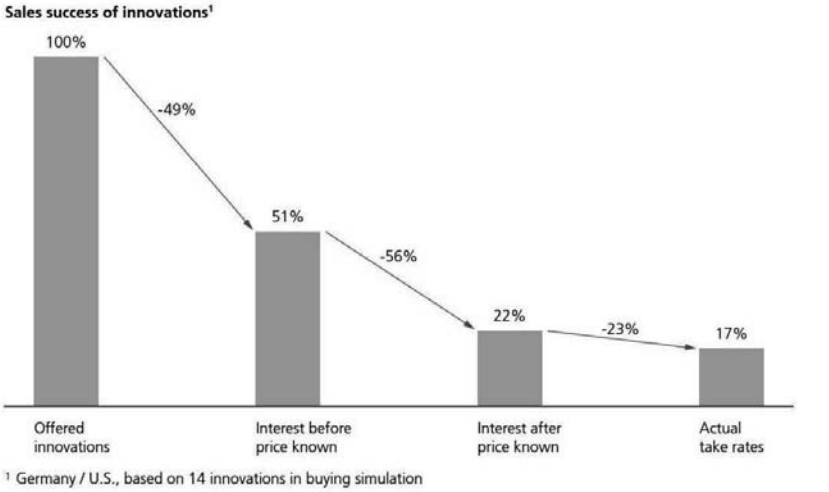

Fig. 2. Impact of innovation on consumer purchasing activity [6]

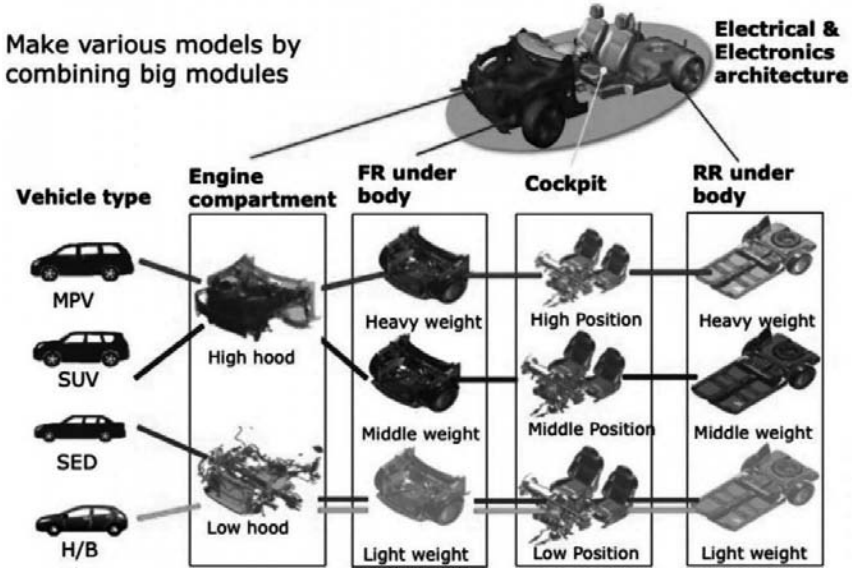

Fig. 3. Structure of module production by Nissan in the program, "Joint modular family Nissan» [8]

Considered technology with certain modifications of production (including the needs of consumers in product differentiation of automotive companies) also used such enterprises as: Ford, General Motors, Volkswagen, Mercedes, Renault Nissan alliance and others [9].

As already noted, this production technology is much better with contracts of cooperation between different institutional units that are present both within the supply chain of a particular company and outside it. One of the main goals of parties cooperation is to improve the competitiveness of all parties of cooperation, by increasing production, stimulating savings of scale and division of costs between the parties aimed at the processes of development and introduction of new products or innovative technologies.

In addition to the above advantages, cooperation enables:

– Reducing the cost of spare parts through standardization,
– Gaining access to advanced technologies,
– Improvement of the level of cooperation between all parties of cooperation,
– Transparency of information flows,
– Optimization of logistic processes,
– Creation of interchangeable parts for different automakers etc.

However, before innovation process in a company it should be noted that all the above benefits can be achieved in greater or lesser value, and are accompanied by other effects [10]. Thus, according to the research conducted, innovations usually increase product quality, and thus increase the cost of the goods, reduce the number of spare parts that are used in the preparation of the product, but the structural complexity tends to increase.

Any merger involves compromises and cooperation in the field of automotive branch under conditions of involving a large number of diverse businesses also puts the problem of optimal operating conditions in a rather broader area. One of such areas are logistics and information exchange within the logistics processes. Tasks such as: production with minimal inventory volumes; implementation of any order within 48 hours; rapid response of all companies involved in the production process to the predicted changes by marketing department in the size and structure of demand for goods; providing information about availability, costs, delivery time, the possibilities of additional production, allocation of necessary spare parts – for all companies, engaged in the supply of raw materials, as well as those engaged in direct sales, repairs processes or servicing of vehicles, shipping products to any destinations, providing an appropriate level of product safety; providing the required level of consumer service (availability of appropriate spare parts), even after removal of goods from production, can be realized thanks to modern systems optimization and rapid development of information technologies, which can be flexibly and comprehensively implemented by companies in various sectors and activities.

LOGISTIC SYSTEM IN THE IMPLEMENTATION OF MODULE PRODUCTION

To build a harmonious spatial logistics system, which facilitates the development of relationships between au-

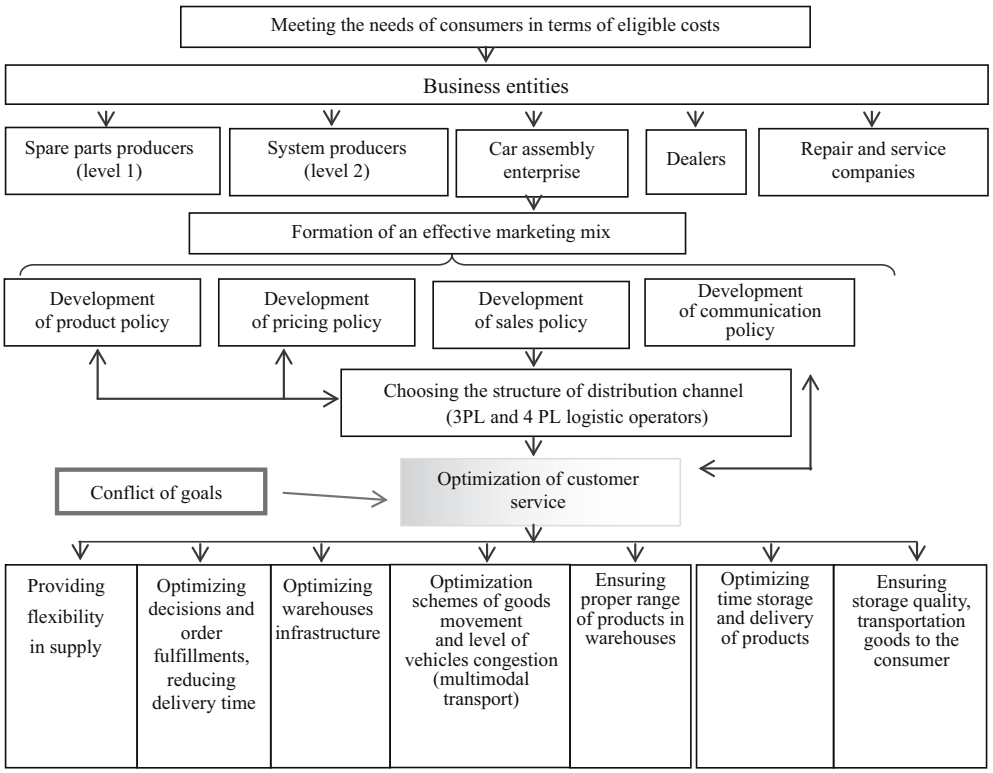

Fig. 4. The hierarchical structure of logistics system tasks realization [11]

tomotive assembly companies, suppliers of first, second levels, suppliers of raw materials, research institutes, enterprises, partners, dealers, 3PL-4PL-and logistics operators, repair companies and service stations, it is necessary to clearly define the tasks of appropriate logistics system and determine those places where there is a conflict of goals. Figure 4 shows the hierarchical structure of tasks in the logistics system.

Any logistics system addresses the needs of consumers in the relevant product or service quality at an appropriate price. Since spare parts as a product are heterogeneous both in matters of the cost of their production (the company) and the requirements for quality and reliability (consumer), so it seems reasonable to analyze components of costs and quality of logistics system components in the automotive industry in terms of module production (Figure 5).

As seen from Figure 5, the analysis was based on the dividing of costs, depending on the stage of production, storage or sales. In general, given dividing is arbitrary, because to make the cost separation of a given process including length and width of the supply chain in the automotive field is somewhat problematic.

So, the first step was outlined costs that cover production processes, and the processes associated with the purchase of raw materials. The second stage involves the production costs of modules, systems and small spare parts by smaller regional and world famous suppliers of automotive systems. The third stage is directly allocated car assembly enterprise and the costs that they incur in the process of developing and assembling vehicles. The fourth stage covers marketing costs, warehousing of finished products and spare parts, as well as the costs of transporting goods to the place of direct sales. At the fifth stage are the costs associated with after sales service of vehicles.

Also, one should allocate the costs associated with the organization partnerships that take place in one or other part of logistics chain. Costs associated with the cooperation may cover costs:

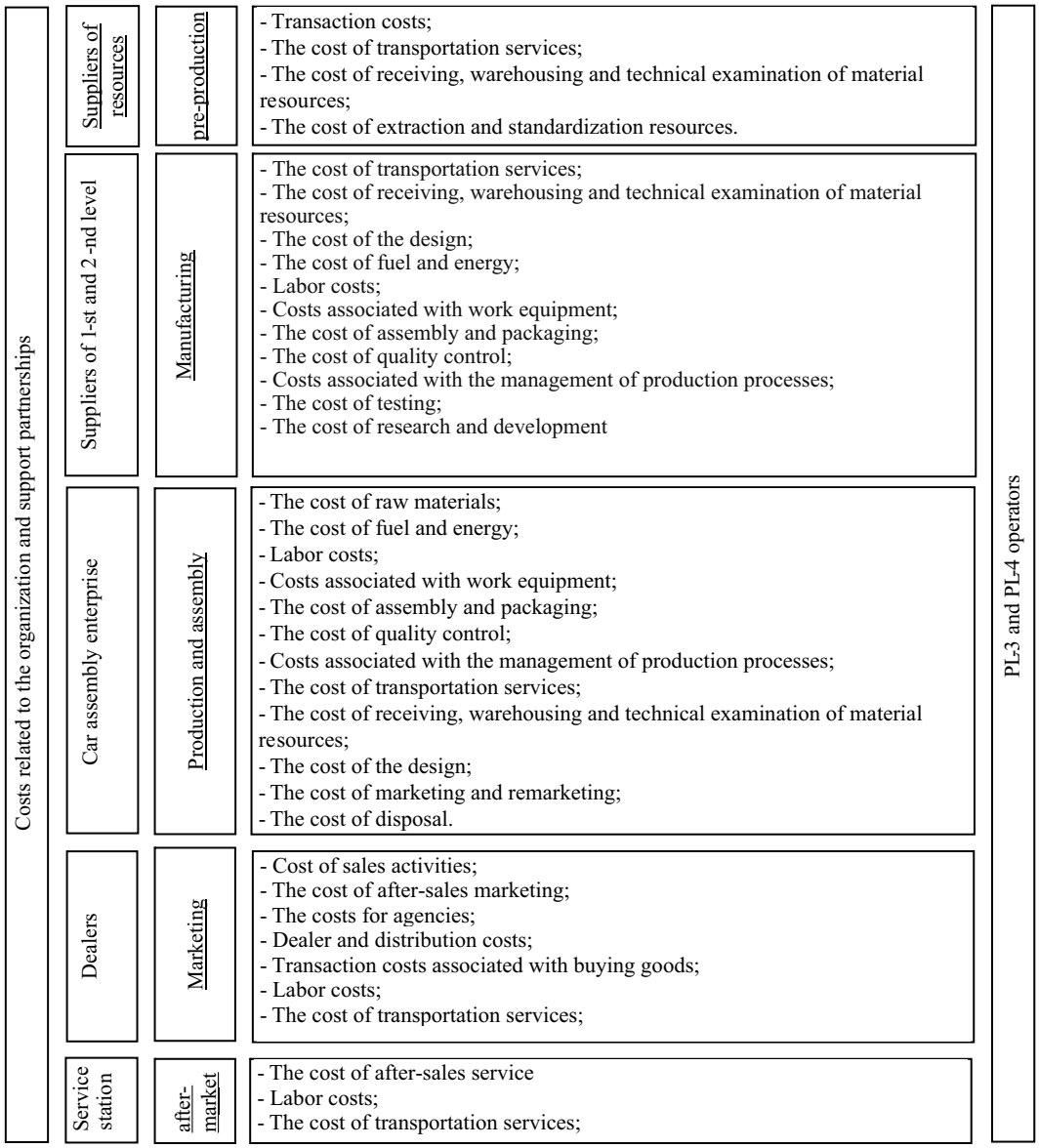

Fig. 5. Components of logistics system costs in automobile industry [12]

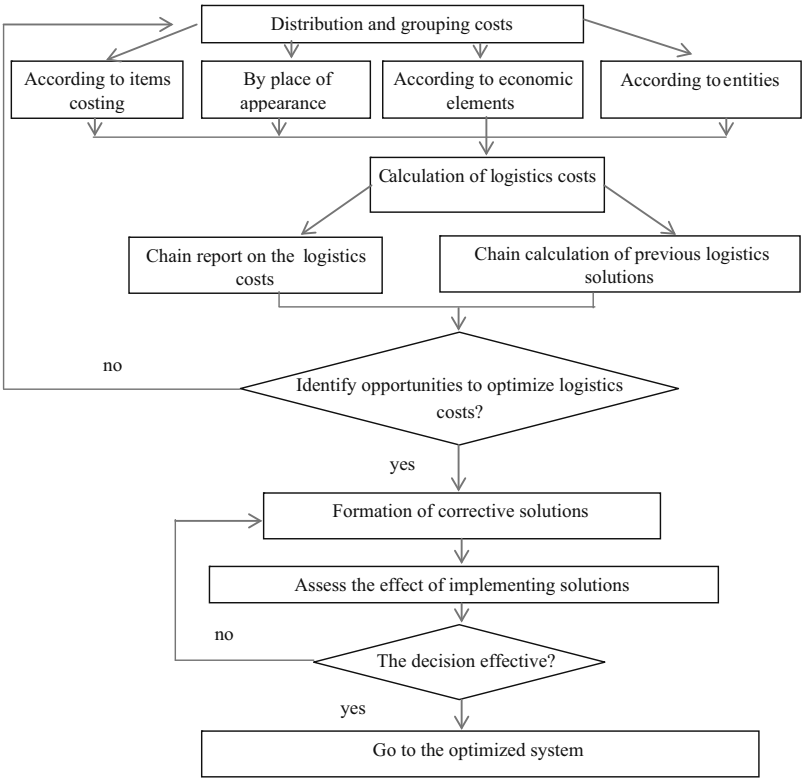

Fig. 6. Pattern of decision making for optimizing logistics costs [12]

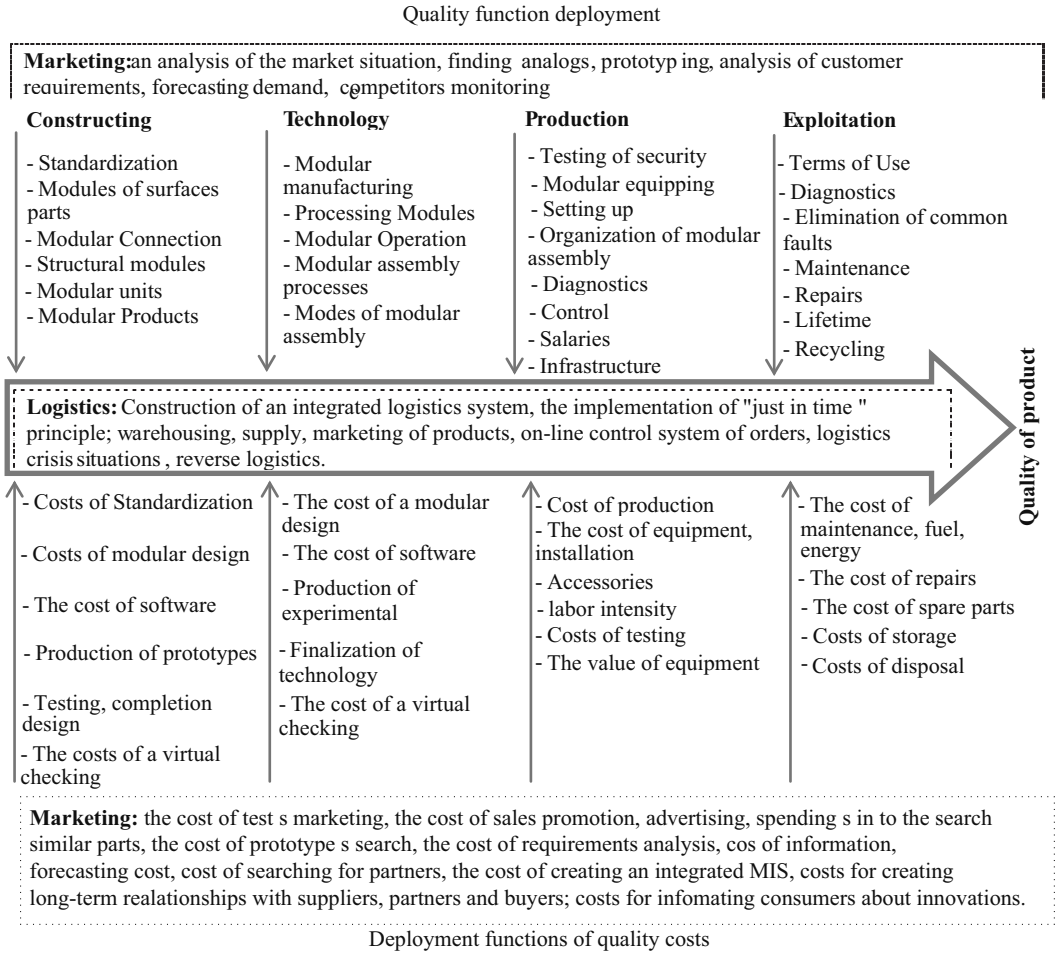

Fig. 7. Deployment cost function and quality function under module production [13]

– for standardization of production process and material financial and information flows,
– for providing an appropriate level of safety,
– for developing new standardized (across brands) spare parts,
– for developing new and improving existing models within the association.

In addition, the authors have singled out 3-PL and 4-PL-operators, as such, which are present at each of the examined stages, and the level of competence which plays a key role in enhancing the competitiveness of integrated logistics chain.

Efficient cost management of logistic systems is not possible without use of appropriate decision-making algorithm (Figure 6).

As it stands, the proposed algorithm enables better structuring of logistics costs by place of origin, thus extending the chances of transition logistics system to a new level of functioning. However, the decision for optimizing or reducing costs should not have effect on the quality of the final product, thereby reducing its competitiveness. Enforcement of this condition is achieved through a comprehensive analysis of cost function and quality function under module production of automobile enterprises products (Figure 7).

Integrated analysis of cost and quality functions facilitates the establishment of spare parts, systems, modules and vehicles, with the combination of quality and costs that would best satisfy consumers' requirements, while ensuring the goals of the enterprise. And implementation of structuring the quality and costs of marketing, logistics, engineering, technology, production and operation stages is prerequisite for finding hidden prospects of a process optimization.

FEATURES OF PARTNERSHIP RELATIONS DEVELOPMENT BETWEEN COMPANIES IN THE AUTOMOBILE INDUSTRY

The sphere of spare parts production for motor vehicles is complex and heterogeneous. Successful operation of automotive manufacturers requires a close cooperation with dealers (as they best understand customer needs and can effectively predict demand for a particular product in a particular region) [14, p.1-2], with manufacturers of spare parts and systems (because the level of competence in production and technology of spare parts of those companies are the largest), with suppliers (quality, price and availability of raw materials at the right moment without close cooperation isn`t possible), with repair stations (providing important information about the level of performance of any spare parts in the real conditions, about their safety and ability to wear, ensuring the formation of long-term relations with customers), with logistics operators (availability, speed, possibility to deliver, reliability, low cost storage, catalog, on-line monitoring of the availability of goods in warehouses or on the road, more experienced management of supply chain, as 3PL and 4PL operators usually have more experience doing business with multiple clients, etc.).

As practice shows, most enterprises in the automobile sector, try to form long-term relationships with the above-mentioned institutions, but generally, these connections are not close, do not provide open information systems, joint research. So, car assembly enterprises are forced to maintain an appropriate level of safety and to avoid existing risks (see Figure 8), forming the base of "secondary" partners. As a result, it becomes impossible to build high-quality, effective cooperation, and core competencies at each element of the logistics system is not used at full level.

One of the ways out of this situation, which has now been implemented in a number of industries in recent years, is the formation of close cooperation between the elements of the logistics system in the limit of core competencies. Strengths and weaknesses of the companies involved in the manufacture, preparation, delivery and sale of spare parts are shown in Figure 9.

Close cooperation include:
– The formation of strategic alliances by exchanging shares parts of companies certain departments (individual entities),
– Based on association - joint development of spare parts technologies, building a common network of repairing facilities, service stations, multi-distribution networks,
– Building a common integrated information system,

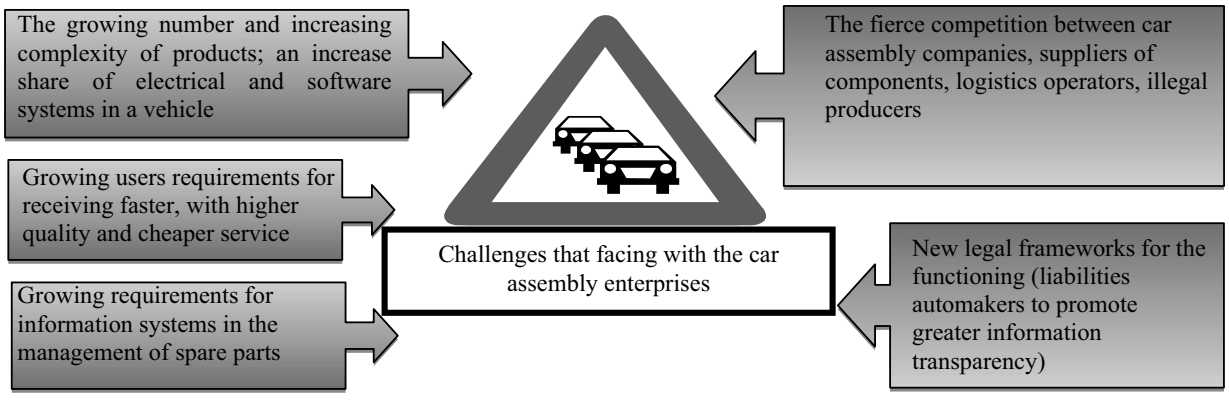

Fig. 8. Challenges that car assembly enterprise are faced by [15]

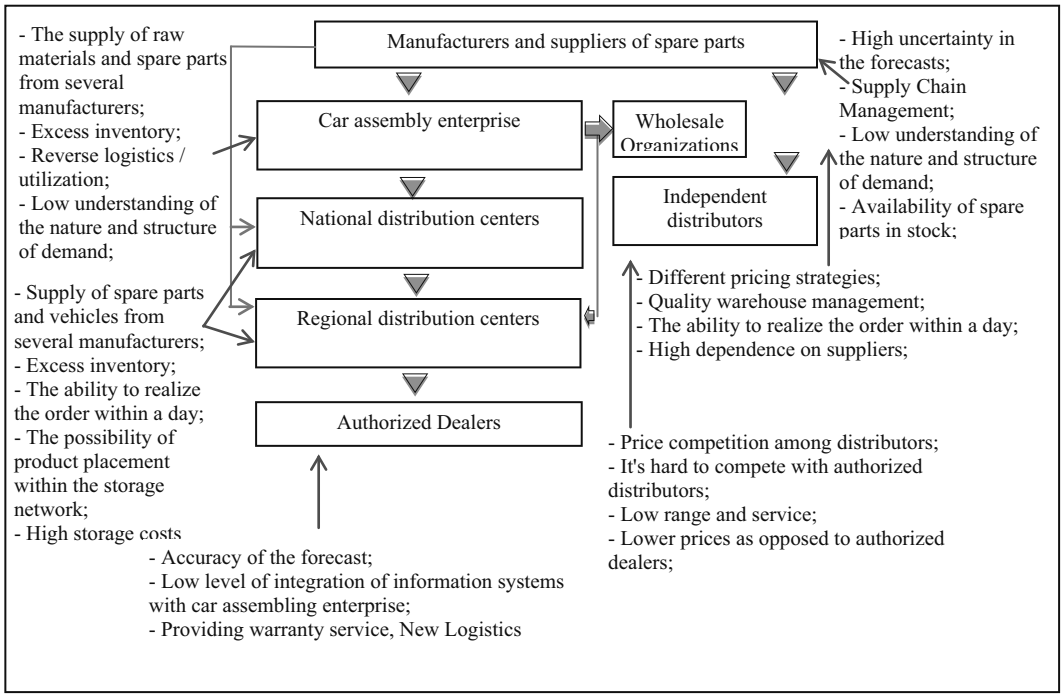

Fig. 9. Structure of the vehicles market with regard to the strengths and weaknesses of each participant [15]

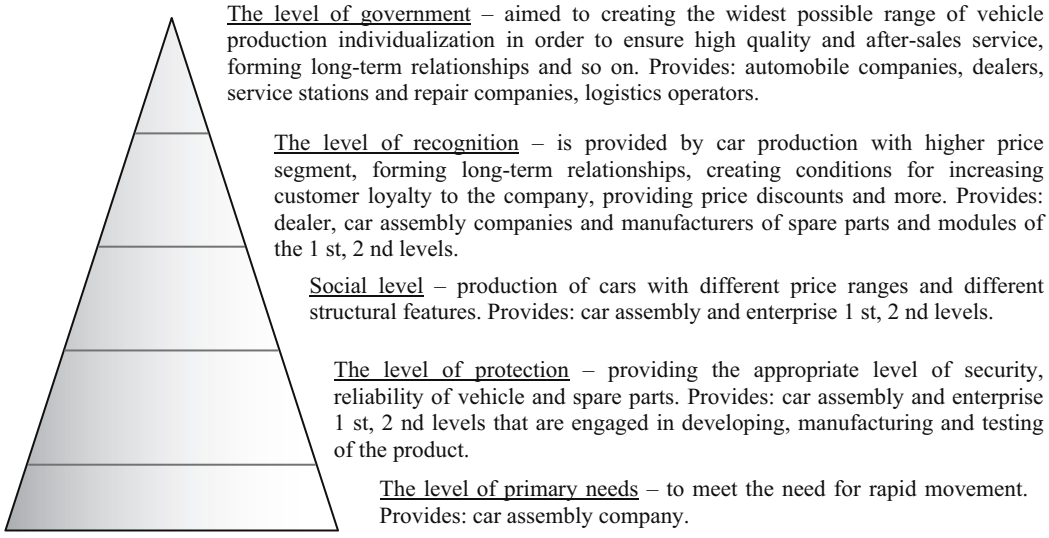

Fig. 10. Hierarchy of needs in the field of spare parts

- The creation of multi-warehouses,
- The formation of a joint system training,
- Formation of joint modular platforms,
- Creation of a transparent information - effective forecasting demand for raw materials, spare parts, modules, cars, etc.,
- Realization of a reasonable service policy.

Based on analysis of the prospects that opens businesses cooperation and considering the needs of end-users, we can construct the corresponding hierarchy of needs in the field of spare parts (Figure 10).

Submitted figure gives a clear picture of every element`s importance in the logistics system and inefficient work of at least one of the elements can lead to collapse of the entire "pyramid".

Performance, as already mentioned, the level and nature of integration in the logistics chain is specific to each system, but changing approaches to the cooperation within the supply chain is critical, especially during the policy module design and production of spare parts, systems or, directly, vehicles [18]. The main cooperation differences are summarized in Table 1.

CONCLUSIONS

Consequently, integration, as the above table shows, involves responsibility growth of all association components, synchronous and coordinated actions, a compromise in resolving disputes, joint development of new

Table 1. The features of enterprises cooperation under integration within a logistics system [17]

Factor	Conflict approach	An approach based on cooperation
profit	following the goals of profit maximization	maximizing for the whole system
relationship	one party dominates	equal partnership
trust level	small	significant
communications	limited and formal	comprehensive and open
information	limited	integrating the common information system
control	tight	common control over the implementation of the goals
quality	emphasizing the shortcomings of the various departments	common issues for improving product quality
contracts terms	tight	flexible
focused	on its own operations	on the consumer

products and their mutual interest in the development of one or another element of the logistics system. However, the requirements that apply to the system give tangible competitive advantage especially at a time when the market has begun to dominate the consumer market producer. Module production in the automobile sector against the background of cooperation of car assembly companies, manufacturers of spare parts, intermediaries, contribute to break down the costs, reduce the duration of the order, increase flexibility, which is effective in competing for the consumer.

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Polycriterial diagnostics of the enterprise development

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Abstract. The method of polycriterial diagnostics of enterprise development on the basis of determination of the integral level of its development considering the development scope and quality was developed. The model of calculation of integral levels of the development scope and quality was formed, the list of business-indicators that serve as basis for complex diagnostics of enterprise development was sustained.

Key words: polycriterial diagnostics, development, development quality, development scope, integral level of development.

INTRODUCTION

Any enterprise functioning in definite environment is developing. But under the influence of time its quality and quantity characteristics are changing. The transition from one stage of life cycle to another is taking place; the position of an enterprise at the market is changing etc. Strategic and tactical plans are usually developed in order to provide a goal-oriented development at enterprises, a successive complex of goal measures, and an active search for effective mechanisms of transition to the new functioning level is performed. It is worth mentioning, that in modern conditions of functioning, which are characterized by unstable financial-economic system, escalation of competition on different markets, active changes in consumer needs etc. it is not enough for enterprises to adapt to changes in functioning conditions, because it is necessary to anticipate such changes in order to hold their stable positions on the markets, which is vividly demonstrated by the leaders in different branches of economy. In such conditions, the problem of the enterprise development diagnostics, distinguishing of the key factors defining this process, definition of the type and level of development which will give possibility to foresee further functioning and enterprises potential is gaining special importance.

THE ANALYSIS OF THE LITERATURE REFERENCES ON THIS PROBLEM

In economic theory and economic practice, the enterprise development is reflected and diagnosed by the life cycle, i.e. by phases and stages of vital activity of the enterprise from launching to its closure. According to the most common concept the following stages of the life cycle of the enterprise development are defined: starting (registration, initial investment activity), the growth (accumulation of volumes of production and supply, image formation, profit increase), the maximum increase of activity (maximum profits, volumes of production and supply), the decline (reduction of activity) and closure. Very often scientists compare the definition of the stages of enterprise life activity with the stages of human life, identifying the launching of the organization as its childhood, youth, early and final manhood, ageing, death or its revival. The polycriterial model concerning the definition of stages of enterprise life cycle development was developed by D. Cherchill and R. Lewis, and according to it five stages of business growth such as existence, survival, success, prosperity, maturity, which are identified on the basis of criteria sum total, that embrace the level of business activity, the company age, the development of formal systems of management, the main strategy, the interrelations between owners and managers, the style of administration are defined. The original model of the company development was developed by L. Greiner (1972), according to which the life cycle of enterprise development consists of five stages: growth through creativity, directive management, delegating, coordinating and cooperation. Each of the stages mentioned consists of the phase of development, stable growth, stability and revolutionary changes, appealing for elimination of crisis, characterized by definite stages: the crisis of leadership, self-government, control, bureaucratization and confi-

dence. It is worth noticing that above mentioned range of types of enterprise life development suggests the wide diversity of criteria of identification of definite stages and phases that considerably complicates the implementation of diagnostics of enterprise development, aiming at estimating its key characteristics and acceptance of corresponding managerial decisions.

It is considered, that the general period of all stages of the enterprise life cycle forms 20-25 years and after this period its closure or revival on the new principles takes place. According to the estimation of the experts, the duration of each stage of enterprise life cycle usually lasts: birth – to l year, childhood – 1-2 years of activity, youth – 3-5 years, early maturity – 6-10 years; crowning maturity – 11-20 years, ageing – 21-25 years of activity. It is worth mentioning, that in modern highly dynamical conditions, the duration of life cycle has shortened considerably, besides it is sufficiently different for enterprises of different sizes and types of economic activity.

Statistical analysis of the dynamic rows according to the indicators chosen with the calculating of chain and basic absolute devices, rates of growth, average rates of increase, change indices, with economic – statistic modeling of dynamics are usually considered as the quantity diagnostics of the enterprise development in literature references and in practice.

The analysis of works of the scientists (A. M. Shtangret, O. I. Kopylyuk [2], H. V. Shyrokova [3], M. V. Hrynyova, V. O. Koyuda, T. I. Lepeyko etc. [4], V. A. Vasylenko [5], V. H. Herasymchuk [6], M. C. Zayukova [7], L. H. Melnyk [8], Yu. S. Pohorelova [9], R. V. Feshchur, M. R. Tymoshchuk [10], I. B. Oleksiv, N. Yu. Podolchak, R. V. Shulyar [11], M. L. Lapishko [12], V. Osypenko [13]) states that the declension rates of increase of key indicator and functioning parameters are analyzed while performing diagnostics of enterprise development. Such approach gives the opportunity, with the parameters combined, to estimate dynamic and structural changes in productive-industrial activity of the enterprise and is directed, first of all, towards the diagnostics of a conversion scale, i.e., the quantitative aspect of development. Moreover, as a rule, the qualitative aspect of development, showing positive changes in the quality of enterprise production, provision of rhythmical and continual process of production, etc. is not taken into account. It is also worth emphasizing, that the usage of definite totality of indicators for enterprise development diagnostics without their further summing up and integration does not allow to form a complete notion about the trajectory of enterprise development as a whole, as the dynamics of individual indicators among the list selected may differ essentially in volumes and directions.

THE AIM OF THE ARTICLE

The aim of the article is to develop the method of polycriterial diagnostics of the enterprise development taking into account the scale and the quality.

THE PRESENTATION OF THE MAIN RESEARCH MATERIAL

Performed research gives the opportunity to suggest the performance of the complex polycriterial diagnostics of enterprise development by the calculation of integral level of development that will depend on two key concepts: the scale level of development and the quality level of development. The scale level of enterprise development demonstrates the quantitative characteristics of changes and transformations that had happened. It is suggested to ground the list of most representative indicators that affirm the quantitative changes of the industrial manufacturing enterprise parameters according to the absolute indices as that concerns the development scale. The level of development demonstrates the key characteristics of the enterprise especially the manufacturing of production in time and without manufacture defect and the capitalization of enterprise value. The pattern of integral level determination of enterprise development is shown in Fig. 1.

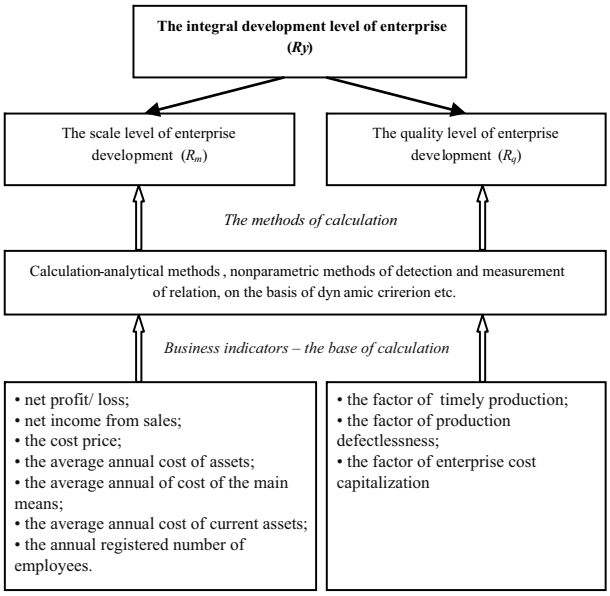

Fig. 1. The model of integral level determination of the enterprise development

To analyze only the dynamics of the indicated business-indicators in Fig. 1 during the reasonable period of time will be insufficient, it is necessary to define the combined tendency of quantitative changes. The most justified and reasonable methods for generalization of dynamic tendencies of totality of factors are non-parametric methods of exposure and measuring of connections – namely, the methods of grade correlation [12, 14]. On the basis of the selected methods it is possible to define and ground dynamic criteria, in other words rating of correlations of growth of key indicators of enterprise functioning that will give an opportunity by means of corresponding statistical indices (coefficient of grade correlation of Spirmen and coefficient of coincidences of Fekhner) to estimate the actual state of dynamics of

the marked indicators in comparison with the criterion in future rates. It is suggested to generalize the marked statistical indices for calculation of integral levels of scale and quality of enterprise development. The foregoing sequence of determination of levels of scale and quality of enterprise development is given in Fig. 2 [15, 16].

Let us consider the usage of the given model more carefully (see Fig. 2) to determine the levels of scale and quality of enterprises development.

1) Establishing of key indicators that in the most representative way testify the quantitative and qualitative transformations of the enterprise.

All indicators that characterize the various spheres of enterprise functioning, usually represent certain transformations in dynamics, but the personal interest within the research limits of scale of development is caused only by those factors, that represent the volumes of activity, results, capital, circulation, efficiency of enterprise functioning.

Taking into account the above mentioned information, such absolute indicators are the most informatively saturated from the scales of the enterprise functioning point of view:

– net profit / loss,
– net income from sales,
– the cost price,
– the average annual cost of assets,
– the average annual of cost the main means,
– the average annual cost of current assets,
– the annual registered number of employees.

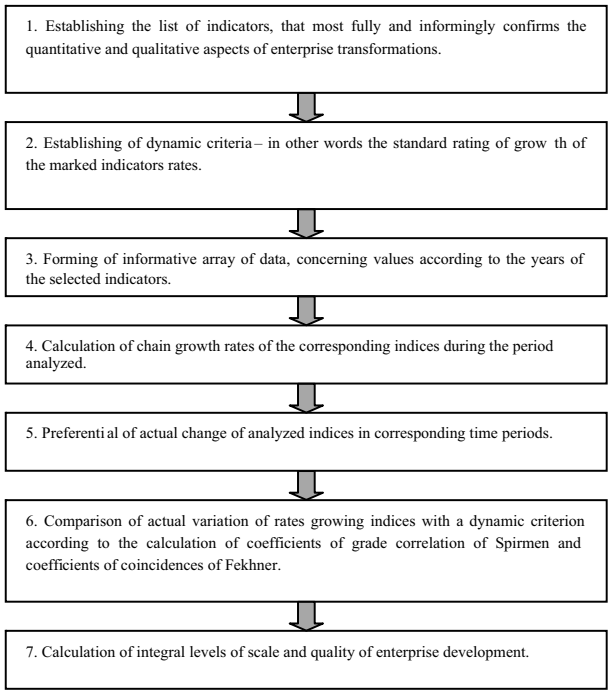

Fig. 2. The model of determination of scale levels and quality of enterprise development

The above-mentioned factors give an opportunity to estimate first of all the scales of the enterprise functioning and obtained results at corresponding operating conditions. Thus, on the basis of their dynamics research it is possible to estimate character and scale of the enterprise development. These factors are, to some extent, interconnected but, taking into consideration the fact that in future in calculations we will be oriented on rates and priority of their change, it will in no way influence negatively the results obtained.

According to the results of research, the most representative factors that allow to diagnose the quality of enterprise functioning are zero defects and timely production, and also the level of capitalization of enterprise cost.

The coefficient of goods production correctness (K_B) represents the share of quality products that meets all standards of quality, in the volume of commodity products, acquires values in range of [0; 1] and is calculated according to the formula:

$$K_B = \frac{B_1(1 - B_5)}{B_1}, \tag{1}$$

where: B_{1} is a volume of commodity products; B_5 – is a share of defective products in commodity products.

The coefficient of timely production (K_C) affirms the systematic character of industrial and economic activity, in other words, making the products after the set chart and assortment in obedience to the requirements of consumers. The coefficient of timely production (smooth production flow) is counted monthly or in quarterly cuts on principles of comparison of the systematic and actual loading of production capacities, and that's why here the factor of seasonality can be also taken into account, and acquires values in a range [0; 1]. The coefficient of timely production is recommended to be calculated by the following formula:

$$K_C = \frac{\sum_{i=1}^{t} B_{1i}^{\min}}{100\%}, \tag{2}$$

where: $i=1...t$ – is the amount of periods in a year, after that there is comparison of systematic and actual production volumes; $B_{1i}^{\min}$ – is a minimum share of commodity products in comparing to the annual equivalent between the systematic and actual productive program, %.

The third indicator that characterizes the quality aspect of enterprise development is a coefficient of cost capitalization (K_K), that represents the correlation of market (V_r) and the balance (V_b) values of enterprise. Thus, it is worth understanding the cost of enterprise in a money equivalent, for that in corresponding spatial-temporal terms potentially there can be a remote enterprise on the basis of voluntary and legal actions of buyers and sellers. Alienation can take place by the sale of stocks, shares, parts etc. The balance value of the enterprise usually equates with the cost of its assets upon the certain date. Thus, the coefficient of capitalization of cost value is calculated by such formula:

$$K_K = \frac{V_r}{V_b}. \quad (3)$$

The coefficient of enterprise cost capitalization must exceed 1 and lead to an increase in its dynamics.

2) Establishing of dynamic criterion – in other words, standard rating of growth of the marked indicators rates. On this stage there is a necessity for determination of the standard rating of factors change.

According to "the golden rule of economy" the change of the indicated factors, with the help of which the scale of development is diagnosed, must take place in such a sequence [17]:

$$Tn > Toa > To > Ta > Toз > Tc > Tч, \quad (4)$$

where: *Tn* – is a rate of increase (reduction) of income; *Toa* – is a rate of increase (reduction) of circulating assets; *To* – is a rate of increase (reduction) of profit from realization; *Ta* - is a rate of increase (reduction) of cost of assets; *Toз* – is a rate of increase (reduction) of the fixed assets; *Tc* – is a rate of increase (reduction) of prime price; *Tч* – is a rate of increase (reduction) of quantity of workers.

As for priority of growth of indicators that characterize the quality parameters of development rates, in this way of the passing ahead in this link there must be an increase of coefficient of zero defects of production that will affirm the incessant increase of products quality; an increase of coefficient of timely production is secondary, that is the consequence of planning processes improvement, production and marketing organization; a consequence after the rates of increase is a change of costs capitalization that depends on previous parameters. Thus, the normative change of the indicated factors will be demonstrated in such a way:

$$T_Б > T_C > T_K, \quad (5)$$

where: $T_Б$ – is a rate of increase (reduction) of production correctness coefficient; T_C – is a rate of increase (reduction) of coefficient of timely production; T_K – is a rate of increase (reduction) of costs capitalization coefficient.

The above-mentioned correlations form priority of increase rates of corresponding factors, in other words, they set dynamic criteria that in future will serve as criteria and norms for comparison.

3) Forming of informative array of data in relation to values after the years of selected indicators. Let us form the informative array of these foregoing factors for the provisional enterprise Joint-stock company "Enterprise" (Table. 1, Table. 2).
4) Calculation of chain growth rates on the corresponding indices during the period analyzed. On this stage there is a necessity for the calculation of increase rates of selected indices for a provisional enterprise (table 3, table 4).
5) The rating of actual change of analyzable factors in corresponding time periods (Table 5, Table 6).
6) The comparison of actual variation of factors growth rates with the dynamic criterion on calculation principles of Spirmen grade correlation coefficient and Fekhner coefficient of coincidences.

Spirmen grade correlation coefficient (K_s) represents a rejection between standard and actual grades after the dynamic rows of factors for corresponding period and is in such range [- 1; 1] [12]:

Table 1. The main factors that characterize the development scale of Joint-stock company "Enterprise" during 2007-2011

Factors	2007	2008	2009	2010	2011
Net profit/ loss (thousand, hryvnia)	909	-2384	1838	2643	-150
Net income from sales (thousand, hryvnia)	13504	4965	22044	23154	10312
The cost price (thousand, hryvnia)	12595	7949	20206	20511	10462
The average annual cost of assets (thousand, hryvnia)	31888	33188	38148	47091	30844
The average annual cost of the main means (thousand, hryvnia)	14219	13480	24752	11536	15358
The average annual cost of current assets (thousand, hryvnia)	17098	18736	24197	32254	15370
The annual registered number of employees	441	361	296	320	275

Table 2. The main factors that characterize the quality of development of Joint-stock company "Enterprise" during 2007-2011

Factors	2007	2008	2009	2010	2011
Coefficient of production correctness	0,78	0,83	0,88	0,91	0,85
Coefficient of timely production	0,87	0,95	0,94	0,82	0,72
Coefficient of cost capitalization	1,09	0,93	0,98	1,03	0,94

Table 3. The increase rates of basic factors that characterize the development scale of Joint-stock company «Enterprise» during 2007-2011

Factors	2007	2008	2009	2010	2011
Net profit/ loss (thousand, hryvnia)	*	-3,62	-1,77	0,44	-1,06
Net income from sales (thousand, hryvnia)	*	-0,63	3,44	0,05	-0,55
The cost price (thousand, hryvnia)	*	-0,37	1,54	0,02	-0,49
The average annual cost of assets (thousand, hryvnia)	*	0,04	0,15	0,23	-0,35
The average annual cost of the main means	*	-0,05	0,84	-0,53	0,33
The average annual cost of current assets	*	0,10	0,29	0,33	-0,52
The annual registered number of employees	*	-0,18	-0,18	0,08	-0,14

Table 4. The increase rates of basic factors that characterize the quality of development of Joint-stock company «Enterprise» during 2007-2011

Factors	2007	2008	2009	2010	2011
Coefficient of production correctness	*	0,06	0,06	0,03	-0,07
Coefficient of timely production	*	0,09	-0,01	-0,13	-0,12
Coefficient of cost capitalization	*	-0,15	0,05	0,05	-0,09

Table 5. Rating estimation of rates increase of development scale factors of Joint-stock company «Enterprise» during 2008-2011

Factors	Dynamic criterion	2008	2009	2010	2011
Net profit/ loss (thousand, hryvnia)	1	7	7	1	7
The average annual cost of current assets (thousand, hryvnia)	2	1	4	2	6
Net income from sales (thousand, hryvnia)	3	6	1	5	4
The average annual cost of assets (thousand, hryvnia)	4	2	5	3	3
The average annual cost of the main means (thousand, hryvnia)	5	3	3	7	1
The cost price (thousand, hryvnia)	6	5	2	6	5
Annual registered number of employees	7	4	6	4	2

Table 6. Rating estimation of quality development increase rates of Joint-stock company «Enterprise» during 2008-2011

Factors	Dynamic criterion	2008	2009	2010	2011
Coefficient of production correctness	1	2	1	2	1
Coefficient of timely production	2	1	3	3	3
Coefficient of cost capitalization	3	3	2	1	2

$$K_S = 1 - \frac{6}{n(n^2 - 1)} \sum_{i=1}^{n} (E_i - F_i)^2, \quad (6)$$

where: n – is amount of factors that represent a dynamic criterion; i – is a corresponding index of dynamic norm; E_i – is standard grades of corresponding factors of dynamic criterion; F_i – is actual grades of corresponding factors of dynamic criterion.

Fekhner coefficient of coincidences (K_F) represents the accordance of actual grade rates of increase standard on the basis of successive comparison of dynamic criterion factors grades and is in a such range [- 1; 1] [12]:

$$K_F = \frac{F}{A}, \quad (7)$$

where: F – is a sum of positive and negative correlation between grades; A – is a maximal amount of paired comparisons between grades.

For the calculation of grade correlation coefficients after rejections let us calculate Tables 7, 8).

Table 7. The sums of squares of grade rejections and coefficients of grade Spirmen's correlation after the rejections of development scale factors of Joint-stock company "Enterprise" during 2008-2011

Factors	Dynamic criterion	2008	2009	2010	2011
Net profit/ loss (thousand, hryvnia)	1	36	36	0	36
The average annual cost of current assets (thousand, hryvnia)	2	1	4	0	16
Net income from sales (thousand, hryvnia)	3	9	4	4	1
The average annual cost of assets (thousand, hryvnia)	4	4	1	1	1
The average annual cost of the main means (thousand, hryvnia)	5	4	4	4	16
The cost price (thousand, hryvnia)	6	1	16	0	1
The annual registered number of employees	7	9	1	9	25
Sum of squares of grade rejections	*	64	66	18	96
Coefficient of Spirmen's grade correlation K_s	*	-0,14	-0,17	0,67	-0,71

Table 8. The sums of square of grade rejections and coefficients of grade Spirmen's correlation after the rejections of factors of development quality of Joint-stock company «Enterprise» during 2008-2011

Factors	Dynamic criterion	2008	2009	2010	2011
Coefficient of production correctness	1	1	0	1	0
Coefficient of timely production	2	1	1	1	1
Coefficient of cost capitalization	3	0	1	4	1
Sum of squares of grade rejections	*	2	2	6	2
Coefficient of Spirmen's grade correlation K_s	*	0,5	0,5	-0,5	0,5

For the calculation of Fekhner coefficient of coincidences it is necessary to define how many coincidences of key indicators changes priority are observed in comparison with a standard dynamic criterion. Thus, the comparison of grades comes true after the rates of increase, if the actual increase of index takes place in standard direction, in other words, exceeds the rates of increase of base index after the rates of increase, then let's identify this situation to the values «+ 1», in opposite case – «-1». The results of calculations are given in Table 9 and Table 10.

7) The determination of the development scale level (R_m) on the basis of integration of Spirmen grade correlation coefficients and coincidences of Fekhner on the development scale factors according to the formula [18]:

$$R_m = \frac{(1+K_S)*(1+K_F)}{2j}, \quad (8)$$

where: j – is a number of indicators that are integrated together (in our case this is $j = 2$).

The quality development level (R_q) is expedient to determine according to the analogical formula (8), but the Spirmen grade correlation coefficients and coincidences of Fekhner are here integrated on the factors of enterprise development quality.

The level of scale and level of development quality, each in particular, allow synthesizing two factors: Spirmen grade correlation coefficient and Fekhner coefficient of coincidences. Thus, we get the only integral index that changes in range in every special case [0; 1] and testifies the quantitative or qualitative aspect of enterprise development. The results of development coefficient calculations for the provisional enterprise are given in Table 11.

On the basis of values of scale level and enterprise development quality level the integral level of enterprise development (R_r) is calculated, that is expected to be in range [0; 1]. Accordingly, with approaching of the index to unit 1, it is possible to assert high level of enterprise development, to zero – low level of development. It is expedient to calculate the index on the basis of middle arithmetic self-weighed entrance levels of scale and quality of development according to the formula [19; 20]:

$$R_r = \frac{R_m \cdot g + R_q \cdot h}{100\%}, \quad (9)$$

where: g – is a ponderability of development scale level for an enterprise, %; h – is ponderability of development quality level for an enterprise, % ($h = 100 - g$).

The necessity of ponderability determination of the indicated development levels is explained by financial viability, in fact, there is different priority for every enterprise in relation to scale and quality of development. If, for example, an enterprise works in full capacity and there is not necessity to increase the scales of produc-

Table 9. Fekhner coefficients of coincidences according to the scale development factors of Joint-stock company "Enterprise" during 2008-2011

Factors	2008	2009	2010	2011
1	2	3	4	5
Net profit // The average annual cost of current assets	-1	-1	+1	-1
Net profit // Net income from sales	-1	-1	+1	-1
Net profit // The average annual cost of assets	-1	-1	+1	-1
Net profit // The average annual cost of the main means	-1	-1	+1	-1
Net profit // The annual registered number of employees	-1	-1	+1	-1
The average annual cost of current assets // Net income from sales	+1	-1	+1	-1
The average annual cost of current assets // The average annual cost of assets	+1	+1	+1	-1
The average annual cost of current assets // The average annual cost of the main means	+1	-1	+1	-1
The average annual cost of current assets // The cost price	+1	-1	+1	-1
The average annual cost of current assets // The annual registered number of employees	+1	+1	+1	-1
Net income from sales // The average annual cost of assets	-1	+1	-1	-1
Net income from sales // The average annual cost of the main means	-1	+1	+1	-1
Net income from sales // The cost price	-1	+1	+1	+1
Net income from sales // The annual registered number of employees	-1	+1	-1	-1
The average annual cost of assets // The average annual cost of the main means	+1	-1	+1	-1
The average annual cost of assets // The cost price	+1	-1	+1	+1
The average annual cost of assets // The annual registered number of employees	+1	+1	+1	-1
1	2	3	4	5
The average annual cost of the main means // The cost price	+1	-1	-1	-1
The average annual cost of the main means // The annual registered number of employees	+1	+1	-1	+1
The cost price // The annual registered number of employees	-1	+1	-1	-1
The positive and negative amounts of correlation between grades	-1	-3	11	-18
Coefficient of Spirmen's grade correlation K_F	-0,05	-0,14	0,52	-0,86

Table 10. Fekhner coefficients of coincidences according to the development quality factors of Joint-stock company "Enterprise" during 2008-2011

Factors	2008	2009	2010	2011
Coefficient of zero production correctness// Coefficient of timely production	-1	+1	+1	+1
Coefficient of zero production correctness // Coefficient of cost capitalization	+1	+1	-1	+1
Coefficient of timely production // Coefficient of cost capitalization	+1	-1	-1	-1
The positive and negative amounts of correlation between grades	1	1	-1	1
Coefficient of Spirmen's grade correlation K_F	0,33	0,33	-0,33	0,33

Table 11. The levels of development scale and quality of Joint-stock company «Enterprise» during 2008-2011

Analyzed periods	R_m	R_q
2008	0,20	0,50
2009	0,18	0,50
2010	0,63	0,08
2011	0,01	0,50

tion, then in such terms attention is paid to the quality of production, its zero defects and systematic character that will predetermine priority of quality development level. Also the opposite situation is possible, when an enterprise makes quality competitive products, works rhythmically, but products demand considerably exceeds existent supply. In such situation the development scale is the priority for an enterprise. The importance of development levels is determined by an expert method by specialists, managers, proprietors and others. The integral levels of development for the provisional enterprise are given in Table 12.

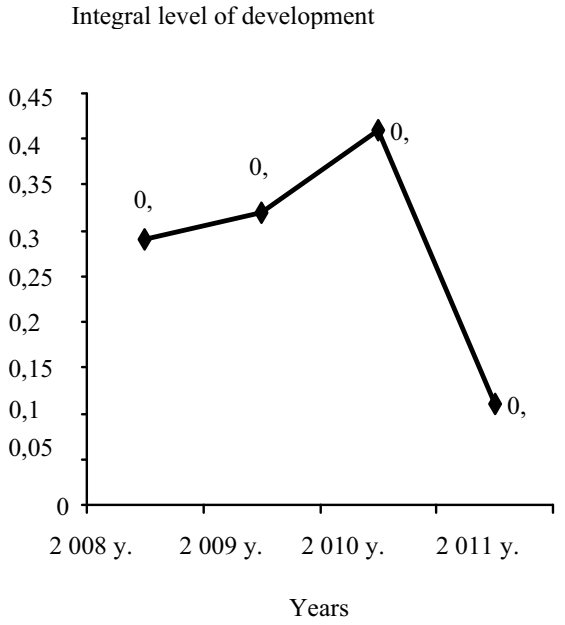

Fig. 3. The trajectory of Joint-stock company "Enterprise" development

The trajectory of enterprise development testifies the tendencies of complex structural changes on the enterprise, their quality and volumes. Thus, the situations when the values of base for the calculations of integral development level of business indicators grow in dynamics, and the trajectory of development descends are widespread. It testifies the imbalance of changes that take place on the enterprise as well as low level of their efficiency.

CONCLUSIONS

On principles of the performed research, the method of complex diagnostics of enterprise development, based on determination of an integral level of development taking into account its two parameters: scale and quality, is suggested. Thus, the level of development scale is based on research of absolute functioning factors growth (net income, income from sales, cost price, assets, fixed assets, current assets, quantity of employees) rates, and the level of development quality – on research of relative indicators growth (coefficients of production correctness and timely production of goods, cost capitalization) rates, comparison of factors changes rating with the reasonable dynamic criteria and the usage of non-parametric approaches of dynamic connections measuring. Research of integral development level of the enterprise in dynamics gives the opportunity to create the trajectory of retrospective development and foresee the direction and the level of perspective development.

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Table 12. The integral development levels of Joint-stock company "Enterprise" during 2008-2011

Analyzed periods	R_m	g	R_q	H	R_r
2008	0,20	70	0,50	30	0,29
2009	0,18	55	0,50	45	0,32
2010	0,63	60	0,08	40	0,41
2011	0,01	80	0,50	20	0,11

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Method for Selection of Company Stakeholders

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Abstract. At the moment the problem of dealing with external environment is an important issue of effective corporate strategic management in the enterprise. One of the factors of company interaction with external environment is company stakeholders. At the moment the theoretical basis of stakeholder analysis is researched insufficiently. The current research pursued the two goals: to show on which stage of strategic management process stakeholder analysis influences corporate activity and to provide effective theoretical and practical ground for the selection of stakeholders.

In order to achieve the first goal the main aspects of stakeholder theory are reviewed in the paper. The place of stakeholder analysis in strategic management process is identified. It is argued that the interests of the most influential stakeholders should be considered in corporate goals, strategy and the strategic decision making process due to the "strategic necessity". The latter means that consideration of the stakeholder influence leads to the increase of corporate performance effectiveness and financial stability.

The second objective is achieved through the review of possible techniques that could be used for stakeholder selection. The most appropriate for such purpose techniques are identified by the analysis of their advantageous and disadvantageous. As the result of the review it is proposed to conduct the stakeholder selection basing on application of the Analytic Hierarchy Process (AHP). The example of application of such method for stakeholder selection is presented in the article.

Key words: stakeholders, corporate strategy, system of corporate goals, analytic hierarchy process.

INTRODUCTION

How the company should deal with its environment is one of the key issues of effective corporate activity. Although a great variety of theories developed in the previous century, such as SWOT analysis, it is not clear whether the interests of stakeholders from the external environment should be considered. The other problem is how the goals of important stakeholders could be implemented into corporate strategy. The necessity to solve these problems resulted in introduction of new managerial theories. In those theories it is proposed to review the enterprise activity from different perspectives (customers, creditors, investors, consulting agencies etc.) and/or aspects of enterprise development (innovative aspect, aspect of labor resources etc.) [27]. Such ideas are supported by the research of some famous scholars. For example, Pettigrew [35] stated that strategy is the set of pragmatic compromises between stakeholders while Mendelow [30] claimed that failure to act in accordance with stakeholder (influence group) requirements leads to possible problems in strategy implementation. Managerial commitment to stakeholder interests will drive strategic decision making, which in turn will affect firm financial performance [3, 33]. The ability to balance stakeholder influence leads to higher level of consistency in corporate activity and achievement of corporate goals. The described approach to forming corporate strategy could be called multilateral. The actuality of such approach lies in balancing of a significant number of economic factors and corporate strategy [27]. The corporate management based on multilateral approach permits to adapt measures of corporate activity to the requirements of different influence groups. The most accented the need in reviewing of corporate activity both from external and internal points is proposed in stakeholder approach worked out by [15]. According to the latter scholar stakeholder is the person, group of people, organization who can affect or is affected by the achievement of organization's objectives or organization's activity [15]. The other definition that is relevant to the current research is the following: a stakeholder is an individual or group that has a stake or can influence the organization performance [2].

Famous theory that considers points of views of stakeholders and transforms them into strategy is the "balanced scorecard theory" developed by [26]. However as Walker and Marr [45] claim in that theory "Kaplan

and Norton, except employees and customers … appear to have overlooked the important category of tracking other stakeholder groups… The strong companies of the future will develop key business indicators for each stakeholder group". In the same time the important issue of Kaplan and Norton's balanced scorecard theory is consideration of some aspects of corporate development that influence corporate activity significantly in addition to the stakeholders.

The stakeholder theory consists of three parts: narrative, descriptive and instrumental [16, 25, 11]. Descriptive theory lies in describing company behavior towards stakeholders and stakeholders towards company. In the normative theory ethical issues connected with company relations with its stakeholders are being solved. Instrumental theory purports to research the influence of stakeholders on the outcomes while making corporate strategy. Some aspects of instrumental theory are the main issues of the current research.

The other important issue is that some scientists consider stakeholders separately from strategic management system while the others think that stakeholder analysis is a part and parcel of strategic management process. As Freeman [16] claimed the strategy should be formulated as a part of needs of stakeholders that surround it. In addition Mendelow [30] said that "stakeholder approach is particularly useful during strategy formulation. Organization is the goal seeking entity. Management should attempt to ensure that the organization stakeholders are prone to behave in a manner that will enhance the organization's ability to achieve its goals".

In the last years the stakeholder theory was mostly concentrated on the research of ethical issues that are the part of narrative theory. Some authors, such as Goodpaster [20], Freeman and Evan [17] claim that managers have the moral duty to take stakeholders into account. In the current research we will make shift towards interrelations of strategy creation and stakeholder analysis. It should be stated that theoretically the place of stakeholder approach in strategic management system is researched insufficiently. Some efforts to study this issue were conducted by Berman et al. [3] who proposed to try investigation of stakeholder relationships relatively to firm strategy and firm financial performance. As the result of the research Berman et al. [3] argued that stakeholder relations influence firm financial performance through corporate strategy. The latter model was called The Intrinsic Stakeholder Commitment Model. In The Intrinsic Stakeholder Commitment Model the interrelationship of strategy and corporate stakeholders were touched but most of the attention was attained to the financial results. The identification of the place of stakeholder approach in strategic management system is one of the objectives of the publication. From the point of view of some scholars [27] the main goal of stakeholder's consideration is improvement of firm strategy and firm strategic management. As Kaplan and Norton [27] claimed that consideration of different influence groups should result in its positive influence on corporate performance and financial results. For example, according to [27] the growth and learning perspective is not considered to achieve good environment on the working place but to provide achievement of main corporate goals. In the current paper the stakeholder approach to creating strategy is reviewed as "strategic necessity" that is one of the constituents of corporate success. The research of stakeholder analysis as the strategic necessity where reviewed by Garengo et al. [19]. The main points of such research are the following: "Atkinson et al. [2] underlined that an organization should know what its stakeholders' expectations are and strive to achieve the objectives they have defined. Dickinson et.al. [10] described stakeholders as the 'final judge' of organizational performance. Funk [18] stresses the importance of creating a sustainable organization, which is 'one whose characteristics and actions are designed to lead to a "desirable future state" for all stakeholders'. However, the needs, wishes and levels of satisfaction of different groups of stakeholders vary, and each company has to monitor these aspects". The current research is a proceeding of investigations of stakeholder analysis as the strategic necessity. While taking into account the interests of different stakeholders we first of all concentrate on the capacity of the company to adjust. The stakeholder interests are considered not to advocate stakeholders but to create the possibilities for effective adjustment and management of corporate activity in rapidly changing environment. The necessity to adjust is explained by the need in additional investments, credits, availability of permanent customers and creation of effective supplying system. The customers, employees, suppliers and the community are important not in their own right but because they help the company to achieve its primary objectives by giving it what it needs to pursue the strategy while the strategy is designed to achieve its primary objectives [2]. In addition the approaches and principles of stakeholder selection whose interests should be considered while development of stakeholder strategy are also researched insufficiently. Thus the other important issue is development of the method that will permit to make effective stakeholder selection.

From the latter paragraphs we can elucidate the objectives of the current article which are the following:

– to study on which stages of strategic management process the stakeholder analysis should be conducted,
– to create the principles and method of selecting stakeholders whose interests should be considered while making strategy.

STAKEHOLDER ANALYSIS IN STRATEGIC MANAGEMENT PROCESS

The Fig. 1 shows on which stages of strategic management process stakeholder analysis should be applied.

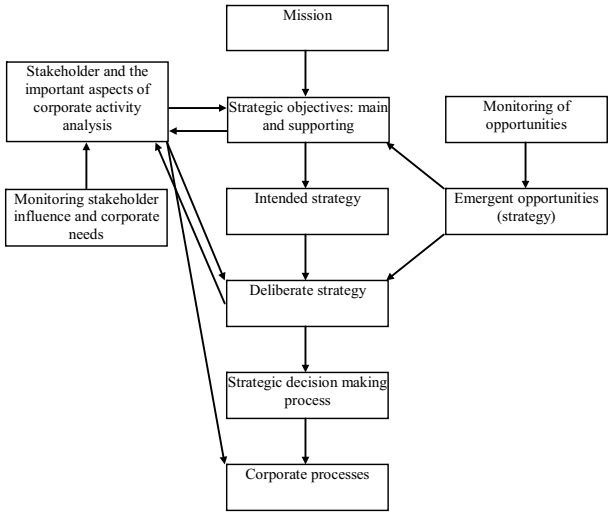

Fig. 1. Stakeholder analysis in strategic management process

Traditionally, the process of company strategic management consists of the following stages [44]:
– Forming of the corporate mission.
– Establishment of corporate objectives.
– Development of strategy.
– Strategy realization.

Evaluation of the results, correction of vision, objectives and strategy considering the received experience and changing environmental conditions.

In the research of Mintzberg [31] the deliberate strategy was divided on intended and emergent strategies. In those research it is claimed that strategy should be reconsidered regularly basing on the conducted monitoring and emergent strategy. Emergent strategy is being crafted as the result of the conditions and opportunities that appear in rapidly changing environment. The results of stakeholder analysis could be used as the constituent to the emergent strategy. Emerging of new opportunities leads to the necessity of reconsideration of the stakeholders influencing corporate activity. Therefore taking into account that strategy is being crafted permanently the stakeholder selection should be conducted regularly.

In the same time the main idea of stakeholder analysis is to include objectives of external stakeholders that are really important for the company into the set of corporate goals. Thus it could be presumed that the results of the stakeholder analysis influence the establishment of corporate intended strategy. The simple hypothetical example of the latter influence is the following. The firm is planning to develop its production line. The obstacle for accomplishment of the latter task is scarcity of financial resources which could be borrowed from the bank. In order to receive money from the bank some of the company measure values, such as liquidity and profitability, must correspond to the requirements of the bank. Thus bank requirements could be included into the set of corporate goals. From the latter paragraphs we can conclude that stakeholder analysis could influence crafting of both intended and emergent strategies.

The strategic objectives of the company could be divided on two sets: main (primary) and supporting (secondary). Atkinson et.al. [2] state that performance measures of the secondary objectives are the way to improve performance on its primary objectives and should be the focus of company measurement. From the latter we can conclude that main objectives usually specify corporate vision while supporting help to create the understanding how the main objectives will be achieved. The organization's inability to achieve its goals leads to the withdrawal of the contribution of the correspondent stakeholder. The stakeholder analysis and establishment of corporate objectives have interrelation. From one hand the main company objectives representing shareholder and manager interests define the supporting goals and thus help to identify stakeholders whose goals should be taken into account. In the previous example of developing additional production line and receiving credit the main objective will be creation of production line while the supporting objectives are the requirements of the bank to corporate activity. From the other hand the influence of some stakeholders could be decisive for successful corporate activity. For example, sometimes the suppliers provide unique equipment for the company. In order to keep good relations with the supplier the company has to include its interests into the set of main corporate objectives. Atkinson et.al. [2] state that both primary and secondary objectives were developed as the result of consideration of stakeholder interests. It is possible to agree with such statement as soon as we agree that mangers and shareholders are also corporate stakeholders.

METHODS FOR IDENTIFICATION OF PRINCIPLE STAKEHOLDERS

In our days the concept and method of stakeholder selection is mostly based on the intuition and personal experience of managers who create strategy. There are no principles or system of approaches to stakeholder selection. In the same time the ordinary judgments such as "this stakeholder is more important than that stakeholder and his interests should be considered" are not grounded enough to be used in practice. Below are presented principles and methods that could be used for stakeholder selection.

For effective development of stakeholder selection method the definition of stakeholder influence should be given. In the literature devoted to the stakeholder analysis there is no definition of "stakeholder influence" but there is definition of "stakeholder power" which is defined as the relationship among social actors in which one social actor, A, can get another social actor, B, to do something that B would not have otherwise done [36]. From the perspective of "strategic necessity" the following understanding of company and stakeholder relations is appropriate: actor, B, should do what actor, A, expects because of two reasons: due to some kind of regulations or if matching of actor, A, expectations would bring

to actor, B, some additional benefits. Thus stakeholder influence could be defined as the necessity to consider stakeholders due to the company statutory documents (managers or shareholders), government regulations or the ability of the stakeholders by some means to change company outcomes or company effectiveness.

From the point of necessity of evaluation the stakeholder analysis is very similar to the corporate performance measurement. Thus some of the requirements to corporate performance measurement system could be applied to stakeholder analysis.

At the moment the following requirements to performance measurement system exist [29, 43]:
- Performance measurement should relate directly to performance strategy.
- Performance measures should vary between companies.
- Performance measures should change over time.
- Performance measurement system should include non-financial measures.
- Performance measurement system should include fast feedback.
- Performance measurement system should be simple and easy to use.
- Performance measurement system should be intended to teach rather than to monitor.

Considering that selection of stakeholders is connected with evaluation some of the issues presented above could be used as the requirements to stakeholder selection method:
- Selection of stakeholder groups should be based on corporate strategy and correspond to strategic necessity.
- The initial group of stakeholders (input group) could vary depending on the type of the company and the type of industry.
- The initial group of stakeholders and judgments of experts concerning the priority establishment could change over time.

The other important issue of stakeholder selection method is consideration of non-financial factors. Non-financial factors are sometimes more important than financial. Subjective information is usually a key component of most managerial decisions, yet in many of today's decision making approaches this data is being overlooked because it is not easily transferred to numerical values [33]. To consider non-financial issues deep level of understanding of experts and special techniques are required. Such situation could be explained by the reason that it is difficult to calculate stakeholder influence. Thus the methods that could be used for calculation of stakeholder influence should be special and should permit to compare judgments of the experts with quantitative evaluation. That is why within current research it is proposed to develop the method that will allow classifying stakeholders in accordance to their importance for the company. As it was mentioned it is quite difficult to evaluate the influence of different stakeholders quantitatively. Thus it could be inferred that the method should include judgments and experience of the experts. In the same time in order to classify the stakeholders objectively the judgments of the experts should be estimated quantitatively. Thus the method combining numbers and judgments will be the most optimal from the point of view of goals achievement. At the moment just a few sophisticated techniques (combination of techniques) meets the stated requirements and thus hypothetically could be used for stakeholder selection. They are:
- cognitive mapping (casual maps);
- regression model with dependent key financial measure and independent indicators representing different aspects of corporate activity;
- regression model with independent dummy-variables representing stakeholder influence;
- classification based on cluster analysis;
- techniques based on application of analytic hierarchy process (AHP) (classical AHP, Analytic Network Process (ANP), AHP combined with cross impact analysis);
- combination of methods listed above.

The common feature of all the presented methods is the idea that stakeholder selection should be based on the strength of their influence on the corporate activity, which is defined earlier in the article. In the research the mentioned techniques of stakeholder evaluation and selection will be reviewed. In the same time the main attention will be concentrated on analytic hierarchy process.

COGNITIVE MAPPING

Cognitive maps can be seen as a picture or visual aid in comprehending the mapper's understanding of particular, and selective elements of the thoughts of an individual, group or organization [12, 13, 14]. For the purposes of current research among the five types of cognitive maps [24] casual maps were selected. The definition of casual maps is the following: casual maps are representations of individual (or group) beliefs about casual structure [28]. The casual maps were selected among other types of maps because they permit to identify casual association between different aspects of the process. For the current research the important issues is finding associations between different aspects of corporate activity [7]. Casual maps could help to create the understanding of how from the point of view of managers (experts) the corporate stakeholders influence aspects of corporate activity. Such approach has one significant disadvantage that makes it less effective for our purposes: casual maps are perfect for visualizing the ideas but not for quantifying judgments. The idea of casual maps is that "managers think and work for most of their lives with language and ideas not with numbers and symbols" [13, 14]. Using such method influence groups could be identified but not classified by the level of their influence while the idea of current research is to create method that will permit to classify stakeholders by the level of their influence on corporate activity. Thus cognitive maps could be used as a supporting tool for the other methods listed below.

REGRESSION MODEL WITH DEPENDENT KEY FINANCIAL INDICATOR AND INDEPENDENT INDICATORS REPRESENTING DIFFERENT ASPECTS OF CORPORATE ACTIVITY

The idea of such method lies in identification of dependent key financial indicator and independent indicators representing stakeholders, building the regression model and the analysis of stakeholder influence basing on such model. That method consists of three stages (Fig. 2). On the first stage indicators that could represent different influence groups are identified. On the next stage the levels of influence of indicators representing stakeholders on key financial indicator(s) are calculated applying regression analysis. The other important issue of the second stage is verification of regression model quality. On the final stage considering the strength of influence of independent variables on dependent variables the most important stakeholders are identified.

Fig. 2. Stakeholder analysis based on regression model

The presented method has some disadvantages determined both by the approach (selection of measures representing different stakeholders) and method of calculation (regression analysis):

- The values of some measures representing external stakeholders could be difficult to calculate, for calculation of the others the monitoring system should be implemented.
- The regression method has some disadvantages as the research strategy method. In regression, the average trend in data is found by minimizing the mean square error. Thus the linkages that took place in the past do not always exist in present [23].
- It is not obvious how many indicators should represent the interests of stakeholders. For example, [27] propose to use 3-4 indicators as possible representatives of stakeholder goals. It should stated that application of 3-4 indicators in multiple regression could bring ambiguity for received results.

SELECTION OF INFLUENCE GROUPS BASING ON DUMMY-VARIABLES

Such approach could be applied in the following way – the experts identify the stakeholders whose influence was decisive over time. The dummy-variables could get just two types of values: "0" or "1". Thus the experts evaluate the stakeholder influence by attaching to stakeholders "0" – "no influence" or "1" – "influence". Such approach has two significant disadvantageous. The first disadvantage is that sometimes stakeholders that had influence in the past don't have it in present. Thus the averages of influences for past periods could result in incorrect evaluation of current influence. The second disadvantage is that there are just two possible values of stakeholder influence: "no influence" and "influence" which could be not enough for the evaluation of current stakeholder impact.

METHOD BASED ON APPLICATION OF CLUSTER ANALYSIS

Such method by some points is similar to the method based on regression model. Applying such methods the experts also select the indicators that could represent different influence groups. The major difference from the method based on regression model lies in using just current or the most recent data in stakeholder influence evaluation. The major disadvantages are the same as the disadvantages "one" and "three" in regression model.

SELECTION OF STAKEHOLDERS APPLYING ANALYTIC HIERARCHY PROCESS (AHP)

Analytical Hierarchy Process technique is often used as strategic decision making tool [4, 37, 41]. The appropriateness of AHP for selection of stakeholders is supported by the following arguments:

- The AHP theory could help to create the image of the system as a whole.
- In AHP permits to combine both judgments and rational choice of alternatives. As Moutinho [33] states "the AHP can be used to synthesize qualitative and quantitative factors in the corporate decision making process".
- AHP permits to verify the consistency of human judgments.

The process of stakeholder selection basing on AHP is the following:

- Creation of the structure that realistically reflects the main aspects of corporate activity and main stakeholders whose influence will be researched. While creation of the structure the following task should be solved: what stakeholders and aspects of corporate activity should be included into the structure. There are no limitations for the quantity of stakeholders included into the structure. If some of the stakeholders are appeared not to be really important they will be eliminated by the method. The division of corporate activity on different aspects is explained by the necessity to create the structure which could be easily evaluated by the experts. The structure could be created either by direct transforming knowledge and experience of experts into structure or by applying cognitive maps. If

it is decided to apply the cognitive maps the strategic aspects of corporate development and links between them should be identified. The application of cognitive maps can provide the deeper understanding of the company as a system.

– The estimation of importance of stakeholder influence on the issues of company activity. Selection of the stakeholders should be based on corporate vision and main corporate strategic goals that correspond to corporate strategy. It should be noted that the experts evaluate not only the level of stakeholder influence on general and specific issues of corporate activity but also the importance of such aspects for the corporation.
– The final selection of stakeholders is based on the weights of their influence on all aspects of corporate activity. Stakeholders could be listed descending by the level of influence on corporate activities.

As it was mentioned the structure could be created both using the experience and knowledge of stakeholders and by applying cognitive maps. Below is presented the example of application of cognitive maps for such purposes.

COMBINATION OF COGNITIVE MAPS AND AHP FOR SELECTION OF CORPORATE STAKEHOLDERS

The application of AHP together with cognitive maps will permit to make AHP structure more real and effective. The examples of application of AHP together with cognitive maps are presented by [6, 43]. The strategic maps could be used to create the structure of important aspects of corporate activity while AHP will help to classify the stakeholders by the level of their influence on that structure. The main idea of cognitive maps is to identify what really means for the company. The example of cognitive map that identifies and interlinks the most important aspects of corporate activity is presented in Fig. 3.

The creation of cognitive map will permit to get deeper understanding of interrelations between main aspects of corporate activity. In addition casual maps could help to find out what aspects of the corporate development are key for the organization.

The draft structure for stakeholder selection using AHP could be the one as presented on Fig. 4.

The levels of AHP process for the stakeholder analysis were selected basing on the following arguments:

– Types of issues influenced by stakeholders. Some stakeholders can influence general issues of corporate activity such as strategic decision making and general management. Those issues could have decisive impact on corporate survival and development that is why they were gathered in the first group. In comparison some specific issues such as supply system or sales system were collected in the second group. For some companies specific issues could be as important as the general issues while for the others the importance of specific issues could be less. In the AHP structure both general and specific issues will be sorted by their importance for corporate development.
– Internal and external specific issues. The division on internal and external issues could be important from the point of view of understanding of business processes going on in the company. Some issues could be both external and internal. For example, sales system could belong either to the enterprise or to corporate counter-agents.
– List of stakeholders. In the current research the system of stakeholder selection includes both corporate managers and shareholders. By some authors shareholders are considered to be "the most important stakeholders". The classic stakeholder theory rejects prevailing of shareholders over other stakeholders [16] while some of the authors claim that shareholders take the highest financial risk and have the strongest influence on the decision making process in the organization [45]. It is possible to agree with the latter scholar and presume

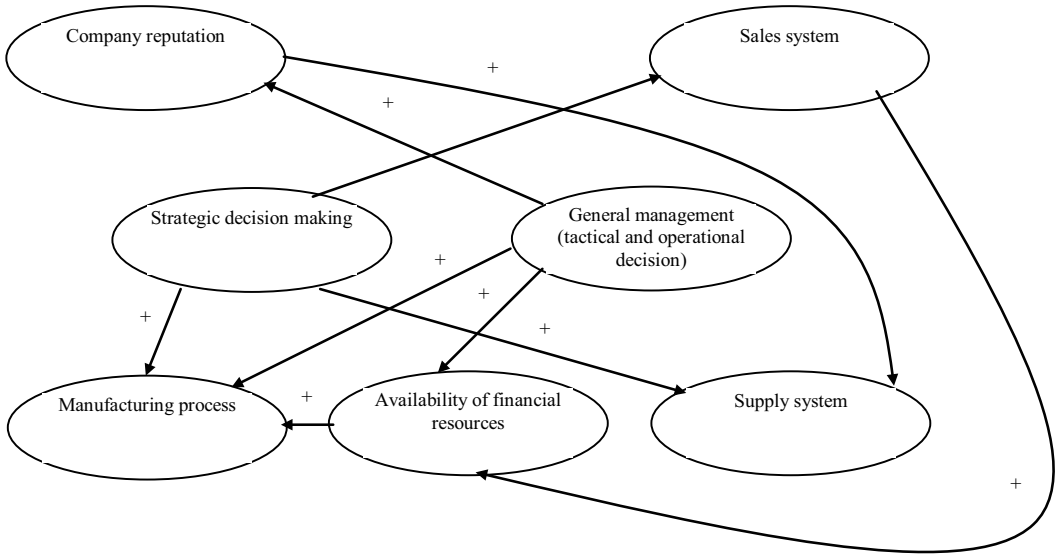

Fig. 3. Casual map of interaction of strategic aspects of corporate activity

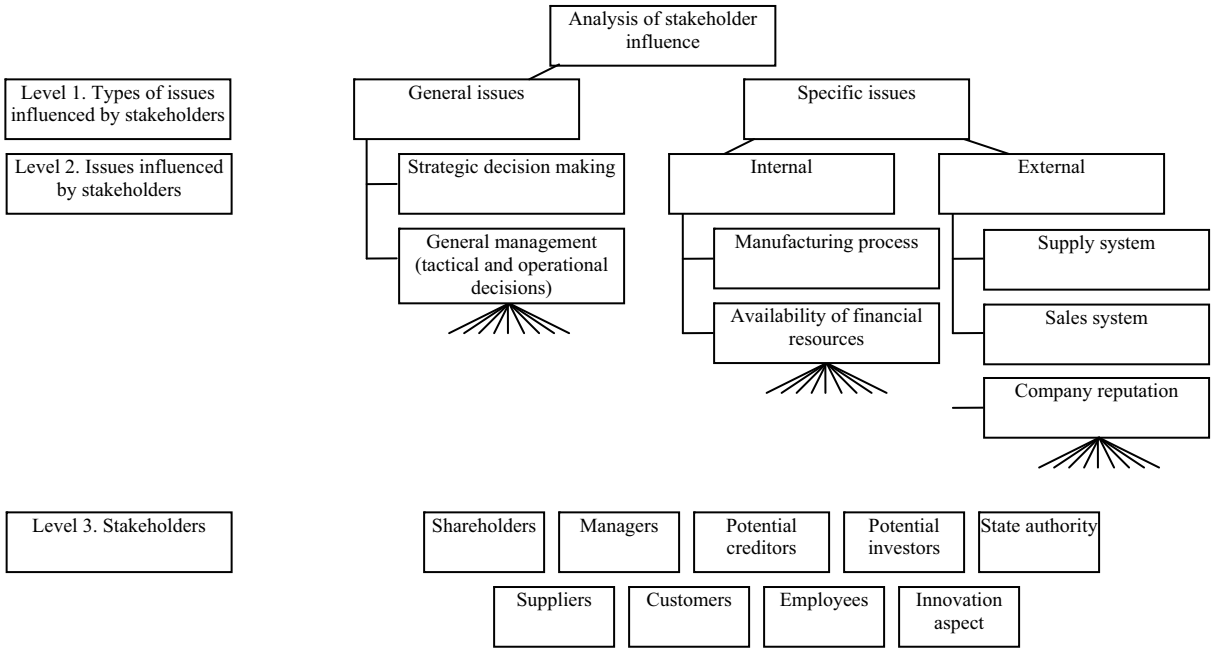

Fig. 4. The draft structure of stakeholder selection

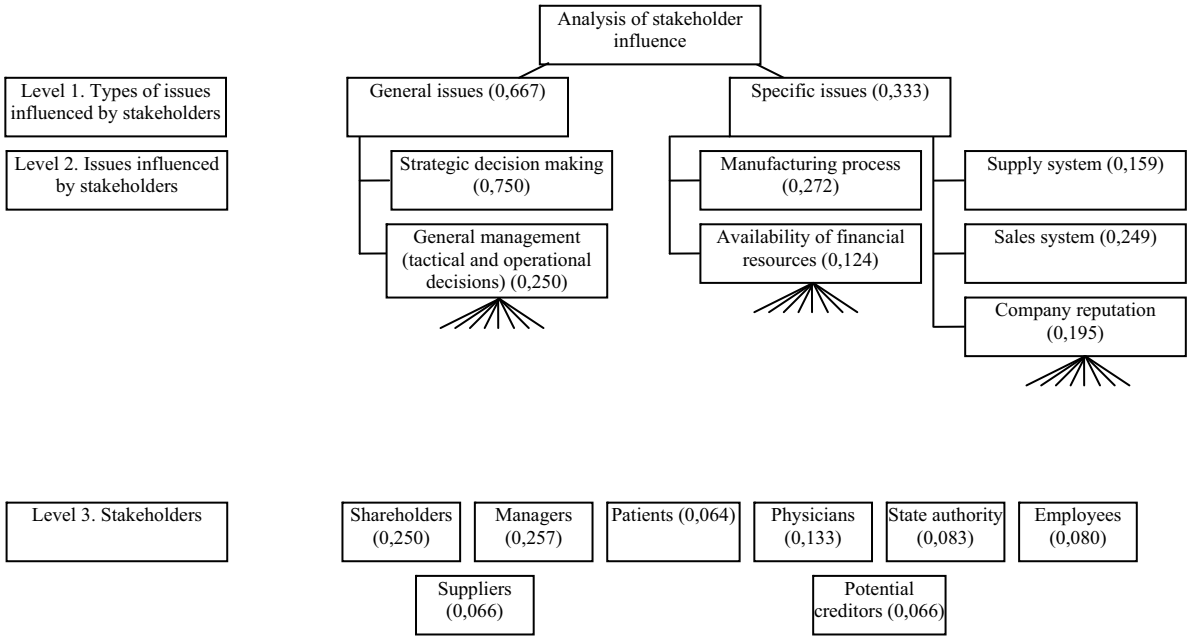

Fig. 5. Analysis of stakeholder influence on the company working in pharmaceutical industry in the United States of America

that shareholders usually have the decisive influence on forming of corporate strategy. The shareholders deserve special consideration over other stakeholders due to the assets specificity. Managers are also very influential group whose influence sometimes could be comparable with the influence of shareholders. The influences of other stakeholders and aspects of corporate development such as suppliers, investors, creditors, state authorities, employees, suppliers and customers are usually determined by the concrete economic situation, industry and country in which company operates. All these stakeholders could be either very important for corporate activity or not influential at all.

It is necessary to pin point that the structure of AHP for stakeholder analysis could vary depending on the type of market in which company operates and the economic condition. The minimal weight of stakeholder influence could be the issue of future research. The general rule for stakeholder selection basing on the influence weight is the following: "just the stakeholders with significant value of influence weight could be selected".

Below are presented the results of application of AHP process to one of the companies operating in the pharmaceutical market of the United States of America. On the Fig. 5 is presented the structure for selection of main corporate stakeholders based on the current situation on the market. The evaluation was conducted by one expert

in order to show the advantageous of such method and the example of result interpretation. While evaluation the expert used the knowledge about the internal economic condition of the company, his own knowledge about the pharmaceutical industry and Business Insights reports devoted to the opportunities of industry development [22]. To evaluate the stakeholder influence the Saaty's 9-point scale was applied [38, 39]. In case of applying AHP in practice stakeholder analysis will be more effective if two or three people participate in the evaluation.

From the general structure (Fig. 4) the division of specific issues on external and internal was removed due to their equal importance for the company. The special group of stakeholders "physicians" was included into structure, which was done by the following reason: while promoting products the company has to negotiate with the physicians. The other special group is the group of state authorities which could have significant influence on corporate activity due to the strong regulations of pharmaceutical industry by the government. The overall consistency ratio of the structure presented on Fig. 5 is 0.04 which means good consistency [39].

To divide stakeholders on groups by their influence on corporate activity the scale, which includes two stages, was created. On the first stage the values of weights were standardized dividing them on the maximum value. On the second stage the interval between 0 and 1 was divided on four equal intervals (Table 1).

Table 1. Standardized Values of Weights

Stakeholders	Actual weights	Standardized weights
Managers	0.2570	1.0000
Shareholders	0.2500	0.9728
Phycisians	0.1330	0.5175
State Authorities	0.0830	0.3230
Employees	0.0800	0.3113
Suppliers	0.0660	0.2568
Possible Creditors	0.0660	0.2568
Patients	0.0640	0.2490

Due to the standardization all the values are located on the interval between 0 and 1. Thus the four equal interval scale of stakeholder influence could be created (Fig. 6).

Applying scale from Fig. 6 the stakeholders were divided on four groups by their influence on corporate activity:

– The group with the decisive influence. Most of the interests of such group should be considered. In the presented example shareholders and managers belong to such group. The presence of the listed stakeholders in the group is quite obvious due to the ability of those stakeholders to influence the situation from the inside of the company;
– The group with the strong influence. To such group belong physicians who have a strong impact on corporate activity due to their right to prescribe medicines to the patients. In order to be successful most of their objectives should be considered through the indicators representing physician requirements. The measures representing such influence group could be included into the strategic management system on the level of secondary goals;
– The group with the average influence. To such group belong employees, state authorities, suppliers and potential creditors. The goals of these stakeholders should be considered selectively;
– The group with low influence. Patients belong to this group. In the current case the weighting coefficient of that group has quite significant values thus some of the patient's objectives could be accounted. In case of low values of weights the influence of stakeholders that belong to latter group could be neglected.

After division of stakeholders on groups it should be decided what measures could represent stakeholder interests in the set of corporate goals.

The application of AHP for stakeholder analysis permits to make the following conclusion: in most cases the inclusion of shareholders and managers into the list of alternatives is not necessary due to their obvious strong influence on corporate activity.

The presented above example of AHP application shows how the selected stakeholders could be divided on clusters. The AHP analysis permits to consider expert experience, judgments and rational choice. The latter could not be achieved applying some different methods including those that were reviewed above. It should be also underlined that in AHP stakeholder selection criteria could move to alternatives and vice versus. For example, some aspect of corporate could be so important for the company that the goal of its development should be included into the set of corporate sub goals. The examples of such aspects are pin pointed by the Kaplan and Norton [27] who review innovation aspect as the key issues of corporate development. In such cases the innovation aspect or corporate reputation could act as the stakeholder. The other important point of the presented method is application of cognitive maps that permits to identify the most important aspects of corporate activity.

It should be noticed that all of the reviewed methods of stakeholder selection including AHP have one significant disadvantage which lies in possible subjectivity of experts

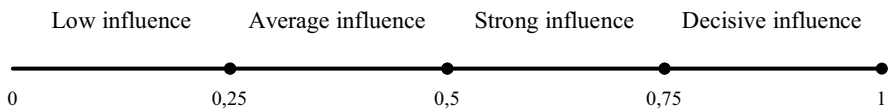

Fig. 6. Scale of stakeholder influence

who participate in either selection of indicators representing stakeholders or evaluation of stakeholder influence on the aspects of corporate activity. Such disadvantage could not be avoided but could be reduced applying such sophisticated techniques as multidimensional scaling or cluster analysis. The example of application of selected techniques for subjectivity reduction is presented in [9].

THE PROPOSALS FOR FUTURE RESEARCH OF STAKEHOLDER ANALYSIS

To consider the stakeholder interests in company strategic decisions the measures representing stakeholder requirements could be implemented into performance measurement system. Thus the further research of stakeholder analysis could be directed towards identification of indicators representing different stakeholders and problems of inclusion them into monitoring and performance measurement system. The other important point that could have both theoretical and practical implications is comparison of the list of important stakeholders of the same industry in transitive and stable market economy. The results of such research could be used by the companies from developed countries entering the markets of the countries with transitive economy and vice versus. In addition the effectiveness of application of the other expert techniques that could be used for stakeholder selection should be further researched in order to find the most optimal method for the concrete situation. Especially promising for this purpose look cross-impact analysis [21] and analytic network process [40, 42] which permit to consider interaction not only between criteria but also between alternatives (in our case stakeholders). For example, cross-impact analysis allows estimating the probability of occurrence or non-occurrence of the event depending on the occurrence or non-occurrence of some other event [21]. Combining this method with AHP [8] will lead to estimation of the stakeholder influence on different issues of corporate activity considering the probability of occurrence of such influence.

CONCLUSIONS

In the current research the place of stakeholder analysis in corporate strategic management process is reviewed. It is argued that in order to be effective the organization has to consider the preferences and interests of the most important influence groups in the strategic decision making due to the "strategic necessity". The influence of stakeholder analysis on the formation of corporate objectives, strategy and decision making is researched in the context of advances in strategic management.

The contribution in terms of approaches to stakeholder selection is also made. AHP is proposed to use in the capacity of the method of stakeholder selection. To increase effectiveness such method could be combined with cognitive maps. In those methods the choice of stakeholders is based on the combination of both subjective judgments of the experts and rational quantitative choice. The main idea of the presented method is stakeholder selection based on the evaluation of stakeholder influence on key aspects of corporate activity.

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Name and surname of the author(s),	Abstract (up to 200 words),	Results, Discussion, Conclusions,
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Scope of service and research:

▶ classical analyses:
- determination of the content of the following elements: Al, Ag, As, Ba, Be, Bi, Ca, Ce, Cd, Co, Cr, Cs, Cu, Fe, P, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Si, Sn, Sr, Te, Ti, V and Zn (basic elements and trace elements) in metal alloys, ferroalloys and other cast materials;
- analysis of sample solutions by instrumental methods:
  - photometric ("Marcel" 5330 spectrophotometer),
  - FAAS, GFAAS (Solaar M6 atomic absorption spectrometer);

▶ determination of the content of elements in solid specimens by the method of optical emission spectrometry (MA (ARL) and GDS 850A (LECO) spectrometers); the following elements are determined: Ag, Al, As, B, C, Ca, Cd, Co, Cr, Cu, Fe, Gd, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, S, Sb, Si, Sn, Sr, Ti, V, Y, W, Zn, Zr, La, Nd, Pr (depending on alloy grade);

- steel: low-, medium, and high-alloyed • cast steel: low-, medium, and high-alloyed
- cast iron: grey, ductile and high-alloyed • alloys of nickel • alloys of cobalt • alloys of aluminium • alloys of copper • alloys of magnesium • alloys of titanium;

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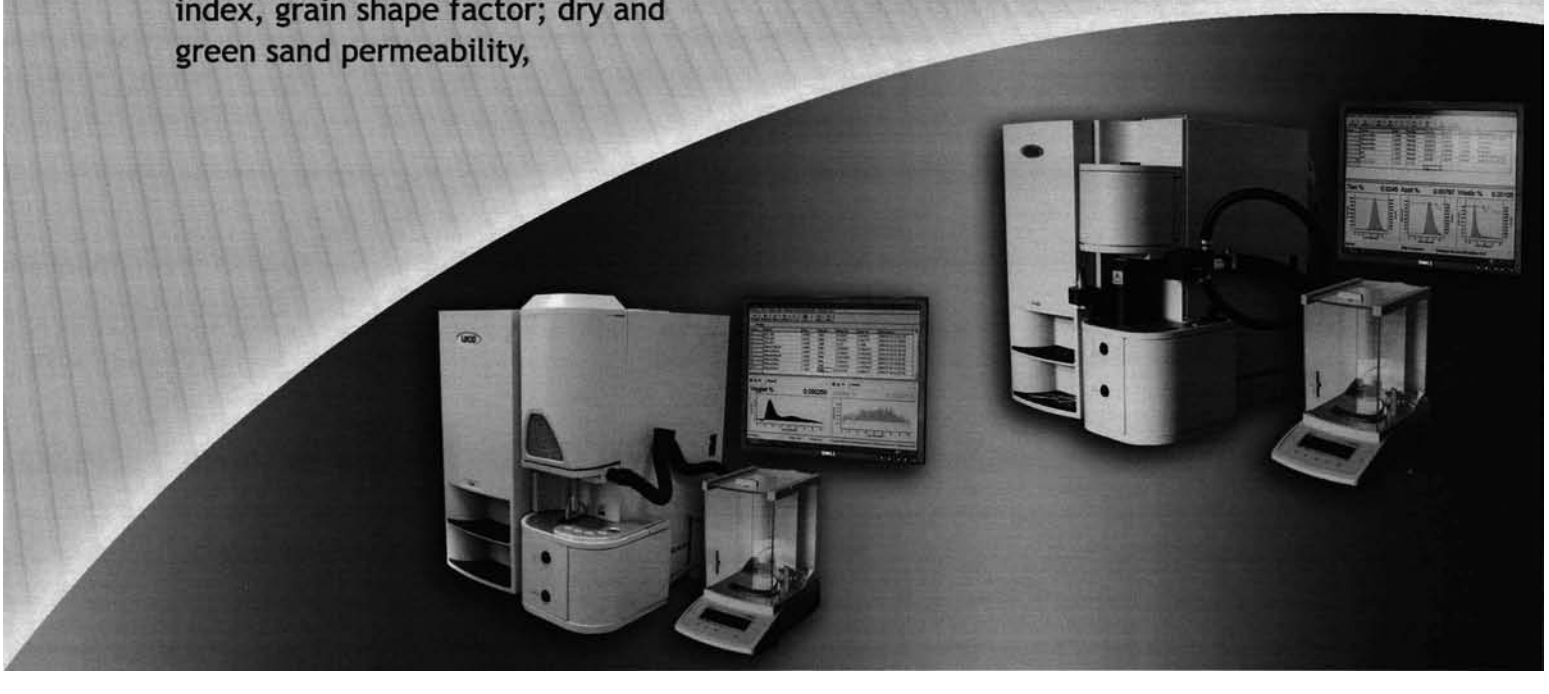

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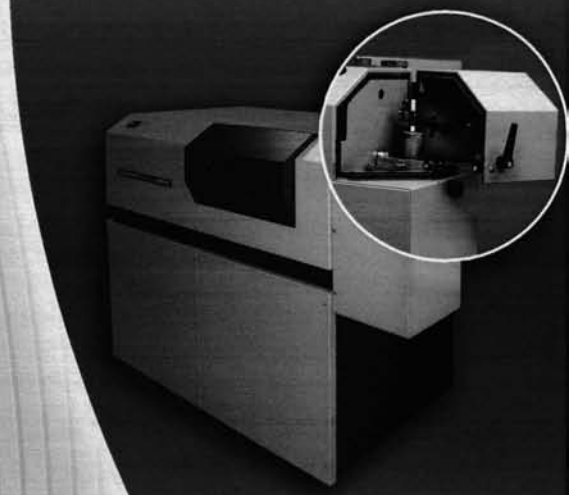
- atomic absorption spectrometry;
- testing of moulding sand properties.



The Laboratory has accreditation certificate No. AB 494 of the Polish Centre for Accreditation for the determination of chemical composition of steel and iron alloys by the method of optical emission spectrometry and for testing the properties of moulding materials.

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Laboratory for Structure Analysis & Mechanical Testing

Metallographic examinations:

- ▶ qualitative metallographic examinations by optical microscopy of the microstructure of materials like metals, alloys, and ceramic stuff:
  - examinations of metallographic specimens, especially as regards the technique of selective etching (light and dark field, polarised light, interference contrast) in magnification range from 12.5 to 1600 x;
  - visual assessment of the microstructure of cast alloys by comparative method (according to PN-EN 945-1, PN-H 04661:1975, PN-EN ISO 2624, PN-EN ISO 643, E-112);

- ▶ quantitative metallographic examinations:
  - grain size evaluation by Heyn method;
  - quantitative assessment of microstructure through determination of stereological parameters;

- ▶ examinations of microstructure of various materials such as metals, alloys, and ceramic stuff by scanning electron microscopy:
  - examinations of rough surfaces and deep etched sections in magnification range from 30 to 80 000 x;
  - fractographic analysis of fractures (identification of fracture path and mechanism from morphological features of the fracture surface);

- ▶ qualitative and quantitative determination of chemical composition in microregions by X-ray microanalysis (EDS).

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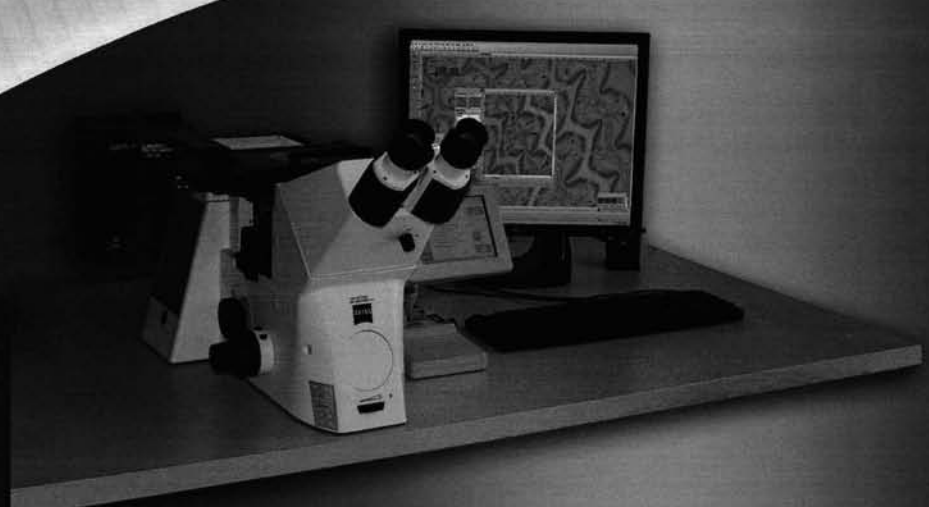
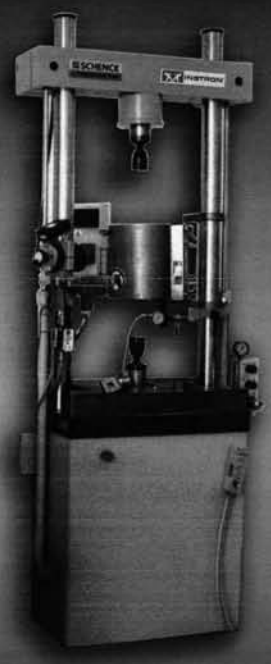


Laboratory for Structure Analysis & Mech. Testing

Conducts:

- mechanical testing: static tensile test in temperature range from -60°C to 1200°C, compression test at ambient temperature, bending test (also in low-cycle mode), also tests using extensometers and resistance extensometry in determination of yield strength and apparent elastic limit, elastic modulus and Poisson ratio;
- impact resistance tests at temperatures from -40°C to 800°C;
- hardness measurements by Brinell, Rockwell and Vickers technique;
- flaw detection (ultrasonic examinations, magnetic powder inspection, X-ray testing and computer tomography);
- ultrasonic examinations of some structural features and/or mechanical properties in selected areas of castings;
- tests for product certification;
- other tests and services in accordance with the Laboratory potential of available knowledge, skill and tools;
- services rendered to various customers both individual and from industrial enterprises, mainly technical expert opinions based on the results of materials testing, regarding the performance failure of ready products or material-related defects formed during the process of manufacture.



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Department of Ferrous Alloys

Offers:

▶ In the scope of metallurgy and technology

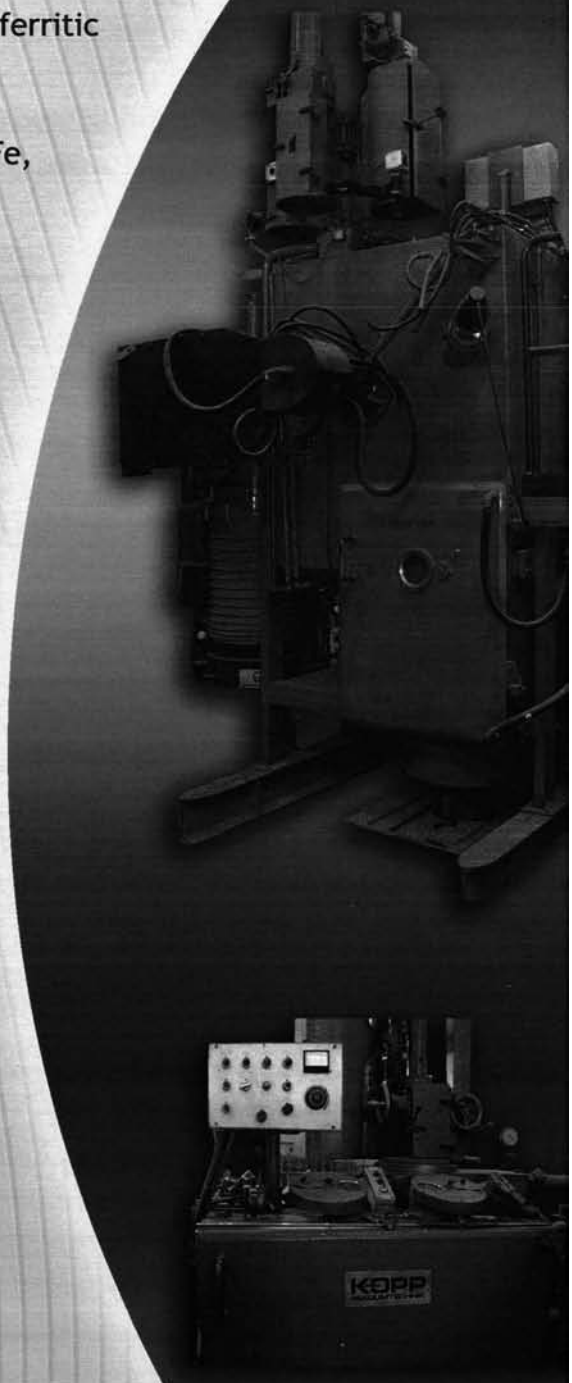
- expert opinions on the condition of foundry shops, proposals for modernisation and supervising current work in this respect; expert opinions on the condition of foundry shops, proposals for modernisation and supervising current work in this respect;
- cooperation with manufacturers of foundry equipment, implementation and start up of installations for the manufacture of ductile iron;
- modernising of melting shops and installation of rotary furnaces with gas-oxygen burners for cast iron melting;
- development and implementation of technology to manufacture various grades of alloyed ductile iron (austenitic, martensitic, abrasion-resistant and heat-resistant);
- development and implementation of master alloys and inoculants for cast iron and cast steel.

▶ In the scope of melting, measurements and heat treatment:

- melting of Fe, Co, Ni alloys and making castings from these alloys in pilot and small-lot production;
- vacuum melting and casting of Fe, Co, Ni alloys;
- development of technology to manufacture various grades of ductile iron (austempered ductile iron - ADI included) based on national and international standards;

Department of Ferrous Alloys

- heat treatment in controlled atmosphere, including austempering of ductile iron castings to produce an ausferritic structure (ADI);
- manufacture of spectrometric reference standards for Fe, Co and Ni alloys;
- measurements of changes in physical parameters of cast alloys during melting, pouring and solidification with application of computer techniques;
- measurement of gas content in molten iron;
- advanced thermal analysis of cast iron solidification;
- cast iron structure evaluation using computer image analysis programme,
- testing erosive wear behaviour of metals and alloys;
- design of temperature measurement systems with wireless data transmission and taking measurements on these systems;
- assistance in preparation of applications for funding of projects from public resources.



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