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Directions of improvement of the logistic systems in the forest complex of Belarus

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Abstract. The article suggests a conceptual model of the formation and effective functioning of the forest complex enterprise logistics, consisting of macro-and micrologistics subsystems, which builds on the methodological principles (consistency, completeness and integrity, adaptability, specificity, reliability), forestry peculiarities (available sources of raw materials on the territory of belarus, seasonal variations in timber harvesting and selling finished products, a full cycle of timber processing, the possibility of non-waste production). the model includes the organizational-economic mechanism of logistics systems formation (including logistics management techniques, the strategy of the logistics system, building relationships between items), tools to enhance the system functioning (evaluation of its operations effectiveness, modeling different versions of production supply and distribution of finished products, the product line planning methodology). The authoring allows you to take into account the interests of all distribution participants (providers, enterprises, consumers) and aims to increase the effectiveness of materials management and relevant information and financial flows.
Key words: logistics system, macro-and micrologistics subsystems, mechanism of formation.

INTRODUCTION

The enterprises of a forest complex are perspective sector of national economy of Belarus that is caused by a considerable export potential of this branch. Activity of the enterprises is connected with large volume of performance of logistic operations at movement of a material stream from forestry institutions of the country to consumers through a chain of the timber industry enterprises making production with a high added cost. The analysis of logistic activity of the enterprises of a forest complex shows that for them, in the majority of cases, the ineffective system of distribution of goods, low level of cooperation with suppliers and buyers, high wear of transport and the stocking equipment, low technical and technological level of cargo terminals, weak level of mechanization and automation of logistic operations is characteristic. Permission of the listed problems demands improvement and integration of logistic activity of the enterprises on the basis of formation of effectively functioning logistic systems.

THEORETICAL PROBLEM RESEARCH

For the first time definition of logistic system as managements of material streams at the enterprises was given in «the concept of material management». World War II has considerable impact on formation of this concept. Military clearly defined the term «delivery», and major product companies of the USA during World War II appeared under strong influence of the Ministry of Defence of the country, interested in creation of new logistic system for full and exact execution of orders.

Thanks to the possibility of management of the material streams by means of computer communications the new concepts of management of the material and information streams were appeared, founding the reflection in such logistic system, as «Planning of requirement for materials» (MRP) developed by O. Wight [21]. In this system for the first time started considering the movement of material streams in whole as a complex of entering and leaving goods. Such approach led to better understanding of interconnection between the business processes happening in the enterprise and directed on management of the material and information streams,

and their coordination. Thus external relations with suppliers of raw materials and buyers of production weren't taken into account.

D. Hammer [12] one of the first in the works attached significance to external relations on the example of implementation of procedures of purchases as one of the elements of decrease in cost price and potential sources of receiving additional profit; V. Poole [17], having emphasized that purchases can reach the same result, became the first who entered the term «active supply».

During 1960-1985 the Japanese companies actively opened up the American and European markets, getting competitive advantages thanks to reputation of producers of high-quality goods and services and use of new management styles. The Japanese companies got additional competitive benefits at the expense of use as standard control systems, for example, control systems of total quality, and absolutely new control systems of chains of deliveries. D. Burt, [6] developed, by its own definition, the integrated systems of supply (ISS) was one of the first researchers of these tendencies in activity of supply.

It defined ISS in the following way: «Integration in supplying activity is presented by results of work of all participants in the case where the whole it is more, than the sum of its components».

D. Burt started developing approach to the organization of multipurpose group which has certain advantages in management of complex material streams and is urged to involve suppliers at a planning and design stage, creating thereby the partnership atmosphere. As a factor of efficiency of logistic system it considered full cost value and emphasized that fact that «the cost of materials – only one and usually not a key factor». The major factors influencing a total cost, the poor quality, inappropriate specifications, non-compliance with terms of deliveries, claims and other reasons influencing financial expenses are. In the researches D. Burt passes from a control system of material streams in the enterprise to a control system leaving out of its limits.

One of serious researchers of logistic systems is P. Witt [22] which gave the general concept about «chain representation» logistics. It the first analysed the movement of a material stream from a source of its emergence to a point of final consumption.

M. Leenders and D. Blenkhom [15] presented 11 stages of process of rapprochement with the suppliers, allowing to lower the general expenses at the expense of optimization of logistic activity. This idea also was developed by H. Fearon [11]. It should be noted that thanks to these works, the movement direction towards a control system of chains of deliveries was defined.

During 1984-1997 the western researchers directed their efforts to creation of reliable system of material support, a control system of chains of deliveries. During this period a number of control systems by transport networks and control systems of production time is developed.

One of the first researchers of these directions is W. Copacino [10]. In its works the considerable attention is paid to control systems of transportations and he starts investigating the integrated logistics systems.

L. Hannon [13] and A. Martin [16] in their works emphasize «full integration of channels of marketing» and that the accent in logistics is displaced from systems of the organization of purchases to systems of distribution of finished goods. A. Martin developed the theory version «Fast reaction / continuous replenishment». L. Hannon, investigating «communications» and «need of modernization of a chain of deliveries», and also as A. Martin, emphasizes that it is necessary to exclude the intermediary as that he calls strategy No. 1, «the first step (in creation of comprehensive system) for the company consists in including system as the necessary tool in own production and distributive capabilities that will add efficiency to operating systems». The ultimate objective consists in having constant smoothly adjustable system of delivery and to exclude warehousing, using system «precisely in time».

D. Waters [20] in the works pays considerable attention to integration in chains of deliveries by means of creation of partnership with the suppliers that allows the separate organizations which are engaged in production, to increase the profit at the expense of increase of system effectiveness of management by chains of deliveries from a point of emergence of a material stream to a point of final consumption of finished goods and decrease in «the general expenses of logistics».

On the other hand the following definitions of logistic system give a number of researchers of the countries of the former Soviet Union:

1) A. D. Chudakov [9], B. A. Anikin [1] give some definitions to logistic system:

– the logistic system is an adaptive system with the feedback, carrying out these or those logistic functions and the operations, consisting, as a rule, from several subsystems and having the developed communications with environment;

– the logistic system is the system which elements are the material, financial and information streams involved in logistic operations, interconnecting these elements, proceeding from common goals and criteria of efficiency;

– the logistic system is the complete economic system difficult organizationally consisting of elements and links, interconnected in uniform management of material and other accompanying streams, set, borders and which tasks are integrated by specific goals of the organization of business;

2) A. N. Rodnikov, S. M. Rezer [18] in the logistic dictionary define logistic system, as «adaptive (being self-adjusted or self-organizing) system with the feedback, carrying out these or those logistic functions and the logistic operations, consisting, as a rule, from several subsystems and having the developed communications with environment»;

3) K. V. Zakharov [23] defines logistic system as a complex of logistic systems: contract purchasing logistics, transport logistics, logistics of financial streams, logistics of stocks, production logistics, price logistics, marketing logistics, distributive logistics, information logistics.

The analysis presented above researches allowed to conclude that the duality of treatment of concept «logistic system» is observed: on the one hand, the logistic system is the logistic network consisting of chains of deliveries, the enterprises, the intermediaries which purpose of functioning is the full satisfaction of demand at the expense of granting goods with maximum consumer value and rational logistic expenses; from another – the integrated system uniting in all logistic operations in the organizations and with the greatest efficiency providing movement of material and information streams, beginning from purchase of raw materials and accessories and finishing distribution of finished goods.

Considering the examined approaches to treatment of concept «logistic system» and features of logistic activity at the enterprises, the essence of category «logistic system» can be presented as set of the micro and macrologistic subsystems which functioning is connected with management of material, information, financial streams and it is directed on maximizing consumer value of goods at rational logistic expenses. The micrologistic subsystem is the system integrating logistic operations, proceeding in the enterprise. The macrologistic subsystem is the system operating processes, connected with the organization of movement of material, information and financial resources at enterprise interaction with buyers and suppliers.

CONCEPTUAL MODEL OF FORMATION OF LOGISTIC SYSTEM OF ENTERPRISES OF A FOREST COMPLEX

The interpretation of category presented in the real work «logistic system» allows to construct conceptual model of its formation and effective functioning at the enterprises of a forest complex (fig. 1).

The concept offered by us includes the methodological principles on the basis of which, taking into account features of a forest complex of Belarus, the organizational and economic mechanism of formation of logistic system of the enterprise of a forest complex is offered. This mechanism is realized in the following sequence:

– the analysis of existing logistic system of the enterprise of a forest complex;

– identification of the main strategic, tactical and operational objectives of functioning of logistic system and development of plans of their achievement;

– definition of elements of logistic system and formulation of communications between them;

– creation of logistic system of the enterprise of a forest complex.

The mechanism presented by us is directed on formation of two subsystems: micro and makrologistic, carrying out the functions connected with purchase, production, information providing, distribution of finished goods and transportation. Thus an indispensable condition of work of these subsystems is their integration at two levels within information system of the enterprise of a forest complex. At the first level there is a process of cooperation of all information streams in the enterprise. On the second – cooperation and coordination of information subsystems of suppliers, buyers with the enterprise of a forest complex [5].

On the third – interaction of information system of the enterprises with information systems of government bodies of the management having impact on movement of information and material streams. Implementation in this way integration will allow to develop administrative decisions which consider interests of buyers, suppliers and the enterprises of a forest complex [2].

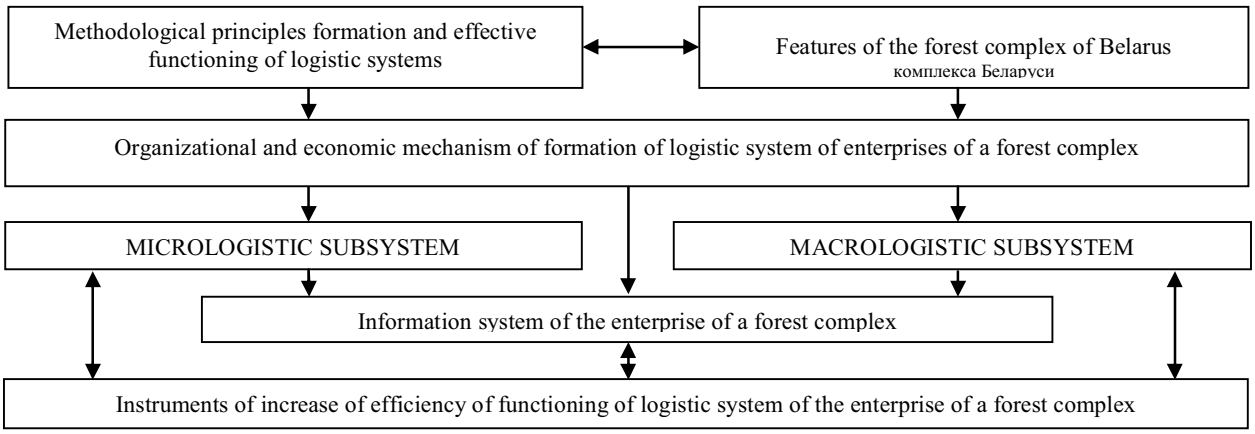

Fig. 1. Conceptual model of formation of logistic system of the enterprise of a forest complex

INCREASE OF EFFICIENCY OF FUNCTIONING OF LOGISTIC SYSTEM OF THE ENTERPRISES OF A FOREST COMPLEX

Increase of efficiency of logistic system is provided with a number of tools (fig. 2) which is switching on a technique of determination of efficiency of functioning of logistic system, a choice of the rational scheme of supply of production and distribution of finished goods, planning of the commodity range and methods of improvement of performance of logistic operations.

Basic technique is the algorithm of determination of efficiency of functioning of logistic system which provides the complex accounting of factors of marketing and logistics [8]. The marketing aspect is based on determination of size of a cumulative rating of quality of service of buyers. In turn logistic aspect – on the logistic expenses presented at two levels – micrologistic (production, warehouse, information, and also charges of stocks) and macrologistic (costs of the sale organization, supply and storage of freights in a way).

For definition of a cumulative rating of quality of service of buyers a number of the criteria were used by us, revealed during poll of buyers of finished goods of the enterprises of a forest complex: convenience of transfer of demands, terms of their performance, delivery periods, quality of delivered production, etc. Assessment of their importance are presented in fig. 3.

At determination of economic efficiency of functioning of logistic system logistic expenses which are understood as the expenses connected with performance of logistic operations were used. Average value of indicators of logistic expenses for 2008-2012 is presented in table 1.

The analysis of table 1 showed that for silvicultural establishments large volume of transportation costs which can occupy over 90% in structure of logistic expenses of the separate organizations that is connected with features of technological process of creation of forest cultures and logging is characteristic. For the timber industry enterprises the important group is made by the expenses connected with the maintenance of stocks of raw materials, materials and finished goods. It is caused by organizational problems of supply, production and distribution of finished goods at inside - and intersectoral interaction of the enterprises.

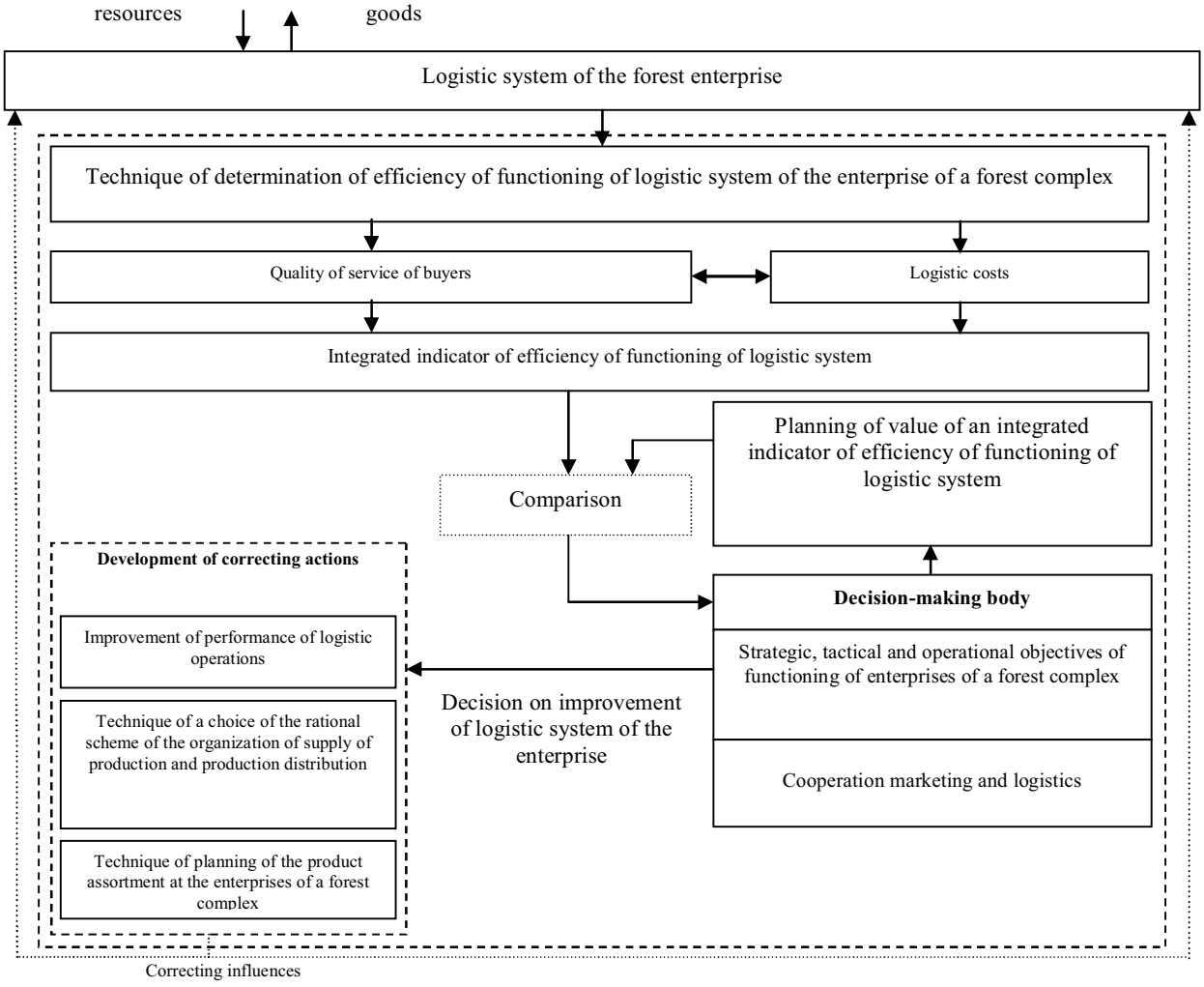

Fig. 2. Methodical scheme of increase of efficiency of functioning logistic system of the enterprise of a forest complex

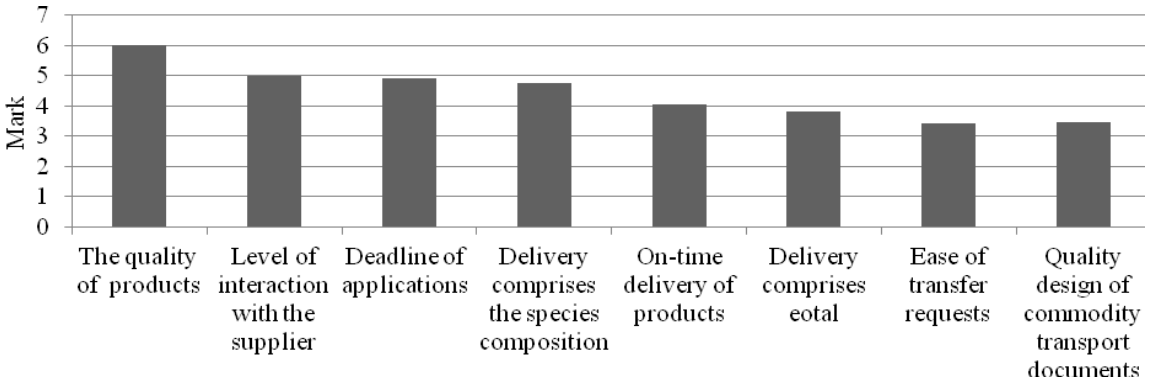

Fig. 3. Value of the criteria characterizing the quality of service buyers

Table 1. Structure of logistic expenses at the enterprises of a forest complex of Belarus in 2008-2012, %

Indicator	Silvicultural establishments	The timber industry enterprises
Charges of stocks of finished goods	3,55	12,10
Charges of stocks of raw materials and materials	6,43	12,70
Warehouse expenses	1,14	1,41
Information expenses	1,47	1,00
Costs of the sale organization	6,45	4,42
Transport expenses	54,74	40,56
Costs of the supply organization	0,71	10,06
Costs of payment to the third-party organizations for transportation of freights (the railway, motor transport, sea etc.)	22,37	17,72
Costs of payment to the third-party organizations for customs cleaning of freights	3,14	0,03
Total	100,00	100,00

Criterion for determination of efficiency of functioning of logistic system is the indicator which calculetes on the following formula:

$$K_e = \frac{In - L - \sum_{m=1}^{M} \frac{I_m}{T_{ul\ m}}}{In} \cdot 100\%, \qquad (1)$$

where: K_e – an indicator of efficiency of functioning of logistic system, %, I_n – enterprise proceeds without indirect taxes, dollars, L – total logistic expenses, dollars, $T_{ul\ m}$ – the period of use of logistic fixed assets, years, I_m – an investment into logistic fixed assets, dollars, $m = \overline{1,M}$ – quantity of investment in the logistic equipment.

For an integrated assessment of marketing and logistic components we offered an indicator reflecting size of a cumulative rating of quality of service of buyers, falling on unit of efficiency of functioning of logistic system of the enterprise of a forest complex. On the basis of comparison of the actual value of an indicator with the planned management of the enterprise of a forest complex the decision on improvement of logistic activity of the enterprise [4] is made.

In our opinion the main directions of improvement of functioning of logistic system are: rationalization of structure of micro and macrologistic subsystems, streamlining of the commodity range, taking into account features of logistic system of the enterprise, improvement of performance of logistic operations in micro and macrologistic systems.

For definition of structure of macrologistic system of the enterprise of a forest complex we suggest to use a technique of a choice of the rational scheme of supply of production and distribution of finished goods (fig. 4) [19].

The essence of the technique offered by us consists in an integrated assessment of subsystems of supply and distribution on the basis of maximizing a value added. It is directed on rationalization of material streams in chains of deliveries (the supplier – the enterprise – the buyer) that allows to define the detailed plans of purchases, production and sale of finished goods, to carry out a choice of suppliers of raw materials and buyers of finished goods, to determine the admissible prices of realization of production and bought raw materials and materials.

The important direction of improvement of functioning of logistic system of the enterprise of a forest complex of Belarus is ordering of the commodity range. We offered a technique of planning of the commodity range (fig. 5) [3].

At the first stage of planning there is a process of collection of information about production and the realization of production which is including: stocks of raw materials and materials, possibilities of suppliers on raw

materials delivery, stocks of semi-finished products, possibilities of production, demand from buyers, a portfolio of orders etc. At the second stage the analysis existing and definition of perspective structure of the commodity range taking into account the marketing and financial purposes of functioning of the enterprise of a forest complex and features of its logistic activity is carried out [7].

THE ANALYSIS OF EXISTING SYSTEM OF SUPPLY OF PRODUCTION, TRANSPORTATION AND DISTRIBUTION FINISHED GOODS

DEFINITION OF «POTENTIAL» SALES MARKETS OF FINISHED GOODS, RAW ZONES, POSSIBLE WAYS OF DELIVERY OF RAW MATERIALS, MATERIALS AND FINISHED GOODS, STRUCTURE OF TRANSPORTATION, POSSIBLE SUPPLIERS OF TRANSPORT SERVICES

DEFINITION OF VERSIONS OF SCHEMES OF SUPPLY OF PRODUCTION AND SALE OF FINISHED GOODS ON THE BASIS INTEGRATED ASSESSMENT OF SUBSYSTEMS OF SUPPLY OF PRODUCTION AND DISTRIBUTION OF FINISHED GOODS

$$AC = \sum_{j=1}^{M}\sum_{\kappa=1}^{K} P_{kj}\cdot V_{kj} - \sum_{i=1}^{N} X_i \cdot Q_i \to \max$$

$$\sum_{i=1}^{N} Q_i = \sum_{k=1}^{K} \frac{V_k}{d_k}$$

$$V_k = \sum_{j=1}^{M} V_{kj}$$

$$\Pi_{kj} = \begin{cases} G_{kj}, (Y_{kj} - P_{kj}) \geq 0 \\ 0, (Y_{kj} - P_{kj}) < 0 \end{cases}$$

$$\Pi_i = \begin{cases} G_i, (X_i - B_i) \geq 0 \\ 0, (X_i - B_i) < 0 \end{cases}$$

$$V_k \leq \sum_{j=1}^{M} \Pi_{kj}, \quad \sum_{i=1}^{N} Q_i \leq \sum_{i=1}^{N} \Pi_i, Q_i \geq 0, V_{kj} \geq 0$$

where: N – number of suppliers of forest products, M – number of consumers of production of the enterprise of a forest complex, K – quantity of types of production of the enterprise of a forest complex, AC – a value added of the enterprise, P_{kj} – contractual price of delivery of k-th of a type of production of j-th to the buyer, X_i – contractual price of supply of round forest products from i-th of the supplier, d_k – norm of an exit of k-th of a type of production, V_k – the maximum volume k-th a type of production which can make the enterprise of a forest complex, G_{kj} – the potential volume of the order of j-th of the buyer k-th a type of production, Π_{kj} – the real volume of the order of j-th of the buyer of k-th of a type of production, Y_{kj} – a ceiling price for which j-th the buyer is ready to buy k-th the type of production defined on the basis of market researches, G_i – potential possibility of supply of round forest products of i-th the supplier, B_i – minimum prices of sale of raw materials of i-th the supplier, defined on the basis of a «popenny» payment and quotations of JSC Belarusian Universal Commodity Exchange, market researches, Π_i – real possibility of delivery of raw materials of i-th the supplier. In this model unknown sizes are standard item of k-th of a type of production of the enterprise of a forest complex to j-th to the buyer (V_{kj}), the size of standard item of round forest products on the i-th enterprise the supplier (Q_i).

CHOICE OF THE SCHEME OF SUPPLY OF PRODUCTION AND DISTRIBUTION OF FINISHED GOODS

Fig. 4. Technique of a choice of the rational scheme of supply of production and distributions of finished goods

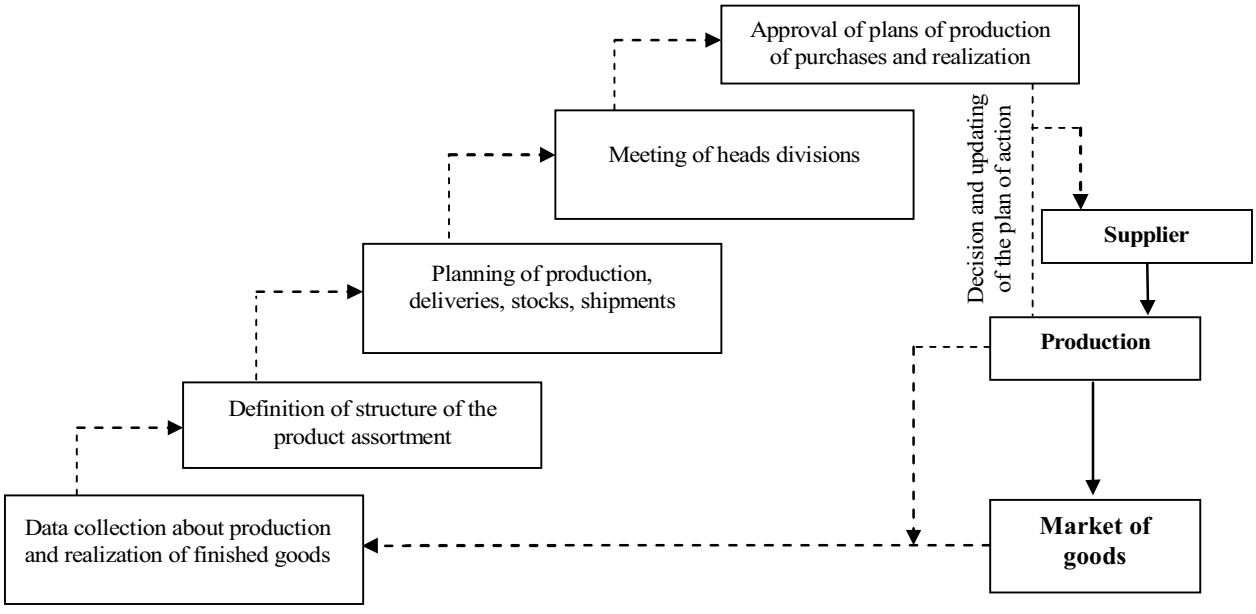

Fig. 5. Technique of planning of the product assortment of enterprises of a forest complex

At the third stage there is a development of plans of sale, production and supply. The fourth stage includes discussion of the developed plans by the staff of the various divisions connected with production, supply and production realization.

During discussion the analysis of the obtained data is carried out, the disagreements arising between various divisions are leveled, discrepancy of supply and demand is estimated, the monthly plan of production is developed. At the fifth stage of planning there is a consideration and adoption of the solution proposed at preliminary meeting on each group of products for which the decision wasn't accepted yet: the adoption of change in outputs and purchases, comparison of the cost version of a sales plan with business plan data, solution of problems in which participants of preliminary meeting didn't come to a consent [14].

The offered technique will allow to operate quickly the commodity range of the enterprise of a forest complex on the basis of the accounting of factors of marketing and logistics that is expressed in increase of efficiency of interaction as the enterprise of a forest complex with suppliers and buyers, and between divisions in the enterprise. It promotes increase of competitiveness of the enterprise and, respectively, will lead to increase of efficiency of its functioning.

CONCLUSIONS

Now the Belarusian economy endures the formation period when search of ways of increase of efficiency of functioning of the enterprises is necessary. One of such ways as shows world experiment, creation of effective logistic systems is. For Belarus formation and development of logistic production, trade, transport and information systems has paramount value as will allow to accelerate integration of the country into world economic and information space. Speaking about a logistics role at the enterprises of a forest complex of Belarus, it is possible to emphasize its optimizing and integrated character. Use of logistic concepts and systems allows to optimize resources of the organizations (material, financial, labor), connected with management of material and accompanying streams.

The concept offered by us is directed on integration of various elements in uniform logistic system. It consists of two large blocks: formation of system and increase of its efficiency. Realization of the first block is directed on formation of micro and macrologistic systems communication between which is carried out by means of three-level information system. The second block is focused on increase of efficiency of functioning of logistic system which has to function on the basis of marketing system of the enterprise, and directed on improvement of the commodity range, structure of systems of distribution and supply, performance of logistic operations. It will allow to improve quality of service of buyers, to rationalize logistic expenses and to increase productivity of activity of the enterprises of a forest complex as a whole.

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Business process modelling using ontological task models

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Abstract. Knowledge-based technologies form a basis for creation of flexible intelligent enterprise. Methods of business process modelling using ontological tasks models allow to create an active modelling system to capture and reuse knowledge patterns in form of ontological models while preserving overall consistency via common ontology usage. High-level business process ontology is presented. Models for business and decision making operations along with their representation in system are specified. Business process modelling tool using task models is described.
Key words: ontology, business process, modelling, task model, intelligent enterprise.

INTRODUCTION

The concept of business process is widely used for analysis and enhancement of enterprise economics. Despite the fact that the term has been firs used in 60's, considerable attention to the study and modelling of business processes has been given to only in 90's of the twentieth century. One of the earliest works in this area [1] applied methods used in technical systems design and analysis to business processes.

Business process analysis approach focuses on process structure, dependencies between operations, resources rather than functions and procedures as earlier approaches. It strives to enhance business process as whole. Improving complex business processes is seen as a major reserve for increasing the efficiency of the enterprise. This view is reflected in the approach to the restructuring of business processes (Business Process Reengineering - BPR) [2], which was popular in the 90's and currently exists in the form of business processes management (BPM) [3].

Today, BPM is considered as the method of the flexible adaptation of business processes to customer needs. BPM attempts to continuously improve processes in the enterprise.

Current approaches to the evaluation and certification of enterprise manufacturing process (ISO 9000, CMMI) is largely based on the analysis and evaluation of business processes quality for certified company [4].

Currently the problem of analyzing and documenting business processes is already sufficiently resolved. Methodological approaches to document business processes, formal languages and software tools for modelling are developed and used [5,6]. Approaches to measure enterprise activity using multiple criteria are researched [7].

There are many languages for building business models that differ in purpose and notation, approach, the possibility of constructing a code from models [3], such as UML, BPMN, BPEL.

In addition to formal languages, modeling tools are becoming increasingly popular. The examples, of such systems are SAP Business Objects [8], MS Business Intelligence [9], Software AG ARIS [10]. These systems allow analyze and obtain value from corporate databases, existing CRM and ERP systems, evaluate the performance of individual operations and business processes, provide decision-makers all the necessary information.

Thus, the main trend in the business processes management is the transition from purely manual documenting, their structures analysis and decision-making to computer-assisted solutions aimed at in-depth study. However the business process simulation tools usually are not reflecting business situation in real time and don't support operative business control decisions.

Decision making is an important operation type in business process. It is performed by domain area experts based on their assessment of current business situation. Decision support process include such steps as understanding a problem (situational awareness -SA), designing possible solutions, evaluating and implementing them. Decision support area is often considered separately from business process modelling [11].

Decision making theory includes classical decision making (CDM), behavioral decision theory (BDT), judgement and decision making (JDM), organizational decision making (ODM) and naturalistic decision making (NDM) [12].

Classical decision support methodologies are considering decision making as a 'choice' process, when expert selects one optimal according to selected criteria solution from a set of available solutions. However there is no guarantee that selected solution will be feasible [12]. Classic approaches has been successfully applied to solve structured decision problems with defined goals, conflict resolution, computational complexity, and requiring optimization.

Naturalistic decision-making requires (NDM) proficient decision-makers and is based on matching patterns of current business situation with patterns derived from experience. If two patterns match, than solution from experience can be applied. NDM usually provide feasible solutions and works for unstructured or semi-structured problems, problems with uncertainty and ambiguity [12].

A large part of decision making follows established patterns and can be automated if those patterns are revealed and specified formally. The high rate of change in business environment requires the building of flexible business processes which are able to react and adapt to changes. This can be achieved by building active business modelling systems where changes in business environment and processes are reflected and processed in real time in order to generate viable solutions.

Active modelling systems for different domains are now developed, starting from conceptual models [13]. On the other hand, the importance of providing real-time analysis and recommendations is formulated in the concept of second generation of business intelligence systems (BI 2.0). It requires including business analytics and decision making to be included in business process and when appropriate to be executed automatically [14].

One of the important assets of modern enterprise is its corporate knowledge. It is often incorporated in numerous loosely coupled documents, existing as employee's experience, stated or implied business rules. This knowledge currently is managed poorly, it is not structured and often at least partly, lost. The effectiveness and flexibility of enterprise can be substantially increased if corporate knowledge will be elucidated, formally specified and documented, made accessible to employees and used as a basis of construction of intelligent software and business process management systems.

The importance of knowledge based systems is currently well understood. Quinn [15] stresses that successful companies will derive their competitive edge from highly developed knowledge assets and core service-based competencies, creating knowledge-based intelligent enterprises.

The commonly used approach for building knowledge-based systems is using ontology, defined by Gruber [16] as "explicit specification of a conceptualization". Ontology can be viewed as a hierarchy of concepts and relations from a specified domain. The usefulness of ontology can be augmented by specifying additionally some constraints and rules. Thus, the ontology provides a structured vocabulary for describing domain along with knowledge about general constraints and rules in domain.

The efforts to build knowledge-based system in business modelling domain resulted in creation of business ontology frameworks [17].

In [18] the use of ontology is perceived as a solution to a problem of lack of specified semantics in communication between humans and systems, which creates communication issues. Proposed enterprise architecture for intelligent enterprise uses three levels of ontologies describing business terms, architecture components and their relations. [19] uses ontology as a part of Enterprise 2.0 architecture to support social, open and adaptive views and stimulate flexibility, adaptability and innovation. In [20] is proposed an approach for construction of ontology-based semantic metrics from the thesaurus of a given domain.

Knowledge based approach is used not only in enterprise integration or business architecture modeling, but also for business intelligence and decision support. In [21] is shown that future of business lies in business intelligence systems that can make decisions, rather than producing reports or simply managing physical assets.

Authors [22] propose to redesign business intelligence solutions using approaches from semantic web development. So, they will be able analyze, process and synthesize solutions based on data meaning.

Knowledge based technologies are used on various stages and tasks of decision making process. For example, [23] research situation awareness in terms of OWL ontology, allowing to specify situations in a common language with computer handling semantics. In [24] ontology is used to provide for data integration and interoperability between different industries, facilitating decision-making process.

Despite a considerable contributed research effort to develop intelligent enterprise architecture and technologies, several areas and problems still are unclear and require a further investigation. For example, in order to implement real-time business intelligence and process modelling, knowledge in form of repeating patterns need

to be captured, formalized, included in system and reused. Ontology as hierarchy of concepts does not support the usage of active, reusable patterns and actions.

In this paper we explore the approach of using ontology and ontological models for building active intelligent business process modelling systems.

This article has several parts. In first part we describe the current state of business process modelling and highlight the trends of intelligent enterprise creation. We show that knowledge processing technologies form a basis to build an intelligent enterprise with highly flexible business processes. In second part we present an approach to use ontology and task models in business process modelling. In third part a business process modelling ontology and basic models are described with examples from the domain of software development. Last part is dedicated to the description of software modelling tool prototype implementing the proposed approach.

KNOWLEDGE REPRESENTATION AND MODELLING SYSTEM STRUCTURE

At present, the main research in ontology modelling is focused on declarative ontologies - domain ontologies, and general ontologies [25]. While general ontologies may be useful for some classes of problems, such as automatic translation, building text digests, medical diagnostics etc, we believe that in order to capture and formalize repeating patterns in decision making or business processes some smaller unit should be selected as a base for knowledge elucidation, formalization and processing. Such smaller, self-contained contained unit in business modelling is business operation or task.

In order to formalize knowledge within the scope of particular task, special type of ontologies (task ontologies) are built. Historically, the tasks ontologies have been developed as a result of scientific analysis of tasks (task analysis). Methods of task analysis are used to define and formalize all factors that affect or are used in the process of solving the problem by an expert or executing specified business operation. Such methods are widely used for designing interfaces of computer programs, in expert systems, decision support systems [26,27].

Task analysis is focused on the analysis and specification of the components of common tasks, determination of its structure and constraints. This allows the expert to better understand the problem, identify possible errors and omissions. Expert can simulate the process of problem solving and task execution and is able to evaluate the results of simulation in order to gain and pass the knowledge to other experts.

The area of task analysis has experienced a significant change with the advent of ontologies. It was proposed to use task ontologies to formalize the concepts and relations for the any given task [28].

Unlike other types of ontologies, such as general or domain ontology, task ontology

- is created for some class of tasks;
- the concept of task goal is important and its formalization mandatory
- the concept of action is introduced [29] in the context of task execution;
- task ontology modelling environment provides execution (or simulation) of actions;

Tasks ontologies research area is closely related to conceptual modelling, because in the process of building of task ontology expert actually creates a formalized conceptual model for task [30]. An important aspect of both conceptual and ontological modelling is the interaction with domain expert who creates and validates an ontology.

In the process of tasks ontology research were implemented simulation environments allowing users to create and execute ontological models for specific classes of tasks. The most advanced of these environments is CLEPE (Conceptual level programming environment) [25]. However, available research is focused on studying tasks ontologies for different tasks separately.

In intelligent enterprise multiple interacting tasks should be performed. In order to make possible this interaction and knowledge reuse, a common for all tasks ontology should exist, describing all common concepts, relations and constraints for enterprise domain. Thus, task ontologies in intelligent enterprise should be built based on concepts of common enterprise ontology. If task analysis reveals that some concept or relation in task representation is missing in common ontology, then this missing element should be included in ontology.

On the other hand, task ontologies are useful as basis for capturing knowledge patterns, action taking and performing business operations. Those ontologies can also include task specific knowledge, which for various reasons was not incorporated in common ontology. In order to differentiate self-contained task ontologies from task ontologies built using common domain ontology, we will call the last one as “ontological model”.

Intelligent, knowledge-based business process modelling system has at its core a knowledge base. The introduction of ontological models adds an ontological models repository to well known structure of knowledge-base [31]. On figure 1 is shown the structure of modelling system which uses ontological models.

Knowledge base contains a common ontology, the repository of ontological models, information base. Information base stores information about instances of types (facts) defined by ontology entities and relations. It also stores models initialized with facts (fact-models). Ontological models serve as templates to create fact-models, providing reusable pattern knowledge about ways to execute tasks. Fact models contain current working data pertinent to task execution. Thus, fact-models could be considered as task in process of

execution. When the execution of task is completed, corresponding fact-model is removed from information base and archived.

When new facts or fact-models are created or modified corresponding constraints from common ontology and models are checked and enforced, providing data consistency.

Complex tasks are executed as result of combined models execution – model can call another model if some subtask needs to be done.

The functioning of modelling system is supported by a number of services. Model Execution Manager monitors external business events, creates, initializes fact-models and supports their execution. Service Broker supports the interaction between models. Information provider implements the search of facts according to given criteria.

In the process of fact-models execution real-world business operations are initiated as commands sent to external services. These services for example, could be implemented within network or local operational system or as a web services built according to the requirements of SOA.

BUSINESS PROCESS ONTOLOGY AND ONTOLOGICAL MODELS

Business process ontology is providing a common set of concepts and relations used for model implementation. The specific set of entities and relations specified in ontology in general case depends on selected domain and ontology competence. Thus, in [17] is proposed an ontology for modelling such important aspects of business architecture as produced product properties, customer relationship management, financial and value flows.

In our work we focused on operational aspects of business process which is prime candidate for automation – business process implementation layer [17]. We built a top layer of business process modelling ontology. It will be later enlarged with components describing specific business domains. As example we mostly use the domains of software development and high school education. As a base we used BPMN language modified and enlarged with some additional objects. Most important entities of business process modelling ontology are shown in Table 1 and relations – in Table 2.

Business process model specifies logical order of operations which are performed in business process. Those operations exist as separate entity types in ontology. We defined such entity types as BusinessOperation, BusinessEvent and Decision types. All those entities inherit from BusinessObject ontology entity.

BusinessOperation entity corresponds to specific stage in business process, when a specified change in business environment occurs and pre-planned result obtained. BusinessOperation has start and completion times properties. With it are associated a metric of success and references to procedures or models for success evaluation.

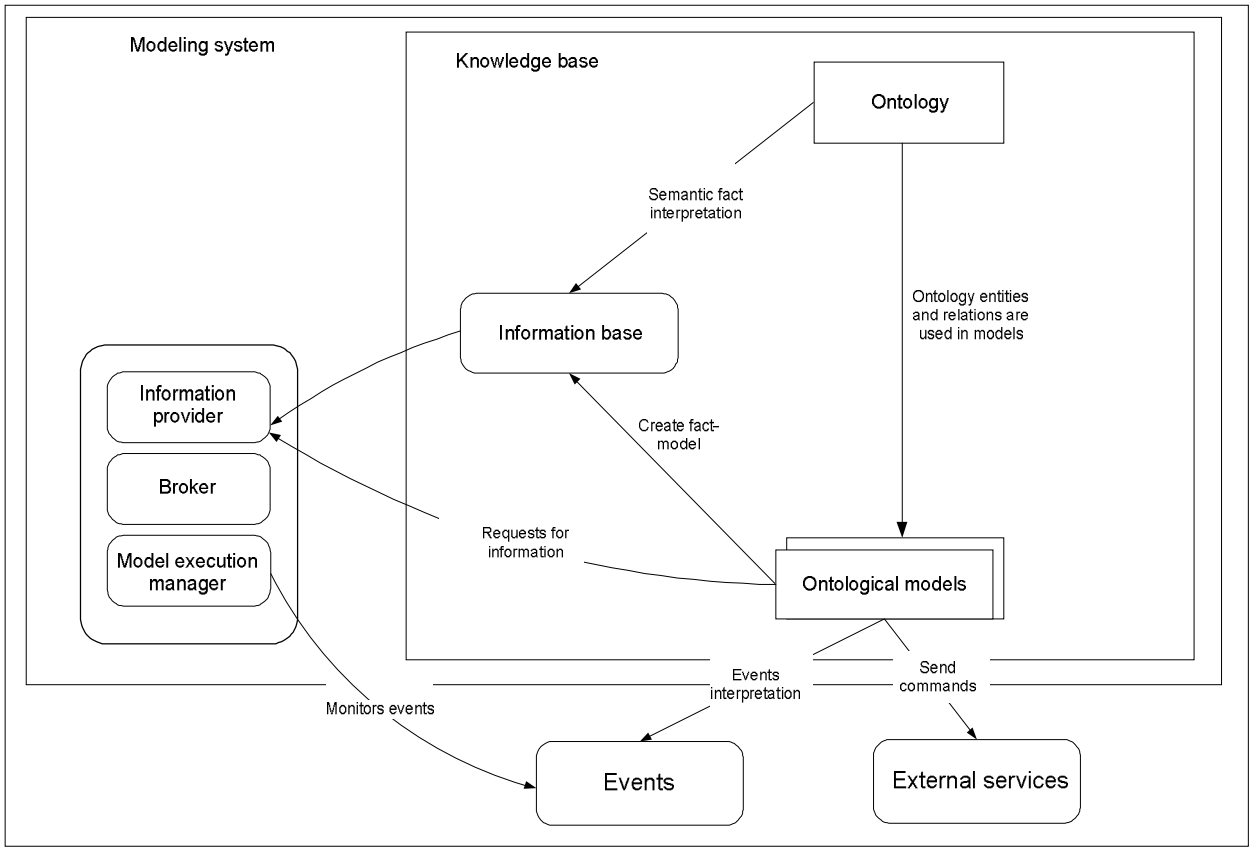

Fig. 1. Structure of modelling system

Table 1. Entities of business process modeling ontology

#	Entity name	Description
Organizations and persons		
1	Person	Human person
2	Organization	Unit performing business processes
3	Actor	The role in a model associated usually with persons or systems
4	Position	Specifies rights and requirements associated with position
Resources		
5	Resource	Something needed for business process execution
6	Resource with controlled access	Resource with limited access
7	Material resource	
8	Financial resource	
9	Workforce resource	
Processes and operations		
10	Business process	Process which results in creation of artifact or service important for a customer
11	Business operation	Limited in time part of business process having expected result
12	Competence	Permanent access rights set
13	Decision	Decision making operation
14	Search for information	Stored search with specified search criteria
Events		
15	Business event	General business event
16	Meeting	
Artifacts		
17	Artifact	Generic artifact, such as document, software program etc
18	Document	Generic document
19	Contract	Contract as a document
20	Email message	
21	Software product	
Commands and services		
22	Service	Service, accepting commands from modeling system
23	Command	Particular command
24	Script	The list of commands
25	Model	
Rules and constraints		
26	Business rule	Organization-wide rule
27	Corporate constraint	Constraint defined by corporation
28	Constraint from law	Constraint which stems from a law
29	Best practice	Optional recommendation
Additional		
30	Annotation	Optional detailed description

Table 2. Relations of business process modeling ontology

#	Relation name	Description
1	Is part	Entity is a part of another entity
2	Is subclass	Entity can be considered as some, more general entity
3	Is after	Defines an order of business operation execution
4	Associate	Generic association
5	Use	Define resources used in business operations
6	Have access	Used in access control models
7	Own	Ownership relation
8	Initialize	Specifies the starting of execution of some model

If necessary, derived from BusinessOperation entities can be created, which expand the basic set of attributes, taking in consideration the specifics of business operation. For example, business operation Lecture has additional attributes specifying the name of lecturer, planned audience, subject and lecture room number.

Unlike business process model, BusinessOperation does not allow further decomposition. However, with BusinessOperation usually is associated ontological model describing how operation is executed, associated entities, resources, relations and operations. For example, with operation CopyFile is associated a model with such entities (roles) as RemoteLocation, LocalLocation, CopyMethod.

Depending from business operation content, ontology designer creates additional constraints to be met by the operation. These constraints are:

• pre-conditions - a list of conditions necessary for the start of operation

• restrictions on the maximum (or minimum) allowable execution time

• post-conditions - a list of conditions that must be true after the operation, to be classified as successful

BusinessEvent entity corresponds to any event, influencing and important enough to be included in model. Differently from business operation, business event does not have durability and is considered one-time object. BusinessEvents can be associated for example, with email arrival, project stage completion or project deadline. In common ontology BusinessEvent entity is derived from more general Event entity. Similarly to BusinessOperation, new entities can be derived from BusinessEvent, adding new information specific to event as attributes.

Decision entity in business process model corresponds to situation during process execution when there is a need to assess business environment and take decision, initiating new business operations. Such a situation usually occurs when some business operation has completed, or some business event occurs. Decision can be made either manually by designated employee or automatically, by model. In case if decision should be made by employee, model references the competence (requirements) to employee to be entitled to make this type of decisions. Alternatively, if decision is made by a model, Decision entity refers to a decision model. This model includes situation signature, and specification of actions. Situation signature is a list of assertions over facts from information base which should hold for the specified situation. If situation is detected, than actions are performed. For example, if in process of automatic software installing an error is detected, system administrator is notified by email.

Entities in business process model are linked with relations to form a whole. Among those relation types we will select relations which form the logical sequence of business operations. Those relations are IsAfter and Initialize. Other relation types, having informative function are Associate, Use.

Relation IsAfter links BusinessOperation with another one, or with Decision operation. The instance of this relation is created only if its starting business operation is completed. The availability of IsAfter relation instance allows start execution of a next BusinessOperation.

Initialize relation links Decision operation with one of several possible BusinessOperations selected as result of decision making process.

Associate relation links model with other models (such as normative or reference models), or artifacts used by model. Relation Use links model with resource used in process of model execution. This relation can have constraints describing the allowed amount of resource usage.

The domain expert works with modelling system using both textual and graphical business process model representation. Graphical representation allows model designer see business process as a whole. For a graphical representation of in the modelling system we used the notation of BPMN. The example of business process of automated software testing is shown on figure 2 To simplify the example, some operations (such as software product uninstall) in the figure are not shown.

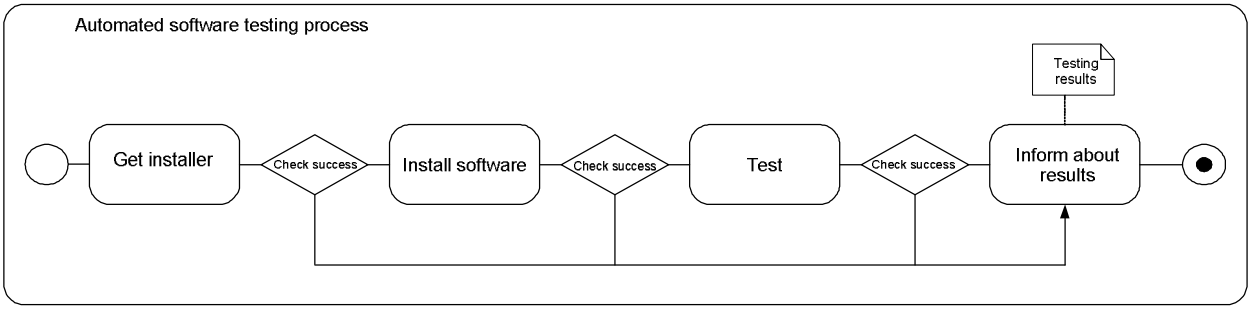

Fig. 2. Graphical representation of automated software testing business process

Model specification is stored in xml format. This format allows store both data and metadata required for model processing into a single file. Below is an example of automated software testing business process model specification.

```
<Model>
    <ModelMetadata>
        <GeneralInfo>
            <ModelId> id </ModelId>
            <ModelType> BusinessProcessModel </ModelType>
            <ModelName>OvernightAutomatedTestingModel</ModelName>
            <OntologyURI> www.acme.org/AutomatedTestingOntology</OntologyURI>
            <ModelRepositoryURI>www.acme.org/ModelRepository</ModelRepositoryURI>
        </GeneralInfo>
        <ActivationInfo>
            <Condition>
```

```
                        <ConditionBd> Was not active during</ConditionBd>
                        <ConditionParameter>15 min<ConditionParameter>
                    </Condition>
                    <StartState>InstallerChecking</StartState>
                </ActivationInfo>
        </ModelMetadata>
        <ModelBody>
                <Operations>
                    <Operation>
                        <OperationName>CheckInstallerAvailabilty<OperationName>
                        <OperationModel>ModelId1<OperationModel>
                    </Operation>
                    <Operation>
                        <OperationName>GetInstaller<OperationName>
                        <OperationModel>ModelI2d<OperationModel>
                    </Operation>
                    <Operation>
                        <OperationName>Install<OperationName>
                        <OperationModel>ModelId3<OperationModel>
                    </Operation>
                    <Operation>
                        <OperationName>Test<OperationName>
                        <OperationModel>ModelId4<OperationModel>
                    </Operation>
                    <Operation>
                        <OperationName>UnInstall<OperationName>
                        <OperationModel>ModelId5<OperationModel>
                    </Operation>
                    <Operation>
                        <OperationName>FinishAndClean<OperationName>
                        <OperationModel>ModelId5<OperationModel>
                    </Operation>
                    <Operation>
                        <OperationName>InformByEmail<OperationName>
                        <OperationModel>ModelId6<OperationModel>
                    </Operation>
                </Operations>
                <Decision>
                    <DecisionCallType>BetweenOperations</DecisionCallType>
                    <DecisionModel>DecisionModelId</DecisionModel>
                </Decision>
                <ProcessFlow>
                    <Signature>
                        <Condition>
                            <IB_Entity Type="Test_Status">ReadyForTesting<IB_Entity>
                        </Condition>
                        <Execute>
                            <SetIB_InstanceValue
Type="Test_Status">CheckingInstallerAvailability<SetIB_InstanceValue>
                            <ExecuteModel>CheckInstallerAvailabilty<ExecuteModel>
                        </Execute>
                    </Signature>
                .....
                </ProcessFlow>
        </ModelBody>
</Model>
```

Code describing the model consists of sections of metadata, activation, and body of the model. In metadata section are specified the name and type of the model, a reference to an ontology and models repository. Activation section defines how the model is executed. In our example the model is activated after a period of inactivity of 15 minutes. Model body section contains subsections of operations, decision making and flow control. In operations subsection are specified the operations of current model and references to the relevant models, describing operations. In decision making subsection is specified how to activate models of decision making (at the beginning and between operations), and links to decision making model. Decision making model analyzes the state of domain by information base and determines the status of the testing process. Then, data flow control subsection is used to activate the next operation.

BUSINESS OPERATION MODEL

Building a model of business operations allows the expert to identify and analyze in detail all relevant to the operation entities, relations, constraints, calls to external services or other models.

The general model of business operation includes the following elements:

• entities from ontology relevant to the operation

• relations relevant to the operation

• initial state, presented as a set of conditions specified using attribute values of relevant entities and relations

• final state of the operation execution. This is a list which includes both states of successful completion of the operation as well as unsuccessful completion states.

• specify the mechanism of the transition between the initial and final states, such as a set of operations (commands) to external service

• determining the metrics of success of the operation and include a reference to external model which implements the evaluation of those metrics.

The model of business operations can be executed either manually or automatically. In the case of manual execution model:

• before actually starting, it automatically checks all prerequisites for its execution and informs a person assigned to perform operation;

• helps the person who performs an operation to identify and obtain relevant information on all relevant objects and their properties needed;

• imposes restrictions on the process of the operation execution as defined by law and corporate rules and regulations.

• after operation completion system evaluates the effectiveness of its execution and updates the information base with results.

For example, when hiring a person's a model helps HR employee to check information on education, work experience, qualifications, and other conditions needed to fill a specified position, verifies the authenticity of the documents submitted reading data from the database of organizations that have issued documents.

In case, if business operation model is executed automatically, after checking the prerequisites, it initializes operation execution. This execution is performed by calling external services. After the operation completion efficiency of execution is evaluated. As in the case of manual operation the result of the business operation is stored in the information base.

Graphical representation of the business operation model should allow the domain expert to capture and understand all relevant aspects of the operation (Fig.3). Therefore, it should have a small number of items (4-7).

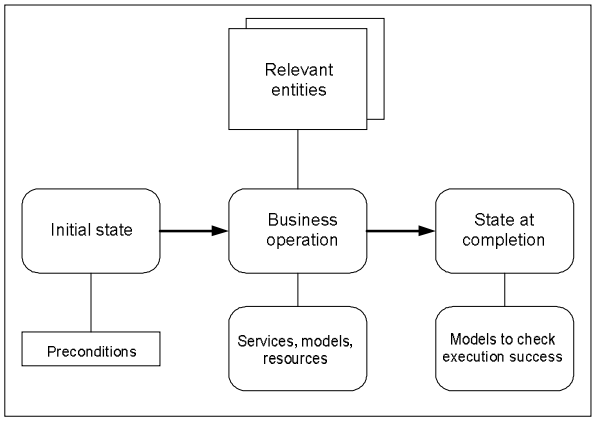

Fig. 3. Graphic representation of business operation model

This representation includes:

• a list of entities and their attributes relevant to the operation,

• preconditions of an operation

• a list of services, resources and models used

• the description of the state of the domain after the operation

• models for evaluating business operation success and execution performance

Textual business operation model is represented in xml-format. An example of textual representation of the generic business operation model is shown below.

```
<Model>
        <ModelMetadata>
                <GeneralInfo>
                        <ModelId> id </ModelId>
                        <ModelType> BusinessOperationModel</ModelType>
                        <ModelName>BO-GenericModel</ModelName>
                        <OntologyURI> www.acme.org/AutomatedTestingOntology</OntologyURI>
        <ModelRepositoryURI>www.acme.org/ModelRepository</ModelRepositoryURI>
                </GeneralInfo>
                <ActivationInfo>
                        <Condition>      OnCommand</Condition>
                        <StartState>CheckPreconditions</StartState>
                </ActivationInfo>
                <Preconditions>
                        <Precondition>
                        ......
                        </Precondition>
                </Preconditions>
        </ModelMetadata>
        <ModelBody>
                <Operation>
                        <OperationName>OpName<OperationName>
                        <OperationDescription></OperationDescription>
                </Operation>
                <Entities>
                        <Entity>
                                <Id>EntityId</Id>
                                <Attributes>
                                        <AttributeId>Id</AttributeId>
                                        .......
                                <Attributes>
                        </Entity>
                </Entities>
                <Resources>
                        .....
                </Resources>
                <Services>
                        .....
                <Services>
        </ModelBody>
</Model>
```

The preconditions for model execution are shown in metadata model section. In model body section are specified relevant entities and their attributes, references to resources and services.

DECISION MODEL

The purpose of decision model is to identify well known situations in business environment and trigger necessary actions. Decision models are placed in specified places of business process model, typically on business operation completion or when some business event occurs.

Decision model contains entities from ontology relevant for decision making for some known situation. Important components of decision model are situation signature and action specification.

Situation signature specifies a set of conditions which hold in this situation. Mathematically each condition is represented by first-order predicate. For example, “A completed testing exists” situation is specified by:

$$\exists t(type(t) = "Testing" and (t.status = "Completed"))$$

An action specification defines the execution of a specific action. For example, such action types are typical:

- Initialization and execution of business-operation model
- External service calling using a specified command
- Complete model execution

Similarly to business operation model execution, decision model can be executed manually or automatically. If model is executed manually, system

selects from information base all facts relevant to situation and proposes recommended solutions, with possible parametrical adjustments.

If decision model is executed automatically, system verifies situation signature and initiates corresponding actions if some situation was identified.

SOFTWARE MODELLING SYSTEM PROTOTYPE

In order to study the feasibility and practical usefulness of model-based intelligent system design approach, a software prototype for modelling system was developed. This prototype consists of four components, united in a common application: Ontology Editor, Fact Editor, Model Editor and Modeller.

Accordingly, the main window of modelling environment has tabs for ontology, facts, model editors and modeller (Fig.4). Also are shown the basic constructs used in systems, such as Attribute types and Roles.

Ontological engineer uses the ontology editor for the creation and modification of ontology. This software component has several functions, such as export and import of ontology; creation, modification and deleting of ontology entities; implementation of inheritance; creation, modification and removal of relations; creation, modification and removal of constraints.

Ontologies and other data are stored in xml-format. The system supports exporting and importing ontology and all related data sets (facts, models) as separate modelling contexts.

Fact editor is designed to create and modify facts. Every fact is an instance of some entity in ontology. User creates facts and also specifies their attribute's values. The system checks the constraints associated with the attributes on process of fact validation. Only the fact that was validated successfully will be accepted by system.

Model Editor is a central component of modelling environment. It allows creating, modifying and deleting models, model metadata and constraints, operations. Figure 5 shows an example of simple classification model. The roles ClassifiedObjectRole and Classification are linked by relation Classify. In the process of model execution not only fact itself is used, but also some objects in this fact's context (for example fact's attribute values).

Component Modeller allows to create fact-models based on specified models, initialize them by facts from information base, execute operations in model.

Figure 6 shows an example of simple interval classification problem solving using the modelling environment.

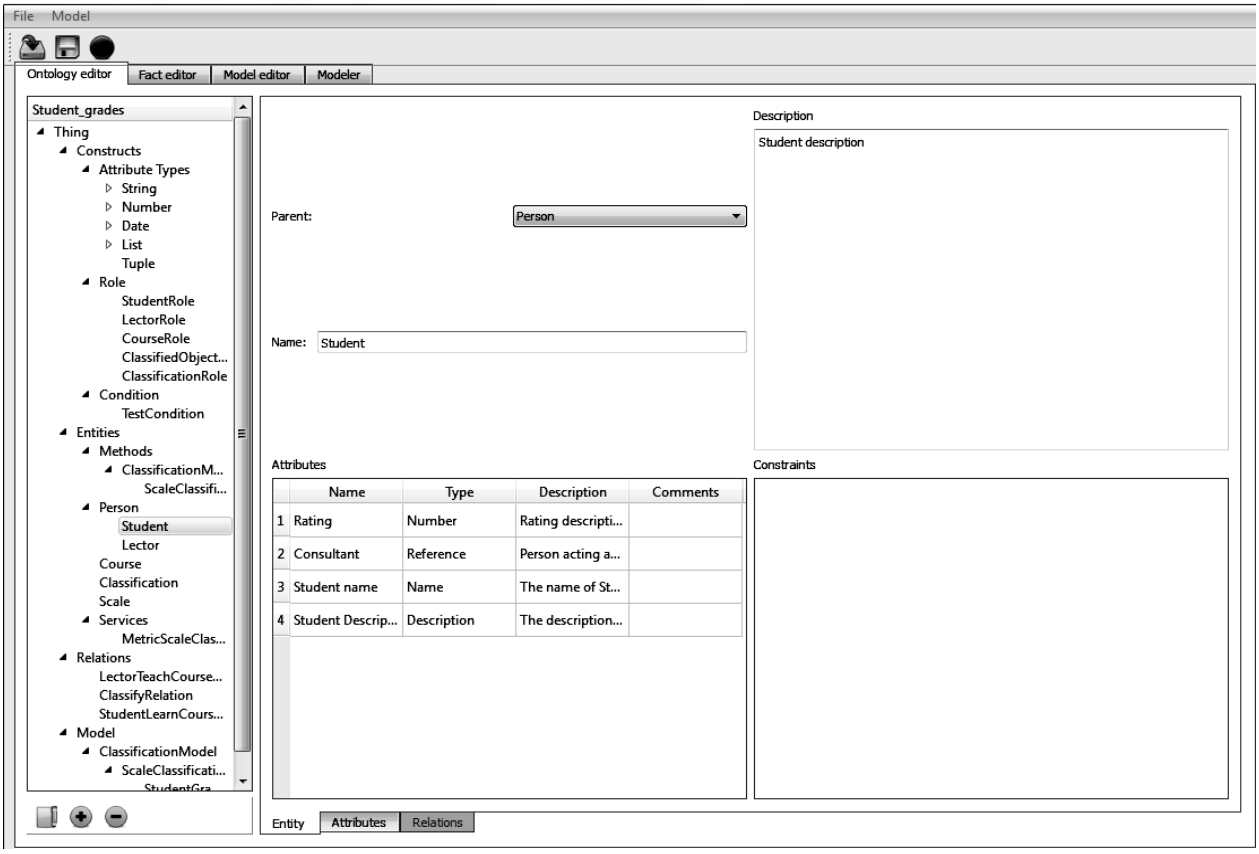

Fig. 4. Main window of modelling environment with ontology editor

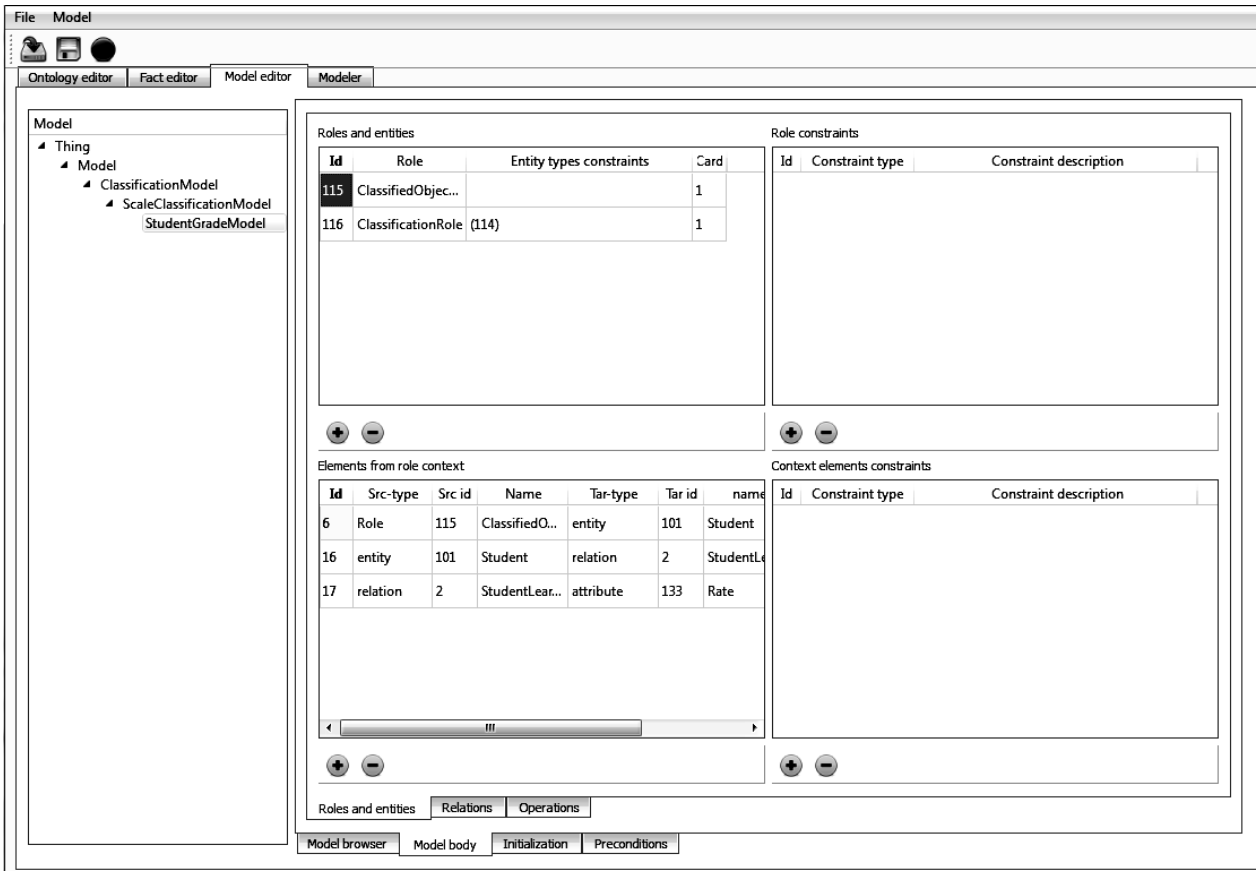

Fig. 5. Model editor

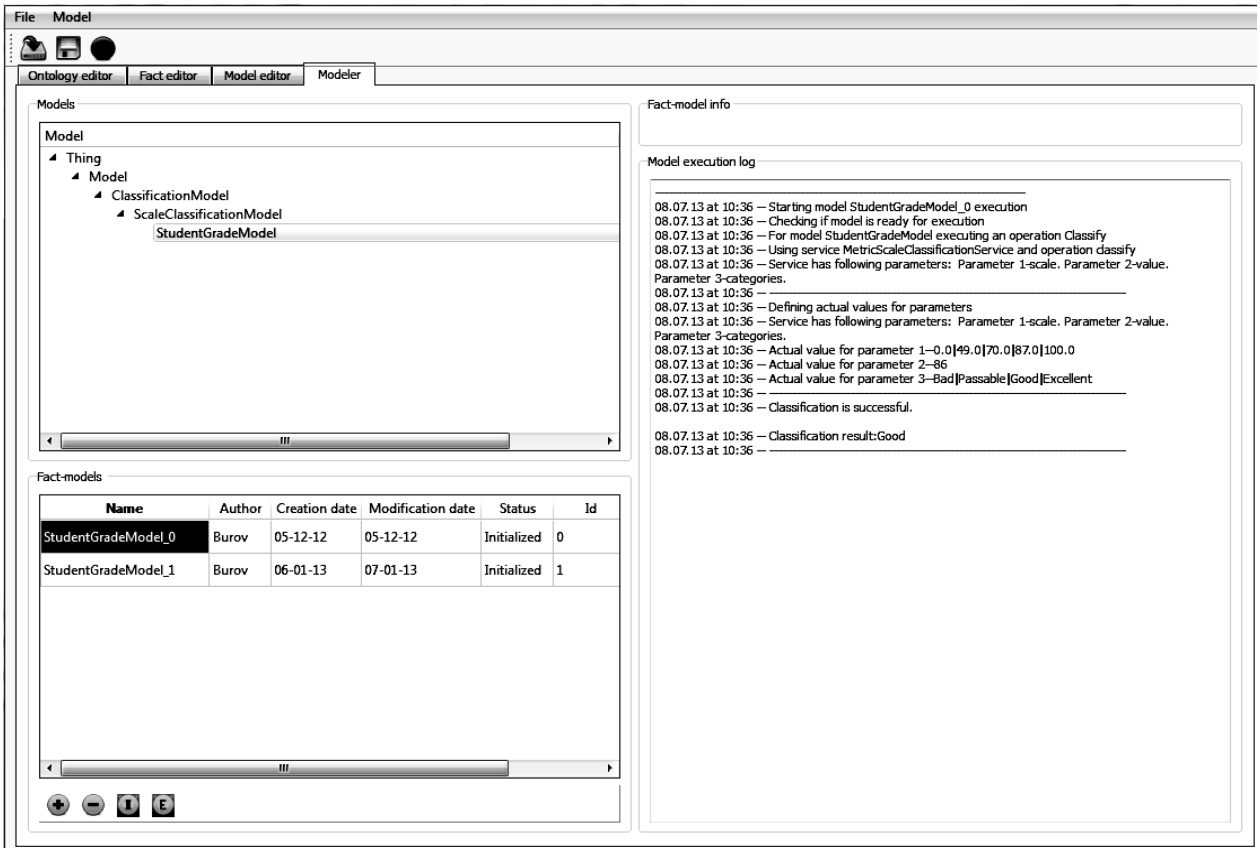

Fig. 6. An example of classification problem resolution

Developed software prototype modelling environment provide necessary flexibility for model modification. For example, the change of classification scale requires only attribute update or creating and using another fact of Scale type. Likewise, if method of classification is changed, then only attribute Method value of Classify relation should be updated.

CONCLUSIONS

Intelligent enterprise paradigm is largely used in order to improve the efficiency and flexibility of business processes. Knowledge-based business process modelling, using ontological tasks model, allows to create common enterprise-wide system of concepts and relations in form of ontology. Typical operations flows, decision patterns are captured in form of ontological models. Knowledge specified in form of ontological models is reused. Corporate standards and regulations are also enforced using corresponding models.

Developed business process modelling ontology along with generic business operation and decision models allows to build complex business process models.

As future work we intend to theoretically research the system created by complex multiple interacting models executed simultaneously, investigate the usefulness of proposed approach during real business processes implementation.

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Use of extrapolation to forecast the working capital in the mechanical engineering companies

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Abstract. The purpose of the article is to study the method of extrapolation, highlighting the effectiveness of the financial activity of JSC «ZAZ» and for its future development. In the process of analyzing and exploring the scientific work of many scientists, effectiveness of using the extrapolation method for predicting performance was determined. As a result of research in the article analyzes the financial position of the enterprises of mechanical engineering in modern conditions, the efficiency of working capital in recent years determined. The feasibility of using the method of extrapolation in terms of instability of the market economy was investigated and proved. The forecast of working capital and total sales was made.

It is offered to use in research the linear correlation coefficient of the pair, the method of least deviation, t – Student's criterion. Data obtained on the basis of the forecast enables businesses to improve their performance, to compete at a high level with other entities to establish a system of sales, to avoid crises in the future, increase profits and develop programs to reduce costs. Prospects for further research in this area will improve and develop an integrated system of economic methods on prediction performance of engineering enterprises based on current market position and variability of the environment.

Key words: Method of extrapolation, trend, coefficient of linear correlation, mean approximation error.

INTRODUCTION

In modern conditions of Ukraine's economy development, the problem of using planning elements and forecasting in the mechanical engineering is attracting considerable attention, ensuring of their economic security and determination of their effectiveness based on mathematics. That refers to the use of economic-mathematical methods and models for solving problems of planning. Structural changes that occur in a market economy of Ukraine positively influence on the development of individual enterprises. This contributed to the increase of production and sales. However, these changes have a positive impact on only a small part of enterprises while other companies still have a large amount of unresolved problems. It is important for them to develop the production process and sales, to win key positions in the domestic market, to attract foreign investment and establish business relations with foreign partners. Solution of these tasks requires introduction of modern forecasting and planning methods in the mechanical engineering, great part among which has forecasting output (sales) production by extrapolating trends, which is important in the present circumstances and complexity of economic processes.

MATERIALS AND METHODS

In the scientific literature [1, 2, 3] it is fairly well described both forecasting methods, based on the simulation of the processes under study, and extrapolation techniques for available information. Issues related to the use in practice of economic forecasting methods have been the research objects of scientists and economists: M. M. Magomedov, V. P. Bozhko, I. J. Karatseva [4], V. V. Vitlinskiy [2], V. A. Kasyanenko [3], G. O. Kramarenko [5], P. V. Krivulya [6], Y. V. Sherstennykov [7], Alieksieiev O., Belyayeva. M. [21] and others whose work analyzed forecasting methods, modeling and planning of economic processes, sales in a competitive market and the variability of the environment.

It should be noted that in the development process and methods of forecasting, modeling, studying growth, extrapolation, averages a significant contribution to the statistics made the following scientists: S. S. Gerasimenko [8], I. I. Eliseєva [9], A. M. Erin [10], A. S. Kazinets [11], G. V. Kovalevskiy [12], B. G. Litvak [13], I. S. Paskhaver [14], E. M. Chetyrkin [15], R. A. Shmoilova [16], and these issues even in philosophy analyzed and considered L. A. Mikeshina [17].

As you can see, the use of the extrapolation method in current conditions, especially in the mechanical engineering, forecasting of working capital and sales, the absence of the forecast to improve financial stability, solvency and business activity – has not lost its relevance today and requires more detailed further research, the possibility of using foreign experience in domestic practice for enterprises in different sectors, including engineering. The level of studying the existing problems and the extent of their decision resulted in the choice of topic and definition of its purpose.

Based on these circumstances, the purpose of the article is to apply the method of extrapolation on the mechanical engineering sector, highlighting the effectiveness of the financial activity of JSC «ZAZ» working capital and total sales forecasting. It is considered the specific use of the extrapolation method in the mechanical engineering. The problem is that without use of forecasting methods, it is impossible to determine the volume of sales, profits and potential effectiveness accurately in the whole. Having reliable forecast would improve financial stability, solvency, competition, reduction of costs and management of inventory [4, 6, 18].

RESULTS

In an unstable world economy development there is a need to predict the amount of working capital, the possible size of sales and calculate future income and expenses in the mechanical engineering. This issue is very relevant for both domestic and foreign enterprises, as there is no single method accurately determined for planning and forecasting performance engineering enterprises. Therefore, the phase of planning margin, gross and net profit various methods can be used: extrapolation method, the method of direct calculation, regulatory method, the method of «CVP»; method of forming a target profit, cash flow forecasting method, the method of factorial design.

This study focuses on the comparative characteristics, the problem of forecasting of the indicators of working capital and volume of goods sold, and also identifying the common features of extrapolation method for planning and forecasting the profits of the enterprise to determine the appropriateness and effectiveness of the application of this method in future studies.

The method of extrapolation is based on the results of trend analysis of margin, gross and net operating income dynamics for prior periods and consists of identifying the «trend line», which allows predicting the amount of data indicators. However, this method of planning the operating profit is the least accurate because it does not account the changes in factors that affect it. This method can be used only for preliminary planning stage (when operating plans are not yet formed), and only for a short forecast period (month, quarter) [19].

Different experts may give their interpretation of this method, and they also vary the certainty related to this approach. However, its effectiveness is proved, therefore it can't be excluded while predicting. Extrapolation method allows understanding the situation well and imagining how the events will develop.

The use of this method is rather difficult because it requires processing a huge number of economic indicators. The amount of information is enormous. In order to be the most effective, we have to make vertical and horizontal coordination.

To apply this method in the mechanical engineering or other organizations, first of all, support from the administration at all levels, from the highest to field managers or leaders of specific departments is need.

Also, you must rebuild the peculiarities of new information perception, so you can explore your past and move them to the future prospects. Extrapolation is intrinsically valid with the method of control, which provides a deep analysis of all the data, and then they can already be carried forward.

When drawing up the forecast plan equity analysis acts as the main form of pre-plan for economic research enterprise is a tool for the prediction and assessment of the expected results. The sequence of perspective analysis is this:

1) defines the terms of General indicators that characterize perspective on the basic directions of economic activity;

2) the system of General indicators supplemented with necessary personal or specific indicators;

3) set the sequence of the analysis of indicators, based on the main lines of communication between the relevant groups of indicators.

Among the methods of economic analysis used in forecasting equity, a significant role belongs to the qualitative and substantive aspects in the auxiliary role of quantitative methods of analysis, that is, holding a forecast analysis methods are used pair and linear correlation, methods of analysis of dynamic series, spectral analysis, extrapolation methods of dynamic rows etc.

Extrapolation methods are used in a relatively stable development of the company (or individual indicators of its activity) or in the presence of seasonal or cyclical fluctuations with a distinct trend. As «the trend» we should understand long trend of economic indicators in economic forecasting. If the development of indicators

of financial and economic activities in previous periods are characterized by considerable uncertainty and significant fluctuations in financial performance, their extrapolation in future periods is not possible, and thus it is impractical to use appropriate methods [19].

As the «trend extrapolating» we should understand the continuation of the extension revealed in the analysis of trends beyond constructed on the basis of empirical data series speakers. The most developed among the forecasting methods is considered to be the extrapolation method, which is based on the distribution the future trends of the past [3, p. 71].

Using extrapolation in predicting the financial condition of the company we will make an assumption about the direct link existence between working capital and sales, which can be expressed by a simple factor (ratio of net capital to sales) or equation communication [5, p. 628] :

$$Y = a + bx. \quad (1)$$

where: a – constant of net working capital; b – regression coefficient, which reflects the degree of circulating capital dependence of from sales.

Let us consider this method at JSC «ZAZ» (table 1) [20].

We can demonstrate the dependence of working capital from sales graphically (fig. 1).

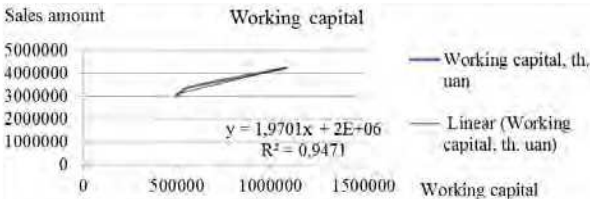

Fig. 1. Dynamics of working capital JSC «ZAZ» in 2009–2011 years

Calculation of linear correlation with statistic function CORREL in Microsoft Excel, confirms the density of communication between two signs, characterized by linear dependence of working capital from sales – 0,9731.

Since the correlation coefficient is calculation is based on a small number of source data, you need to check it out on the base of probability t – Student's criterion [1, 4]:

$$t=0,973191*1/(1-0,9471)=18,39\ldots>3 \quad (2)$$

Since the value obtained is greater than 3, the coefficient of linear correlation is to be recognized as essential. Further we will express the signs dependence with the line equation (1). To find the parameters a and b we use statistic function of Microsoft Excel. For a – function INTERCEPT (value _y; value _x) and for b – SLOPE (value _y; value _x). Thus, the volume of sales dependence on the working capital can be imagined as a regression equation:

$$y=1,9701x+2E+06.$$

From the equation it implies that if the company will increase the amount of working capital to 529617 USD. from the last quarter, sales volume will be:

$$Y=1,9701*(529617+1085305)+2000000+6=$$
$$=5181564 \text{ USD.}$$

In our case of pair linear regression can be used a statistic function FORECAST (value _y; value _x), where x – variable for which to be a forecast. This value 5181564 UAN corresponds to previously calculated by solving the regression equation.

A prerequisite for the use of this method is the prediction of the constancy of the factors that make a trend detected, but a fundamental point – identifying the trend typical for the dynamic rate under the research.

In theory and practice, there are different ways of calculating the trend. One is the method of the least deviation. If there is a steady linear dependence of the investigated parameter (x) value on the time interval (t), it is advisable to identify the trend and to build straight, described by a linear regression formula 1.

Parameters a and b of trend equation are chosen so that the actual sum of squared deviations of rate x_t from the theoretical values, that describes a straight line should be minimal :

$$f(a,b) : \sum_{t=1}^{m} (x_t - (a + bt))^2 \rightarrow \min. \quad (3)$$

where: m – the set of analyzed dynamic rate periods; x_t – the value of the studied parameters; t – time interval; a, b – the unknown parameters of the trend equation.

On the base of mathematical transformations we obtain algorithms for calculating the parameters a and b:

$$b = x = \frac{12\sum_{t=1}^{m} tx_t - 6(m+1) - \sum_{t=1}^{m} x_t}{m(m^2-1)}, \quad (4)$$

$$a=(1/m)\sum_{t=1}^{m} x_t - b((m+1)/2). \quad (5)$$

Table 1. Calculation of derived data for the financial condition of the JSC «ZAZ» forecasting

Years	Working capital, th. UAN (x)	Volume of sales, th. UAN(y)	x*y	x^2	y^2
2009	495902	2952243	1,464E+12	2,4592E+11	8,7157E+12
2010	555688	3370840	1,8731E+12	3,09E+11	1,1363E+13
2011	1085305	4239725	4,60E+12	1,18E+12	1,7975E+13
Total	2136895	10562808	7,9386E+12	1,7326E+12	3,8054E+13

Table 2. The calculation of basic data for forecasting the financial condition of the JSC «ZAZ»

№ c/p	Working capital, th. UAN	Absolute growth	Volume of sales, th. UAN	Absolute growth
2009	495902		2952243	
2010	555688	59786	3370840	418597
2011	1085305	529617	4239725	868885
2012	1033276	-52029	4202425	-37300
2013	1131510	98233,8	4417005	214580
2014	1229744	98233,8	4631586	214580
2015	1327978	98233,8	4846166	214580
2016	1426212	98233,8	5060746	214580
2017	1524446	98233,8	5275327	214580

The advantage of this method is an ability to determine the needs of the enterprise in net working capital (after calculation of the above mentioned factors predicted sales) [2]. The disadvantage of this method is taking into account only the factor of sales and the level of demand for net working capital in the short term depend on the duration of inventory turnover, accounts receivable and payable, the level of business activity and more. From the rate of capital's turnover also depends its profitability and as a result – the liquidity, solvency and financial stability of the company.

Let us determine the projected performance for an improved method of least deviation using the information contained in the table 2 and construct fig. 2, which shows the extrapolation of working capital and total sales.

Let us forecast the cost of working capital from the table 2. Empirical data on the values of the studied parameters assume for x_t. The sum of these figures for the three periods that make up the dynamic rates, is equal to 2136895 thousand (495902+555688+1085305). The total value will be t_{xt} 4863193 thousand (1*495902+2*555688+3*1085305). Substituting the appropriate values in the formula for calculating the parameters of the linear regression, we obtain: b = 98233,83; a = 640341,02. The desired function of the line that describes the trend will take the following form: x_t = 640341,02+98233,83t.

Thus, the predictive value of the indicator revenue in 2017 year will amount to 1524445,52 thousand (640341,02+98233,83*9) and observed positive changes in this indicator, which is confirmed by fig. 2. Similarly, it is possible to forecast the next period.

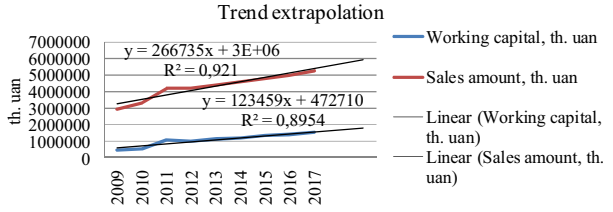

Fig. 2. Extrapolation of the trend of working capital and proceeds from the sale of JSC «ZAZ» in 2009–2017 years

Analyzing the data table 2 and fig. 2 let us turn to identifying the future volume of sales. It is characterized by the following indicators: x_t is 10562808 thousand (2952243+3370840+4239725); t_{xt} = 22413098 thousand (1*2952243+2*3370840+3*4239725); b = 214580,3; a = 3344104. The direct to the volume of sales has the form: x_t = 3344104+214580,3t. Predictive value tends to increase: in 2015 it will amount 4846165 thousand, 2016 – 5060746 thousand, and in 2017 held an increase of 214580,33 thousand compared to the year 2016 [19].

For use as a tool of trend prediction must numerically evaluate the parameters (coefficients) of equations (a_0, a_i) [19]. Options equation determined by the method of least squares:

$$\sum(y_t - \overline{y_t})^2 = \min. \quad (6)$$

In equation (6) variables y_t, and $\overline{y_t}$ are known quantities and parameters of equation (a_0, a_i) – are unknown quantities. For their definition the derivatives from expression (6) must equate to zero for each initial setting separately. After appropriate transformations we obtain a system of normal equations for linear trend equation :

$$\sum y_t = a_0 n + a_i \sum t$$
$$\sum y_t t = a_0 \sum t + a_i \sum t^2. \quad (7)$$

where: a_0, a_i – unknown quantities; n – number of periods; t – time interval.

Quality is measured by the equation system performance. The most important indicator for the evaluation of each equation is the pair correlation coefficient – for linear equations and pair correlation ratio – for all non-linear equations that reflect the closeness of the connection between the effective rate (function) and the factorial sign (argument).

Linear correlation coefficient of the pair for the equation ($y_t = a_0 + a_1 t$) is calculated as :

$$r = (n\sum yt - \sum y \sum t) : \sqrt{n\sum t^2 - (\sum t)^2 * n\sum y^2 - (\sum y)^2}. \quad (8)$$

where: n – number of periods; y – the specified value (working capital); t – time interval.

The conclusions about distress communications can be made of the following parameters:

$r \le 0,5$ – weak link;

$0,7 \ge r \ge 0,5$ – communication medium;

$r \ge 0,7$ – relationship strong.

In addition to distress communications for evaluating the adequacy equation real process are the following indicators:

1. The average error of approximation :

$$\varepsilon = 1/n \sum \left| \frac{y_t - \overline{y_t}}{y_t} \right| 100, \quad (9)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

2. The average deviation between the actual and estimated values of the function :

a) absolute :

$$\sigma_{абс} = \sqrt{\sum (y_t - \overline{y_t})^2 : (n-1)}, \quad (10)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

b) relative :

$$\sigma_{відн} = \sqrt{\sum ((y_t - \overline{y_t}) : y_t)^2 : (n-1)} 100. \quad (11)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

3. The average deviation between the actual and estimated values of the function:

a) absolute :

$$\Delta_{абс} = \sum \left| y_t - \overline{y_t} \right| : n. \quad (12)$$

where: n – number of periods; y_t – working capital in thousand UAH; $\overline{y_t}$ – working capital is calculated based on the equation.

b) relative – is defined in the same way with the indicator, calculated by formula (9).

The smaller the values calculated according to formulas (9-12), the higher is the quality of the selected equation. The maximum level is set independently, based on knowledge, experience, feature data analyzed as there are no evidence-based recommendations on these matters.

In table 3, with the example of an amount of working capital for 9 years, we show the order of parameters calculating the statistical characteristics of a linear equation in accordance with the above formulas.

Similarly, on the same principle, that is based on pre-calculated intermediate data and statistical parameters are determined the characteristics of other equations, including quadratic.

Substituting the obtained in tab. 3 (gr. 3-10) intermediate calculation data into the appropriate formula, we can calculate the required values.

Parameters of equation (a_0, a_1) we can calculate on the basis of equations in (7):

$$\begin{cases} 9809 = 9 \times 1 + 45 \times 2; \\ 56449 = 45 \times 1 + 285 \times 2. \end{cases}$$

By implementing the system of equations, we get: a_0=473,2; a_1=123,4.

Linear correlation coefficient of the pair in (8) is:

r=(9*56449-45*9809)/√(9*285–45^2)*(9*11710967–9809)=0,946.

The volume of output, calculated from the equation we can get, if the value of the argument (time t) is successively substituted for each year.

Based on the estimated parameters of equation (a_0, a_1) linear equation can be written as follows: $\overline{y_t}$ = 473,2+123,4t.

Substituting equation at the specified value of t for the first year (t = 1), we calculated the value of output in 2012 (table 3) – 966,8 thousand, in 2013 – 1090,2 thousand, in 2014 – 1213,6 thousand and so on up to 2017 – 1583,8 thousand, that there is a positive trend in this indicator.

The average error of approximation in (9) is – 10,05%. Since the error is less than 15%, then this equation can be used as a trend. The average deviation between the actual and estimated values of the function:

а) absolute in the formula (10) =
=√106594,16/(9–1)=115,43;

б) a relative in the formula (11) =
=√0,186/(9–1)*100=1,52%.

Table 3. Data on the dynamics of working capital of the enterprise and the calculation of intermediate parameters to determine the parameters and statistic characteristics of the equation $y = a_0 + a_1 t$

№ i/o	Working capital, th. UAN Y_t	t^2	y^2	y_t*t	Working capital, calculated on the base of equation yt_{cep}	$\lvert y_t - yt_{cep} \rvert$	$(y_t - yt_{cep})^2$	$(y_t - yt_{cep})/y_t$	$((y_t - yt_{cep})/y_t)^2$
2009	496	1	246016	496	596,6	100,6	10120,36	0,203	0,041
2010	556	4	309136	1112	720	164,00	26896,00	0,295	0,087
2011	1085	9	1177225	3255	843,4	241,60	58370,56	0,223	0,050
2012	1033	16	1067089	4132	966,8	66,20	4382,440	0,064	0,004
2013	1132	25	1281424	5660	1090,2	41,80	1747,240	0,037	0,001
2014	1229	36	1510441	7374	1213,6	15,400	237,160	0,013	0,0002
2015	1328	49	1763584	9296	1337	9,00	81,00	0,007	0,00
2016	1426	64	2033476	11408	1460,4	34,40	1183,360	0,024	0,001
2017	1524	81	2322576	13716	1583,8	59,80	3576,040	0,039	0,002
Sum	9809	285	11710967	56449	-	732,80	106594,16	0,904	0,186

The average deviation between the actual and estimated values of the function:

а) absolute in the formula (12) = 732,8/9 = 81,42 thousand UAH;

б) the relative is defined as was observed earlier, the same average error of approximation is 10,05 %, respectively.

Proposed indicators for assessing the quality of the equation do not contradict each other. Which is better to use is at the discretion of the expert. In general, we can say that the constructed equation is characterized by high and reliable performance, and also confirms the previously made predictions about the growth of working capital of JSC «ZAZ» until 2017 year and has even more positive dynamics.

CONCLUSIONS

Summing up the above, one can draw the following conclusions. The research examined the extrapolation method and its specific application in the mechanical engineering. It should be noted that this method can be used for forecasting of working capital and the volume of sales in the mechanical engineering. A forecast for several years makes it possible to assess the financial situation and create a plan of development, establish relationships with partners, improve the technical equipment to attract foreign investment. This method allows modeling the volume of sales based on market fluctuations and especially price changes, consumer demand for the products of new advanced car models. Further development of the results will be towards developing an integrated system of economic methods of performance indicators prediction based on existing market position and variability of the environment.

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Technology of evaluation of intellectual property objects of enterprise with the objective of their further sale

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Abstract. The existing classification of intellectual property objects (IPO) in order to give a more precise definition of it was analyzed; the criteria for IPO valuation of an enterprise were formed; the approaches and corresponding methods of enterprise's IPO valuation were analyzed; valuation technology of enterprise's IPO for subsequent sale taking into account the suggested selection criteria was developed.
Key words: intellectual property objects; classification; valuation; criteria; approaches; method.

INTRODUCTION

According to paragraph 2 of article 54 of the Constitution of Ukraine, every legal entity has ownership rights to its intellectual property; it can freely purchase and sell them for specific purposes. [1]

According to the records of the WIPO Assembly of States members, on 20-29 September 1999, 21st would become century of economics, based on knowledge, in which intellectual property is the main driving force. [9]

Therefore, intellectual property as a result of mental creativity is a multidimensional, complex category which has been attracting increasing attention of scientists under conditions of the humanization and socialization of economic development in leading countries of the world.

In modern economic literature "intellectual property" is characterized as the coexistence, competition and combination of different theoretical and methodological approaches, formed by representatives of leading scientific schools and directions of economic research. [3, 113]

If we talk about the results of intellectual property in terms of particular enterprise or company, they are only ideas, which have certain price, but do not have a market value, which will lead to the expected result. The problem for enterprises is correct valuation of their own intellectual property objects and gaining additional profit from their intended use or sales on the market.

Formation and effective use of scientific and technological potential of the country is practically impossible without the active participation of its business entities in exchange of products of intellectual activity. Purchase and sale of patents, licenses, know-how, engineering services, foreign business trips of experts, participation in scientific conferences, exhibitions, fairs, etc. are the forms of exchange in intellectual property (IP) that are part of the assets of innovative and active enterprises. Today's problem is that companies are not always able to properly evaluate their assets and the IPO, in order to obtain additional income. Enterprise's IPO should have some degree of legal protection, technical level, novelty, specific development, value and other characteristics which fundamentally distinguish them from existing in the market, only then above characteristics will bring to enterprise's additional revenue. Various aspects of research issues are presented in the works of local and foreign scientists: V. Alexandrov, A. Butnik-Seversky, S. Valdaytsev, V. Vitlinskyy, L. Hatovskyy, V. Geets, L. Edvinson, L. Kantorovich, A. Kozyrev, P. Krainov, A. Kuzin. Quotes, A. Novosel, A. Podoprigora, A. Podoprigora, B. Prahov, T. Sakayya, B. Santo, O. Svyatotskyy, M. Skrypnychenko, R. Solow, T. Stewart, L. Tymoshchuk, L. Fedchenko W. Hartman, P. Tsybulov, W. Stock, S. Shuhardin, Y. Yakovets. [3-20]

Typical enterprises' IPO in Ukraine include: utility models, industrial prototypes, samples for goods and inventions, the output of which is given in the form of statistical data presented on Figure1.

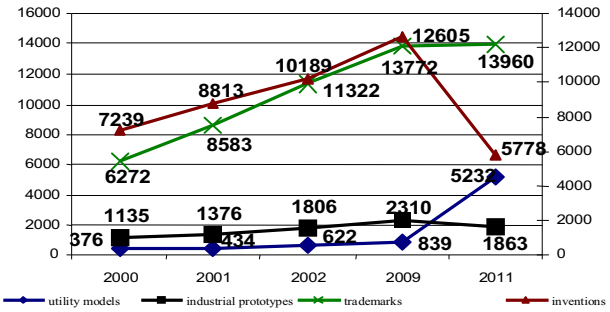


Fig. 1. The process of submission of applications for patents to the State Department of Intellectual Property of Ukraine

Source: According to the State Department of Intellectual Property of Ukraine

On Figure 1 the negative dynamics can be detected concerning patent grants for invention, samples of goods and industrial prototypes. This comes from the fact that companies underestimate their existing IPO; they are not able to find effective application for them; and they are not able effectively evaluate objects for vendition.

Due to the fact that not all enterprises in Ukraine are able to correctly valuate the available IPO for sale it causes this negative dynamics so statistics is inconsolable. The only thing which can be detected is that during the last two years there is constant number of patent grants for trademarks and this fact may be caused by the stabilization of commodity market.

Suggested research is aimed at heads of enterprises, institutions, companies, which possess objects of intellectual property, develop them and willing to sell them. The developed technology will help them to make the right decision on intellectual property object valuation, the necessity of selling it, forms of its calculation and the profit evaluation which were received from IPO's realization.

AIM AND OBJECTIVES

The aim is to develop technology of IPO's valuation in a particular enterprise for its further implementation.

The achievement of this aim caused the necessity the following objectives:

- to examine the existing classification of intellectual property objects for its specification;
- to form criteria of enterprise's IPO valuation;
- to analyze approaches and corresponding methods of company's IPO;
- to develop enterprise's IPO valuation technology for further selling of it, taking into account the proposed selection criteria.

THE MAIN RESULTS OF THE RESEARCH

Results of the research, which are of scientific novelty and obtained during solving of objectives above, are the following:

- On the basis of analyzed sources the IPO's classification received further development.

Classifications which were distinguished by the author are listed in Table. 1.

The criteria for selecting alternative evaluation of intellectual property objects were determined (Table 2).

Table 1. Fragment of IPO classification by proposed features*

Features**	Types of enterprise's IPO
According to intellectual property rights	Objects of industrial property, innovative intellectual property objects, copyright and allied rights.
According to the direction of influence on enterprise's financial results	Intellectual property objects which are able to generate direct income, by their application into exploitation. Objects that indirectly affect the financial results of the enterprise.
According to the results of intellectual activity	Economic, social, technological, environmental and organizational.

* Formed using the sources 5,6,7

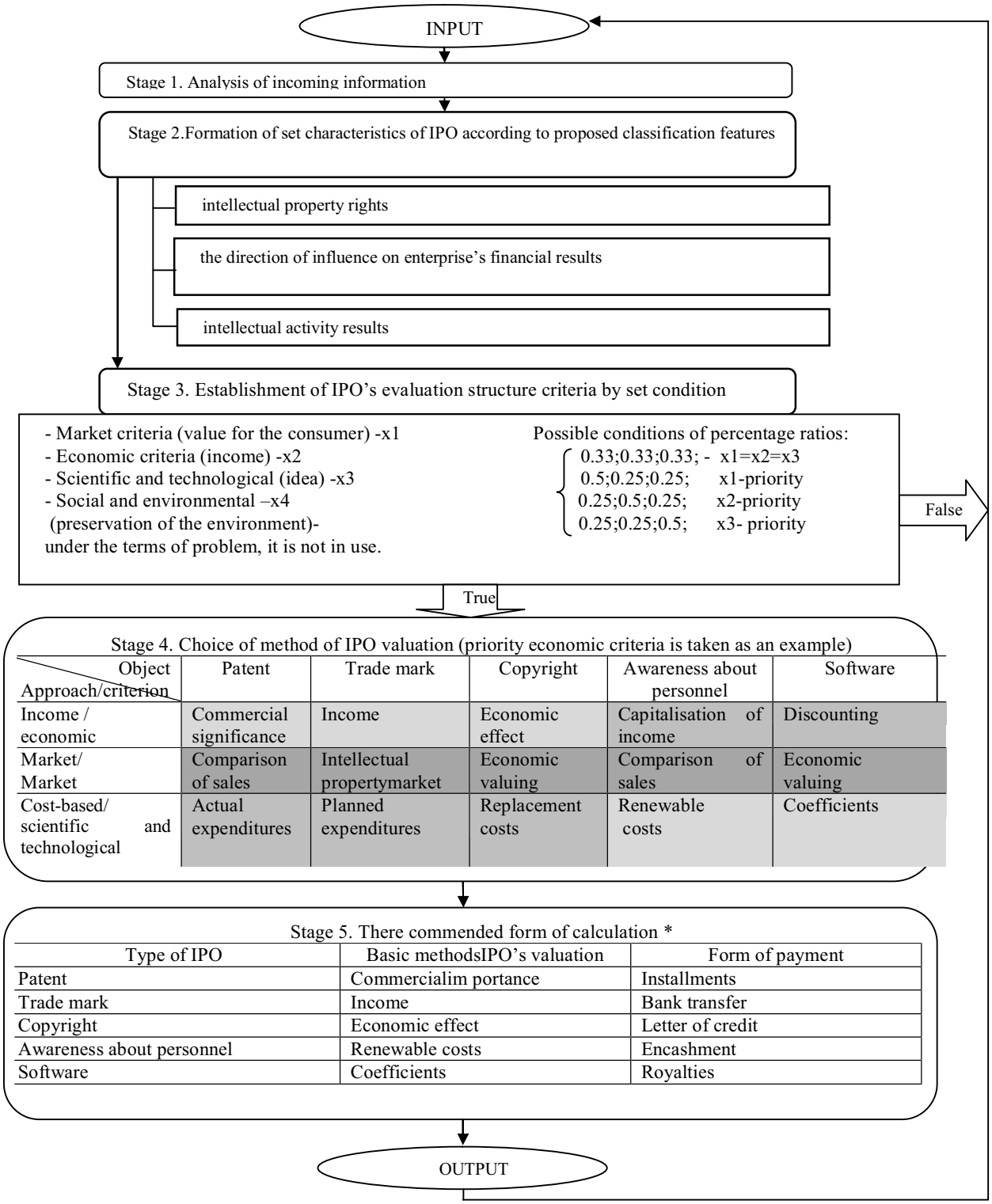
** The features proposed by the author

Table 2. The criteria for selecting alternative evaluation of intellectual property objects were determined

Criteria	Explanation
Market	the relevance of the project to market demands; commercial success of the project implementation; the level of advertising to promote suggested product to the market; competitiveness of products by price and quality; protection from obsolescence, etc.
Economic	the required amount of financing for the project implementation; the estimated annual profit; project payback; share of own funds in total project costs, etc.
Social and environmental	impact of the project implementation on the level of employment; effect of manufacturing processes, which are involved in the project implementation, on the environment, etc.
Scientific and technological	prospects of scientific and technological solutions; novelty of products and patentability of technical solutions which are used; prospects of application of expected results in future developments, etc.

Table 3. Basic approaches to determine the value of IPO

IPO types	Approaches		
Patents	Income based (financial)	Marketable (analog)	Cost-based (investment)
Trademarks	Income based	Marketable	Cost-based
Copyright	Income based	Marketable	Cost-based
Awareness aboutpersonnel	Cost-based	Income based	Marketable
Software	Cost-based	Marketable	Income based



Object / Approach/criterion	Patent	Trade mark	Copyright	Awareness about personnel	Software
Income / economic	Commercial significance	Income	Economic effect	Capitalisation of income	Discounting
Market/ Market	Comparison of sales	Intellectual propertymarket	Economic valuing	Comparison of sales	Economic valuing
Cost-based/ scientific and technological	Actual expenditures	Planned expenditures	Replacement costs	Renewable costs	Coefficients

Type of IPO	Basic methodsIPO's valuation	Form of payment
Patent	Commercialim portance	Installments
Trade mark	Income	Bank transfer
Copyright	Economic effect	Letter of credit
Awareness about personnel	Renewable costs	Encashment
Software	Coefficients	Royalties

Notation conventions:

	Basic (priority) methods to determine the value of IPO
	Secondary methods to determinethevalueof IPO
	Ineffective methods to determine the value of IPO

Fig. 2. Technology of enterprise's IPO valuation for further implementation.

The choice of the criterion by which we measure our intellectual property objects, at some degree affects the effectiveness of expected effect of this object.

• the approaches to evaluate the market value of intellectual property objects were identified.

The first approach – cost-based (investment) includes five methods: the actual cost method, planned expenditures method, the replacement cost method, the renewable value method, the coefficient method.

The second approach – marketable (analog) includes three methods: the comparative sales method, the intellectual property market method, the expert estimations method.

The third approach – income based (financial) includes six methods: the commercial importance method, the economic benefit method, the "profit capitalization" (income) method, the discounting method, the royalties method.

Basic approaches to determine the market value of IPO are presented in table 3.

TECHNOLOGY OF ENTERPRISES' IPO VALUATION FOR FURTHER REALIZATION

The developed technology is presented in the form of the algorithm and is shown on Figure 2.

The algorithm, which is proposed by the author, includes features of types of enterprises' IPO classification and the criteria for evaluation intellectual property objects ownership. Let us consider each of the elements of the algorithm.

Stage 1: Analysis of incoming information

On this stage, we conduct: analysis of enterprise's financial statements; evaluation of its financial results; the efficiency of non-current assets; formation of data on IPO; prove expediency of its selling.

Stage 2: Classification of IPO according to proposed classification features

On this stage, we analyze the existing enterprise's IPO and classify them according to the proposed criteria: intellectual property rights; the direction of influence on enterprise's financial results; intellectual activity results.

Stage 3: Establishment of IPO's evaluation structure criteria

After the IPO's classification we form the structure of the proposed criteria (market, economic, scientific and technological, social and environmental) and we choose, on the basis of expert method, the most important for a particular enterprise. For example, if on the present stage of development profit is more important than an idea and / or benefits for consumers, the criteria structure will be the following 50%, 25%, 25%, 0%. In our assumption under the terms of problem, social and environmental criteria are not in use.

Stage 4: Choice of IPO's valuation method according to the table which was set in the algorithm.

Having analyzed approaches and methods to determine the value of IPO, in literature sources,we have identified the main approaches and corresponding methods that would the most suitable to determine the value of IPO.

Stage 5: The recommended form of calculation when enterprise's IPO are implemented.

We have offered to make payments in accordance with the forms which are commonly used in the practice of payments between domestic enterprises. Specific form of calculation is proposed for the purchasing of particular IPO, which in our view, consistent with the objectives of both parties.The major forms of payment include: bank transfer; letter of credit; encashment. Installments and royalties can be considered as specific forms.

CONCLUSIONS

On the Ukrainian market of intellectual property, in contrast to developed markets, many of concluded contracts are concentrated in heavy industry. The share of license agreements enclosed in high-tech industries is very low. Moreover, in the total of transactions the share of patents on the disposal of intellectual property rights is also very low, especially compared to the world figures.

There is a general negative trend of innovation performance in the form of development of new products in the industrial enterprises with significant backlog in implementation of advanced technological processes and resource saving technologies.

Theoretical principles and practical guidelines which were formed can be used:

on the macro level – during the improvement of intellectual property sales regulation in national system and during the development of trade policy of the country;

on the meso level – in the process of international corporate strategies development; identification and competitive advantages, promotion of the region connected with intellectual property;

on the micro level (enterprises level) – for making optimal decisions on the development of innovation on the basis of sale of intellectual property objects.

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Problems of intercultural communication in temporary project teams in Ukraine

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Abstract. The paper deals with the problems of managing intercultural communication in implementing temporary complex projects. The essence and tasks of communication in difficult temporary project teams are explained. The author describes the main peculiarities of intercultural communication in Ukraine and CIS countries. The problems in managing intercultural communication in implementing temporary complex projects are given on the example of designing and constructioning of the Lviv stadium "Arena Lviv".

Key words: intercultural communication, temporary complex projects, temporary project teams, managing intercultural communication.

INTRODUCTION

In recent decades, due to Ukraine's independence obtaining, with the expansion of its international relations with other countries and multinational population of Ukraine, a special theoretical and practical interest is paid to the problems of intercultural communication, especially in global business and complex international projects. The impetus for the research was also the fact that in different countries the business had to use local employees, who were characterized by a peculiar cultural competence, which complicated the activities of multinational companies, that is why they began to study and implement mechanisms of intercultural communication. Contemporary processes of globalization and democratization stressed the issue of intercultural communication at the international level as well as within national (multinational) states.

The interesting fact is that the access to Ukraine's past as well as to the history of its ethnic composition was fully or almost closed, and the existing information, which sometimes appeared, was not complete and quite controversial. Hence, the scientific problem reflects the conflict between the achieved levels of sociological knowledge about the features of intercultural communication in multinational temporary project and need for building the successful intercultural relations through communication in it.

MATERIALS AND METHODS

It should be noted that different theoretical and methodological aspects of the described problem are being researched quite actively by the global and domestic social science.

Anthropologist Edward T. Hall [1] is generally acknowledged to be the founder of the scholarly field of intercultural communication during the 1951-1955 periods when he was at the Foreign Service Institute of the U.S. Department of States. The 1954 year may be considered as the date of birth of intercultural communication as an academic discipline that was the date of Hall Edward T. & Trager George L. [8,9] "The Analysis of Culture" Publishing. The authors in this paper proposed for the first time the term "intercultural communication" for the general use, which reflected, in their view, a special area of human relations. Later, the main provisions and ideas of intercultural communication were more fully developed in E. Hall famous work "The Silent Language" [7] where the author showed a close relationship between culture and communication. It is believed that E. Hall is a founder of intercultural communication as a separate discipline. At

his book "*Understanding Cultural Differences"* Edward T. Hall [8] noted: "For the past thirty years we have conducted research in the field of intercultural communication: designing programs for the selection and training of people working in foreign cultures, consulting to international business, and writing books and articles on the intercultural process. We specialize in identifying the nonverbal components of intercultural communication – the unspoken signals and assumptions that flow from human psychology and national character, elements critical to success in business."

The profound basis for the study of modern communications is the theory of communicative action of Jürgen Habermas [2], which makes it possible to understand the fundamental features of intercultural communication. It is important to use the data for building successful cross-cultural relationships through communication in complex temporary project teams.

RESULTS AND DISCUSSION

Depending on the nature of the tasks, project teams can be formed on a permanent or temporary basis. Regular project teams are created for the long term and move from one project to another almost at full composition. Temporary project teams are created in a complex and uncertain situations associated with multiple unpredictable circumstances, according to which it is necessary to quickly change the decision. They are formed according to specific objectives of the project and are completed by functional departments of the company staff and are disbanded after completion of the performed works.

Because of unpredictability and high work riskiness of temporary project teams, it is more difficult to create and manage them. The process is more complicated in the case when specialists from different countries are involved at the intersection of several disciplines and work on the projects realization. In order to make decisions and achieve goals, managers need highly skilled, often unique specialists from different spheres, who often may be found abroad while planning and implementation of complex and unique projects [5].

In practice, temporary project teams are formed for the construction of the original objects building, innovative products development for emergency operations realization and medical services providing as a result of emergency situations of industrial or natural origin etc. For example, the 57th annual song contest "Eurovision 2012" was held in Azerbaijan capital Baku on the stage of recently built sports - concert complex Baku Crystal Hall. This new, multi-functional hall was built in record short time - for 8 months. Typically, 4 - 5 years are needed for the process of building design and construction with the size of a football stadium. In order to complete the project on time, works on the design, engineering and construction were carried out in parallel. "Baku Crystal Hall» is built in the form of steel structure, consisting of three independent parts: a modular stadium, roof and internal membrane of exterior. Roof weighs about 2,400 tons. Hall is built according to German and European standards for sports and concert halls. This building – is the outcome of many organizations work: the general contractor of German company ALPINE Bau Deutschland AG, GMP International GmbH, a multinational company NUSSLI AG with its headquarters in Switzerland, as well as dozens of contractors and consultants [3].

Intercultural communication as a special kind of converse involves communication between speakers of different languages and different cultures [11]. The comparison of languages and cultures reveals not only a general, universal, but specific, national, original, which is stimulated by differences in the history of nations development. Intercultural communication deals with understanding and agreement which means: to understand something alien and at the same time to be understood while talking in a foreign language.

The peculiar feature of geopolitical position of Ukraine is that it is defined by its location in the zone between East and West (between Western European and Eastern European cultures), between the Catholic and Orthodox branches of Christianity. During centuries, two types of European culture - western and eastern were formed. The synthesis of these two traditions was the most clearly manifested in the period of Kievan Rus' and the Cossack state.

The geopolitical position of Ukraine as a specific zone between different culturological systems of East and West, South and North contributed to the fact that Ukraine organically absorbed the values of different cultures, and this opens up great opportunities for both its domestic development and gaining a worthy place in the international community.

The historical influence of different cultures on the development of Ukrainian society contributed to the fact that a system of interconnected regions was formed in Ukraine into one integrity with specific historical, economic, geographic, demographic and cultural characteristics. The structure of population of Ukraine are includes: Ukrainian 77.8%, Russian 17.3%, Romanian 0.8% (including Moldovan 0.5%), Belarusian 0.6%, Crimean Tatar 0.5%, Bulgarian 0.4%, Hungarian 0.3%, Polish 0.3%, Jewish 0.2%, Greeks 0.2% and other 1.6% (including Muslim Bulgarians, otherwise known as Torbesh and a microcosm of Gotlander Swedes of Gammalsvenskby) [14].

Ukraine is the major source of migrants in many of the European Union Member States. During the 1990s and early 2000s, Ukraine's sputtering economy and political instability contributed to rising emigration, especially to nearby Poland and Hungary, but also to other States such as Italy, Portugal, Spain, Turkey, Israel, Russia and Canada. Although estimates vary, approximately two to three million Ukrainian citizens

are currently working abroad, most of them illegally, in construction, service, housekeeping, and agriculture industries.

By the early 2000s, Ukrainian embassies reported that 300,000 Ukrainian citizens were working in Poland, 200,000 in Italy, approximately 200,000 in the Czech Republic, 150,000 in Portugal, 100,000 in Spain, 35,000 in Turkey, 20,000 in the United States and small significant numbers in Austria, Belgium, France, Germany, Greece, Sweden, Switzerland and the UK. The largest numbers of Ukrainian workers abroad, about one million, are in the Russian Federation. Since 1992, 232,072 persons born in Ukraine have immigrated to the US. These features should be considered in the whole system of state building, including the development and implementation of complex projects of national scale [14].

The problem of regional unity of Ukraine has great international significance. The geopolitical position of Ukraine holds her responsible for the construction of a common " European home " and the new world order as a whole, because if Ukraine for some reason becomes a zone of social and political tension, or even conflicts, the hope for a comfortable "European House" is vain. Analyzing different approaches to Ukraine regionalization, we believe that it is appropriate to take into account the specifics of business conducting in regions, taking as basis the national and regional peculiarities of the nation mentality.

An interesting phenomenon which is observed in Ukraine, in Russia and other post-socialist countries is a "*Blat*". There is a wide range of social networking across all business contacts at those countries. This is apparent as social networking has evolved from a Russian and Ukrainian cultural tradition, called Blat, which has been important, historically, involving the use of personal contacts to acquire resources. *Blat* is a system of networking, embedded within Russian and Ukrainian culture, which relies on informal, personal contacts which, when employed in business, provides the potential to gain competitive advantage [4]. *Blat* has been practiced for centuries in post-socialist countries and it still has deep roots in culture and the economy. *Blat* is built into the Russian hierarchical social structures and is especially relevant in dealings with tax authorities, customs offices, banks, and regional administration and is still important in doing business, more generally in temporary projects teams. The authors distinguish *Blat* as being in two forms in contemporary Russia and Ukraine [4]:

1) Traditional *Blat* that provides for informal networking based on trust and long-term personal relationships,

2) Modern *Blat* based on utilizing uni-directional power and domination within the networks.

Using data from a sample of 100 Russian and Ukrainian businesses, the authors find that traditional *Blat* is positively correlated with innovation and organizational performance; while modern *Blat* is negatively correlated with performance. A possible negative impact of *Blat* should be considered when managing temporary complex intercultural projects.

Each member of the temporary transnational project is a carrier of their specific culture or subculture, which includes a variety of features: ideological, linguistic, ethno-national, religious and so on. Therefore, it is clear that at the meeting of different cultures representatives each of them will act in accordance with their cultural norms.

Today this moment is supported by various ethnic groups in their efforts to self-identify, maintain their traditional roots, not to be dissolved in a multinational public space. However, the coexistence of ethnic groups in a social and cultural space imposes a stamp on communication models between them, on their cultural and behavioral practices [3].

Among many factors that cause impact on the communication of different cultures representatives, a special place is the desire to come to mutual understanding with each other, create, in the conditions of general life problems, (socio- economic, socio-political, socio-cultural, etc.) the optimal intercultural communicative competence, namely the ability to implement effective communication in intercultural contexts. Ukrainian scientists discussed such problems, for example the ttheoretical approaches to communications management in IT industry of Ukraine are explained by Semenyshyn V. and Oleksiv I. [18].

With the formation of temporary project teams of national level of objectives and scale – the variability of communication and status characteristics of the different cultural environments representatives is observed. Taking into consideration the ethno-cultural identity and specific interpretation of messages in such projects it is impossible to avoid cross- functional and international conflicts. Representatives of the various functional units usually speak in different professional language, they have different settings and knowledge, values and priorities, and therefore it is not easy for them to cooperate [12]. If ordinary employee from one unit is equal with the head of the other unit, it is impossible to preserve the hierarchical system. And when we talk about international team, employees often work in different countries, and spend their part time communicating through information and communication technologies. Due to the time difference and language barriers, various misunderstandings, inconsistencies and failures often occur. In addition, employees do not have time to adapt to the new colleagues methods of work, their characteristics and work habits. The absence of the formed professional relationships in temporary project complicates the work - people sometimes do not even know each other's names (for example, in cases of saving projects during disaster or emergency medical

operations in large hospitals where doctors, nurses and technicians who work on a sliding scale should act as a single entity: quickly understand what to do and ideally make a whole set of measures) [4]. Therefore, it is difficult for projects members to communicate and negotiate in the temporary cross- functional and international groups [17].

Thus, if the organization should implement something she had never done and probably will not do in the future, a common structure of the project working group does not fit. Because it is impossible to definitively predict which knowledge and skills will be needed, also we can not exclude that the circumstances may change during the performance of work. The hardest and the most important for project managers is to establish close cooperation and constant communication, to help participants to find common ground. Under these conditions, the project manager must be able to not only manage a team, but also to set operational teams and provide them with conditions for work. It is necessary to rank the tasks according to the sequence that involve inverse interdependence, and explain when professionals or subgroup must meet - directly or online - to agree future steps, identifying necessary resources, analyzing of the problem and decisions-making.

With the implementation of large projects on a national scale it is important to consider the existing features of intercultural communication in the Ukrainian business as a way of sharing knowledge, ideas, beliefs, concepts, emotions, etc., and a set of common cultural values and norms of the business organization in the host country. An example of conflicts that may arise in the implementation of major national projects is the construction of a football stadium in Lviv for the matches of the European Football Championship 2012. Today, with the number of seats for spectators "Arena Lviv" takes 4th place in Ukraine, with the illumination of pitch- the first place [5].

Design and construction of the Lviv stadium "Arena Lviv" was accompanied by scandal situations and ambiguity. In particular, for the order of the Lviv city authorities in 2007, the German company «Hochtief Construction» developed a project of the new arena. According to the plans of German architects – the stadium was designed for 32,000 spectators, the construction was planned to be completed by 2010. The cost of the stadium was estimated at 70 million 400 thousand euros. In early 2008 the German company «Hochtief» was replaced by Austrian company «AlpineBau». The developer of the stadium project acted "Design Bureau Albert Wimmer," which projected the stadium to host the final part of the European Football Championship 2008 in Austria. Lviv firm "Arnica" worked together with Austrians. Later in the year and a half after the announcement of the host of Euro 2012 the construction work has not started, and the Austrian company «AlpineBau» refused to carry out the orders of Lviv authorities in early October 2008. The parties did not agree on the amount of funding, as 85 million euros proposed by city authority, was not enough for a company that wanted to bring their own vehicles to the city and Austrians builders, which greatly would have increased the estimate [5]. The information about the negotiations between the leaders of the city and a corporation IUD (Industrial Union of Donbass) was announced in November 2008. Mariupol JSC "Design and Construction Company «Azovinteks»" was executant and contractor of works. Ministry of Regional Development and Construction chose this company among 3 candidates - other potential project implementers were architectural firm of Yuriy Seriogin (representative of the German company "Hohtif") and Turkish company "Yeditepe" [7]. 22 firms participated for comparison, in the competition for the construction of Euro 2012 National Stadium in Warsaw in 2008, including elected Executive - Consortium JEMS Architekci-Dawos [18].

As a result, Lviv stadium is the third most expensive stadium in the history of Ukraine (after the "Olympic" and " Donbass-Arena"). According to the order of the Cabinet of Ministers of Ukraine "On approval of the corrected project and the title of structure "Building of a stadium in Stryyska street - Ring Road in Lviv" dated on March 28, 2012 № 167 -r total construction budget amounted 2,944,692 UAH or approximately 375 million $ [3] .

Thus, the lack of the processes understanding of intercultural communication features in Ukrainian business as a way of sharing knowledge and a set of common cultural values and norms of business conditions management in Ukraine, foreign companies could not get the project of building the stadium, even with its technical processing and commercially attractive proposals.

CONCLUSIONS

1. Intercultural communication in the framework of international temporal project is characterized by peculiarities of communicant's national character, the specifics of their emotional composition, cultural-specific features of thinking etc. Communication in such projects between workers happens also within the same culture (inner cultural communication).

2. The hardest and the most important for project managers are to establish close cooperation and constant communication, help participants to find common ground. Under these conditions, the project manager must be able to not only to manage a team classically, but also gain operational teams and provide them with conditions for work. The emphasis is made on tasks ranking according to priorities, organizing participants meetings - directly or online - to agree future steps, planning and distribution of resources, analyzing problems and making appropriate management decisions.

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Investigation of numerical model of Lenze 530 Dc drive in Matlab

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Abstract. This paper describes DC drive with thyristor voltage regulator Lenze 530 series. To investigate the transients of the drive system developed numerical model in MatLab is developed. Dual circuit structural diagram of "TCV-DC motor" system with negative feedback for the current and angular speed or current and armature voltage in model is realized. By introduction of current feedback, torque and current limit are achieved and with using of armature voltage or tacho automatic speed stabilization is obtained. At this model certain standard settings of cascade control system are made.

The basis of the internal loop consist from PI-regulator with $K_{P.C}$=2 and $K_{I.C}$=100 gains, TCV and armature transfer functions, covered by armature current feedback. Current controller is configured at technical optimum.

Second circuit can have armature voltage feedback; can be tuned at technical optimum and has a P-regulator with $K_{P.S}$=36 gain. In same way it can have a speed negative feedback with the same tunings.

A numerical model has restrictive blocks: to limit the maximum and minimum speed and maximum current. To demonstrate the obtained results virtual oscilloscopes were used. Also the electromechanical characteristics of the drive with armature voltage and current or speed and current feedbacks using XYGraph block are presented. At this paper the electromechanical characteristic of the real DC drive Lenze 530 series is presented too.

According to research results at numerical model and physical investigation equipment graphs of instantaneous values of current and electromechanical characteristics are made. Analysis of graphs confirms the adequacy of the results obtained at the numerical model and the real drive system, which enables the use of the developed numerical model for the investigation of similar DC drives.

DC drive model with thyristor voltage regulator Lenze 534 and results of investigations of electromechanical properties are presented.

Key words: Transition process, semiconductor voltage converters, feedback, PI-controls, electromechanical characteristics, model.

INTRODUCTION

Now modern regulated drives based on power electronics are widely used in industry [5, 9, 10, 15]. Technical characteristics, that are presented at datasheets for drive elements, do not give information about their work at transients. For obtaining a information about transients it is need to carry out investigations at laboratory and testing equipment, that leads to significant amount of time loss and additional costs of their creation. It is possible to simplify the study of transients using electric drive numerical model [1-4, 6-8, 11, 14-18] in MatLab, which consists of a DC motor with separate excitation and Lenze 530 Series thyristor voltage converter.

MATERIALS AND METHODS

Analysis of driving performance was based on the theory of electric drives and using computer models of the MatLab system.

AIM OF THE WORK

To provide reliable performance of DC drive with semiconductor voltage converter Lenze 530 Series at transient processes in MatLab system computer models with a significant reduction of time and reduce material costs.

RESULTS AND DISCUSSION

Thyristor voltage converters (TVC) of German company Lenze Series 530 (Fig. 1) are produced in four versions with output power range from 0.36 to 2.04 kW and are designed for use with DC motors with separate excitation in the first quadrant.

Converters work with negative armature voltage feedback (IxR-compensation) or speed tachometer voltage feedback [13].

On the front side of the device adjustment potentiometers are presented: I_{max} – setting of maximum device current; I×R – regulation of armature voltage feedback anchor (I×R-compensation); n_{max}, n_{min} – saturation of maximal and minimal motor speed; T_i – adjustment of the needed transients.

Fig. 1. Appearance of Lenze 530 Series thyristor voltage converter

Electrical scheme of drive with TCV is presented at Fig. 2. When a voltage is applied to the DC controller, current appears in the excitation winding, and for power supply of the motor armature circuit, switch RFR must be enabled. In this manner enabling the drive magnetic flux is set to the nominal before start of the motor. Speed is adjusted by potentiometer R= 10 kOhm or external source of voltage control U_C=0…10V. Using negative speed feedback jumper between terminals 2-4 is removed and tachometer U_{BR} connected to terminals 3-4.

«Thyristor voltage converter – DC motor» dual circuit system with armature current feedback and armature voltage of tachometer voltage feedback is presented at Fig. 3 [12]. By introducing current feedback in to the drive system current and torque limitation are achieved. Using armature voltage or tachometer voltage automatic speed stabilization is obtained.

Current feedback gain $k_{C.F.}$ can be obtained as a ratio between maximal speed setpoint voltage $U_{S.S.max}$ and maximal (starting) motor current:

$$k_{C.F} = \frac{U_{S.S.\max}}{\lambda_I I_N}, \quad (1)$$

where: λ_I – available multiplicity of starting current; I_N – rated current of the motor.

EMF stabilization of TCV is achieved by supplying of negative feedback coherent signal $u_{V.F} = e_{TCV} - i_A R_{COMP}$ to the input of adjustment speed signal. Changing of R_{COMP}, we can regulate feedback gain value. When load is increases the voltage at motor connectors is decreases due to losses at armature circuit. This increases the voltage drop across the resistance R_{COMP}, the signal from which is subtracted from the e_{TCV} and consistently applied to the input $u_{S.S}$. The output voltage of TCV is automatically increased.

According to structural diagram of the electric drive (Fig. 3) we can write the following equations of electromechanical characteristics with negative feedback of current and armature voltage:

$$\begin{cases} k_{TCV}[u_{S.S} - (e_{TCV} - i_A R_{COMP}) - k_{C.F} i_A] = (T_{TCV} p + 1) e_{TCV}, \\ e_{TCV} - k_E \omega = R_A (T_{A\Sigma} p + 1) i_A, \end{cases} \quad (2)$$

and with negative feedback of current and angular speed:

$$\begin{cases} k_{TCV}(u_{S.S} - k_{V.F}\omega - k_{C.F} i_A) = (T_{TCV} p + 1) e_{TCV}, \\ e_{TCV} - k_E \omega = R_A (T_{A\Sigma} p + 1) i_A. \end{cases} \quad (3)$$

After the transformation equations (2) we obtain the expressions of dynamic electromechanical and mechanical characteristics of electric drive:

$$\omega = \frac{k_{TCV} u_{S.S}}{k_E[(T_{TCV} p + 1) + k_{TCV}]} - \frac{R_A[(T_{TCV} p + 1) + k_{TCV}](T_{A\Sigma} p + 1) + k_{TCV} k_{C.F} - k_{TCV} R_{COMP}}{k_E[(T_{TCV} p + 1) + k_{TCV}} i_A, \quad (4)$$

$$\omega = \frac{k_{TCV} u_{S.S}}{k_E[(T_{TCV} p + 1) + k_{TCV}]} - \frac{R_A[(T_{TCV} p + 1) + k_{TCV}](T_{A\Sigma} p + 1) + k_{TCV} k_{C.F} - k_{TCV} R_{COMP}}{k_E k_M[(T_{TCV} p + 1) + k_{TCV}} t_L. \quad (5)$$

When p = 0, equation (4) and (5) are the equations of static electromechanical and mechanical characteristics:

$$\omega = \frac{k_{TCV} u_{S.S}}{k_E(k_{TCV} + 1)} - \frac{R_A(k_{TCV} + 1) + k_{TCV} k_{C.F} - k_{TCV} R_{COMP}}{k_E(k_{TCV} + 1)} i_A, \quad (6)$$

$$\omega = \frac{k_{TCV} u_{S.S}}{k_E(k_{TCV} + 1)} - \frac{R_A(k_{TCV} + 1) + k_{TCV} k_{C.F} - k_{TCV} R_{COMP}}{k_E k_M(k_{TCV} + 1)} m. \quad (7)$$

Stiffness of the mechanical characteristics in the closed system depends on the feedback gains, namely from coefficients $k_{C.F}$ i R_{COMP}. So, at $R_A(k_{TCV}+1) + k_{TCV}k_{C.F} = k_{TCV}R_{COMP}$ charac-teristics has infinite rigidity $\beta=\infty$, and at $R_A(k_{TCV}+1)+k_{TCV}k_{C.F}<k_{TCV}R_{COMP}$ – has a positive rigidity $\beta>0$.

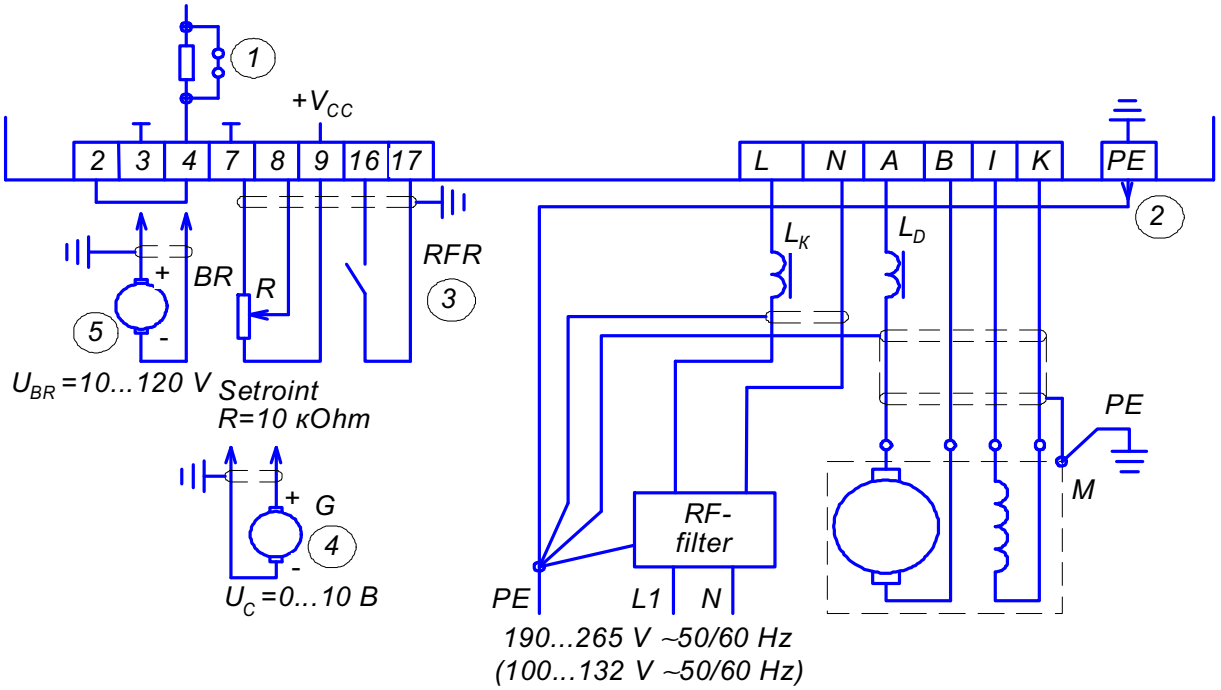


Fig. 2. The circuit diagram of DC drive with Lenze Series 530 voltage converter: 1 – jumper; 2 – fast-on connector; 3 –*RFR* switch for voltage connection in to the motor armature circuit; 4 – external source of control voltage; 5 – tachometer

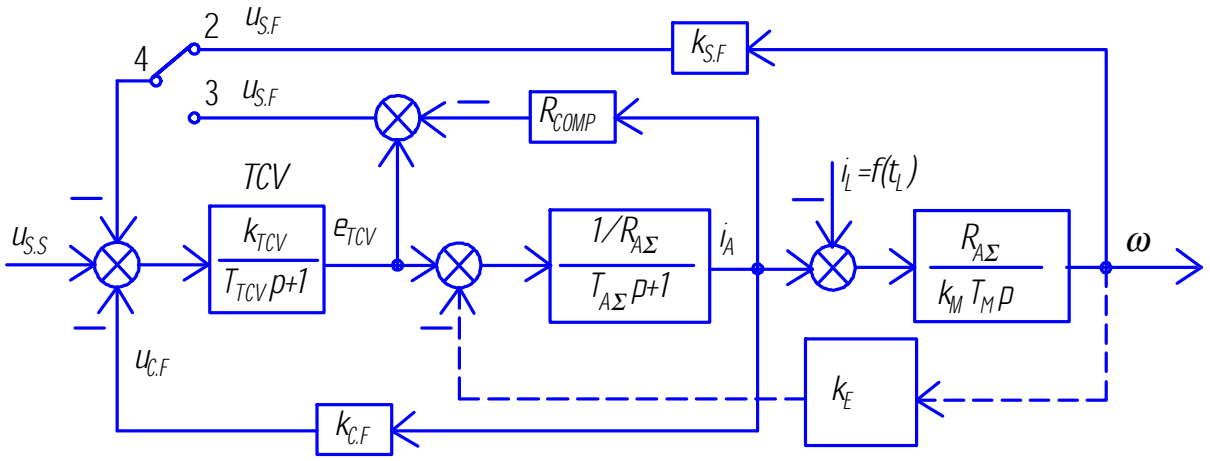


Fig. 3. Dual circuit structural diagram of "TCV-DC motor" system with negative feedback for the current and angular speed (jumper 2-4 is closed) or armature voltage (jumper 3-4 is closed): $u_{S.S}$ – speed signal setpoint; $u_{S.F}$, $u_{V.F}$ – feedback signals by speed and armature voltage; $u_{C.F}$ – current feedback signal; R_{COMP} – compensation resistance; $R_{A\Sigma}$ – total resistance of armature circuit; TCV– thyristor voltage converter; k_{TCV} – TCV gain; ; k_E– electrical constant of DC motor; k_M– mechanical constant of DC motor; $k_{C.F}$, $k_{S.F}$ – current and speed feedback gains, respectively; T_{TCV}, $T_{A\Sigma}$ – electromagnetic time constants of TCV and armature current; T_M – electromechanical time constant; e_{TCV} – EMF of thyristor voltage converter; i_A, i_L – instantaneous value of the circuit armature current and current, that is proportional to the load of the working machine; t_L – instantaneous value of load torque; p – Laplace operator.

Equation of static mechanical characteristic can be obtained after transforming of equations system (3).

$$\omega = \frac{k_{TCV} u_{S.S}}{k_E (1 + k_S)} - \frac{R_A + k_{TCV} k_{C.F}}{k_E k_M (1 + k_S)} t_L, \qquad (8)$$

where: $k_S = \frac{k_{TCV} u_{S.F}}{k_E}$ – gain of the system.

Analysis of equation (8) shows that increasing of negative speed feedback gain $k_{S.F}$, and therefore k_S, ceteris paribus reduces the speed of the idle speed and increase rigidity of mechanical characteristics. When k_S=∞ mechanical characteristics becomes absolutely rigid.

Based on the electrical circuit of TCV, models in MatLab with negative armature voltage feedback (Fig. 4, *a*) and angular speed (Fig. 4, *b*) were created.

Simulations carried out on the example of the electric DC motor with separate excitation MI32 314-02 with parameters:

P_N= 0,78 kW; U_N= 110 V; I_N= 8,2 A; n_H= 2500 rev./m.; U_{EX}=110 V; I_{EX}=0,35 A; η_N= 0,86; J= =0,053 kg·m^2; R_A= 1,8 Ohm; L_A= 0,021 H; G= 38 kg.

Calculated values for the model:

T_{TCV}=0,01 s; $T_A=L_A/R_A$=0,021/1,8≈0,02 s; $R_N=U_N/I_N$=110/8,2=13,4 Ohm; $R_A^*=R_A/R_N$= =1,8/13,4= = 0,134; $\omega_N=\pi n_N/30$=3,14·2500/30=262 rad/s; $T_M = JR_A\omega_N^2 I_N^2 / P_N^2$ =0,053·1,8× ×262^2·8,2^2/780^2 =0,72 s; $I_{S.C}=U_N/R_A$=110/1,8=61 A; $k_E=(U_N-I_NR_N)/\omega_N$= =(110-8,2·1,8)/262= =0,36 V·s/rad; $k_M=k_E$=0,36 V·s/rad; $k_I=I_{SC.C}/I_N$=61/8,2=7,4; k_IT_M= 7,4·0,72= 5,33 s.

Following marking are used at the equations:

T_{TCV}, T_A – electromagnetic time constants of TCV and armature circle; L_A, R_A – inductance and resistance of armature winding; R_A^* – armature resistance in relative units; ω_N – nominal speed of armature rotation; T_M – electromechanical time constant; ω_0 – idling speed; $I_{SC.C}$ – short-circuit current; k_E – electrical constant of DC motor; k_M – mechanical constant of DC; k_I – multiplicity of short-circuit current.

Input parameters of the model are given in relative units. To convert them from relative units to the real it is need to multiply obtained results with the corresponding baseline values U_N, I_N, R_N and ω_0.

In present model (Fig. 4, *a*) block "Transfer Fcn" models link of armature motor with T_A =0.02 s and gain of $1/R_A^*$, and block "Transfer Fcn1" models link of voltage thyristor converter with T_{TCV}= 0,01 s. Block "Integrator" and block "Gain" with coefficient $K=1/k_IT_M$ implement the equation of drive motion. The load current is formed by blocks "Step1", "Gain2" with coefficient K_2= 0,7 and "Integrator1" as the integral from continuous signal.

To achieve high accuracy of speed control was necessary to simultaneously control armature current (torque). For this purpose subordinate control system with certain standard settings is used.

The basis of the first circuit is a PI controller, TCV and armature winding of motor, covered by negative feedback of armature current. Usually the current controller is adjusted at technical optimum. However, according to the theory of automatic control [12] it is required that the transfer function of controller had the form:

$$W_{C.R}(p)=\frac{T_{A\Sigma}p+1}{T_{TCV}p}. \qquad (9)$$

According to (9) the gains of current regulator are next:

- integral gain coefficient:
  $k_{I.C}=1/T_{TCV}$= 1/0,01= 100,
- proportional gain coefficient:
  $k_{P.C}=T_{A\Sigma}/T_{TCV}$= 0,02/0,01= 2.

The external circuit with armature voltage negative feedback is adjusted at technical optimum and contains a proportional regulator too. Coefficients are taken from transfer function of controller [12, 15]:

$$W_{I.R}(p)=\frac{T_M}{2T_{TCV}}. \qquad (10)$$

According to (10) speed regulator gain is:

$$k_{S.R}=0,72/(2\cdot 0,01)=36.$$

By means of T_i potentiometer adjustment, which mounted at the front panel of TCV (presented at Fig. 1), gain of proportional speed regulation can be changed, that allows changing time of transients.

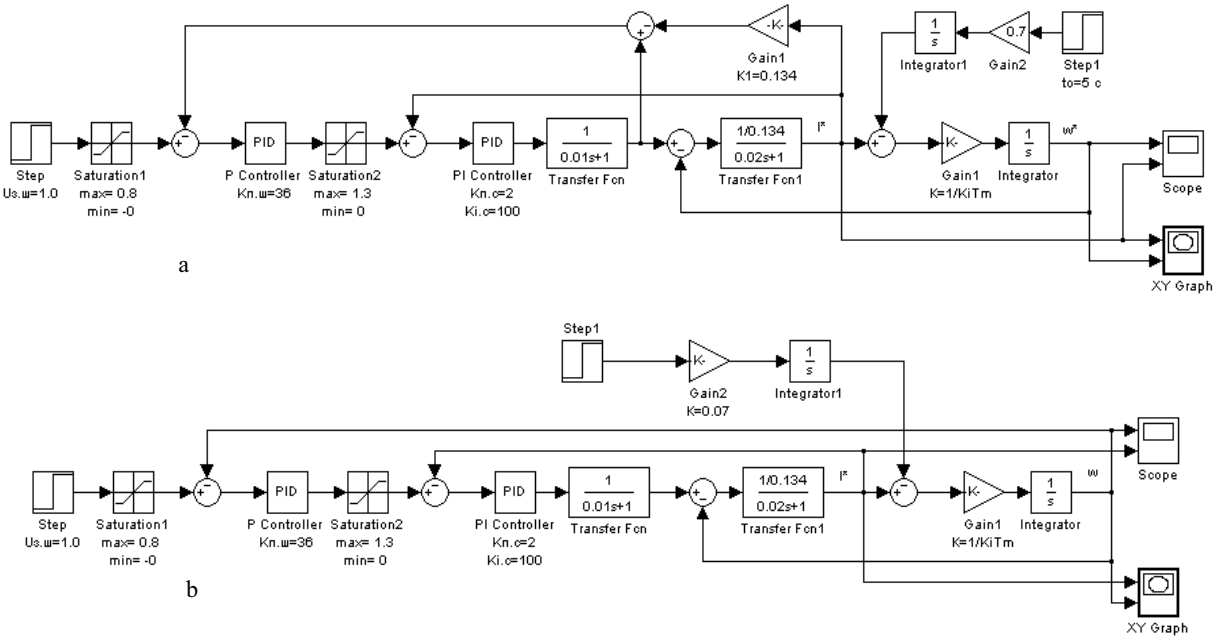


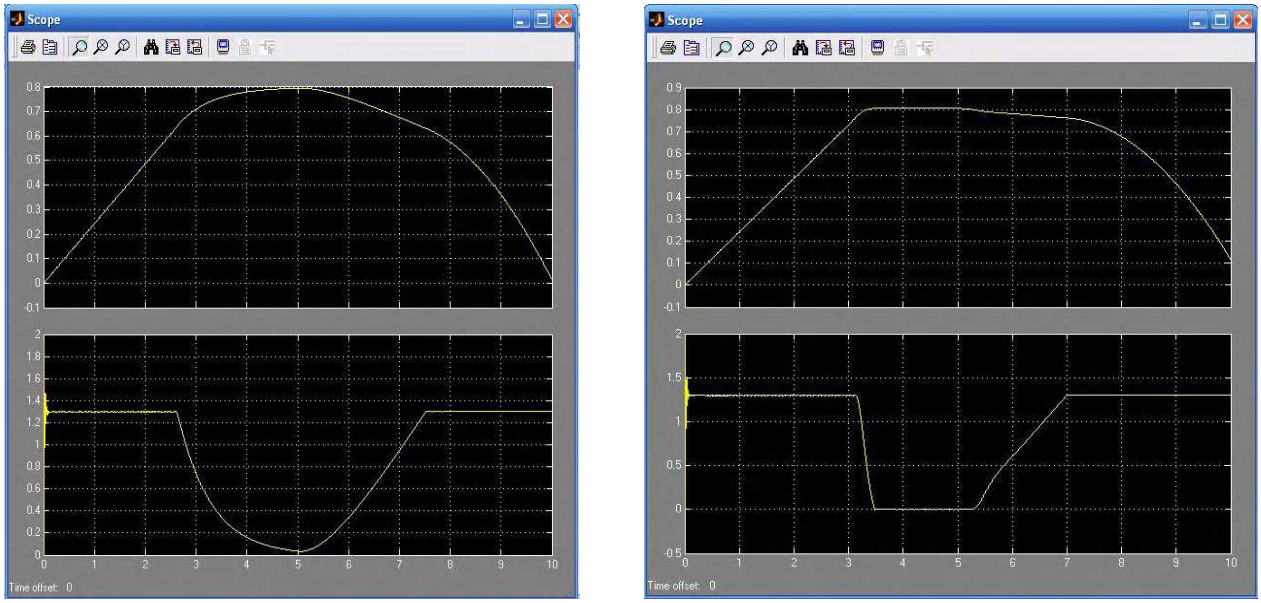
Fig. 4. Numerical model of DC drive with negative armature current and voltage (*a*) and angular speed (*b*) feedbacks

Control of the model is adjusted by “Step” block, which specify the output voltage of TCV. Model has two limiting blocks “Saturation”. “Saturation1” is used for limiting of maximal n_{max} and minimal n_{min} angular speed, “Saturation2” – for limiting of maximal armature current I_{max}.

To visualize the electromechanical (mechanical) characteristics “XYGraph” is used, and at the oscilloscope “Scope” trends of angular speed and armature current are observed.

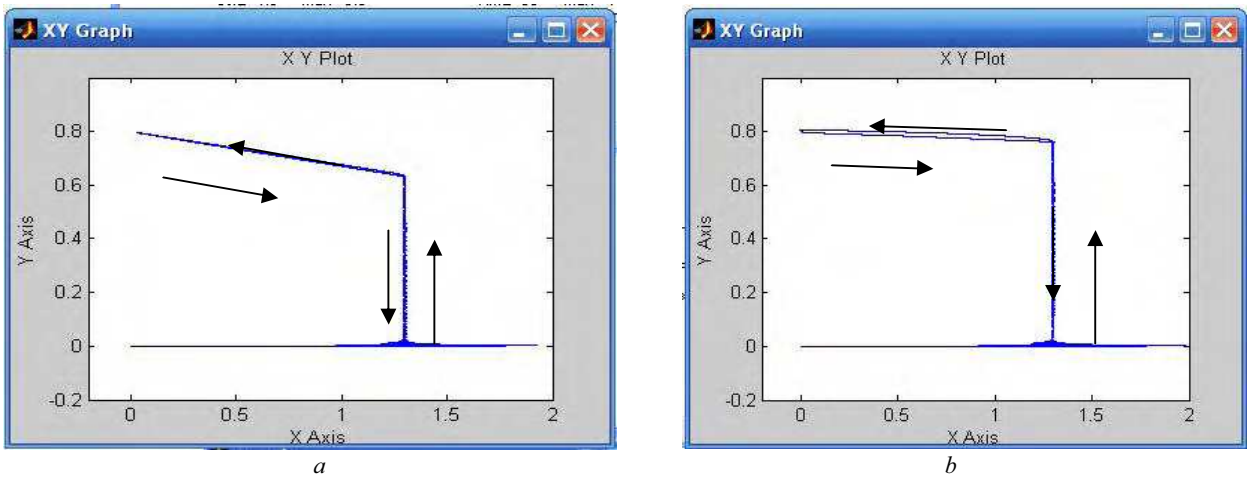
The simulation results of the electric drive work are shown at Fig. 5 and 6.

The process of the motor work modelled as follows. Motor starts with no-load (Fig. 5), and after 5 s, the load starts to increase. According to adjusted value of speed the limits are set: for the speed up to $0{,}8\omega_0$, and for the current up to – $1{,}3I_N$. Numerical model accurately tracks established limits, as shown at Fig. 6. At start when the difference between adjusted and actual speed value is large enough, speed controller switches to "saturation" mode. Herewith current setpoint is constant and we have only armature current control loop. Due to PI-regulator the value of armature current remains constant and angular speed increases linearly (Fig. 6). When P-regulator of angular speed (armature voltage) comes out from «saturation», control system becomes dual-loop with internal current regulation loop and external voltage regulation loop. This increases the rigidity of characteristics, but they become not absolutely rigid because of using of P-regulator. Starting current drops and the system stabilizes the angular speed at adjusted level. When the motor load becomes greater than the critical torque, the motor speed is reduced and the system again switches to stabilize the current.



a *b*

Fig. 5. Angular speed (top) and armature current (bottom) transients. *a* – R_{COMP}= 0,034 p.u.; *b* – R_{COMP}= 0,134 p.u.



a *b*

Fig. 6. Electromechanical characteristic of the drive: *a* – R_{COMP}= 0,034 p.u.; *б* – R_{COMP}= 0,134 p.u.

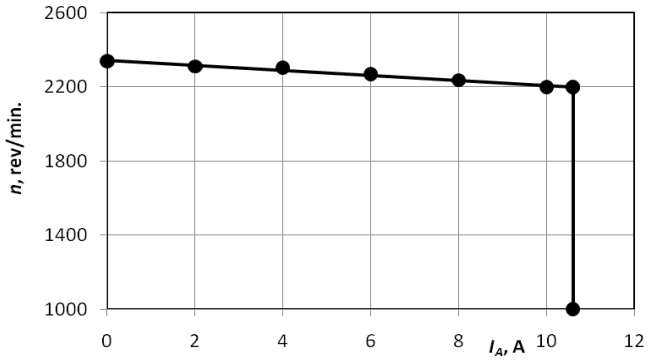


Fig. 7. Electromechanical characteristics, obtained at laboratory equipment (R_{COMP}=0,134 p.u.)

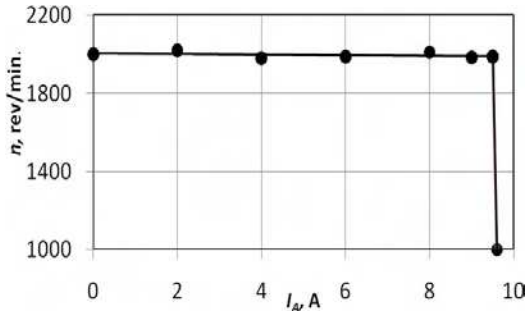
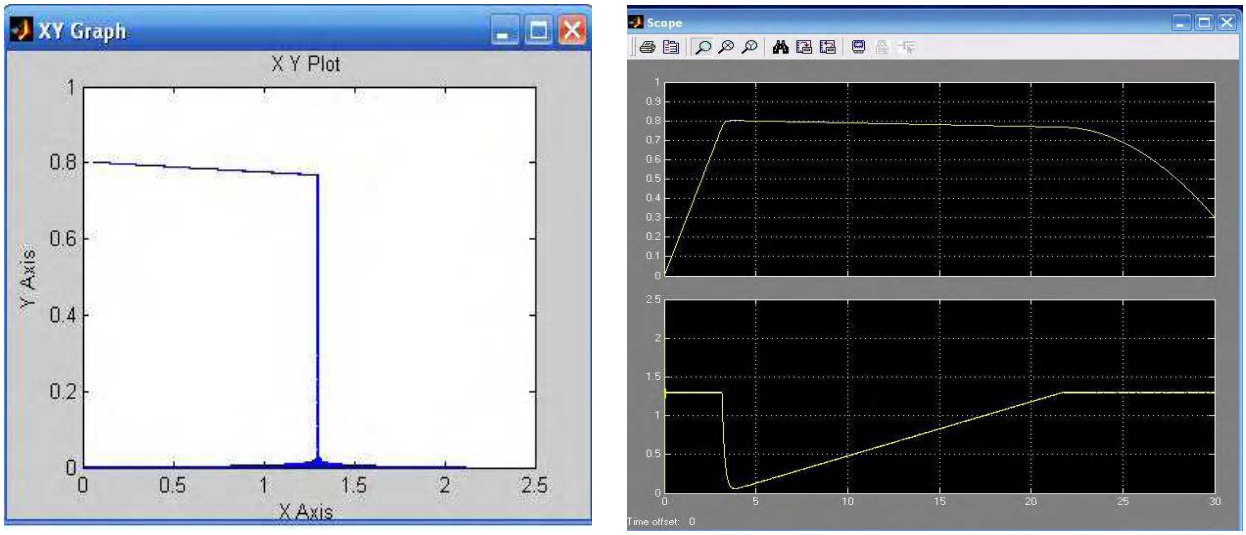


Fig. 8. Electromechanical characteristics, obtained at laboratory equipment



a b

Fig. 9. Results of drive research at the Matlab model:
a – electromechanical characteristic; б – angular speed (top) and armature current (bottom) transients

There is the following explaining of the obtained electromechanical characteristics (Fig. 6). When starting the motor there is a slight wobble of starting current, then it is held at the maximum allowable level, while the motor speed increases. When the current becomes less than the maximum, angular speed increases linearly up to maximum $0{,}8\omega_0$. When the load increases, the reverse process occurs. At Fig. 6, *b* it is good to see the impact of dynamic moment when over clocking motor (upper curve of electromechanical characteristics).

Simulations performed for two values of feedback gain of armature voltage , determined by resistance R_{COMP} (compensation coefficient). As shown in Fig. 6 rigidity of electromechanical characteristics increases with increasing feedback gains, confirming the theoretical calculations previously presented. Coefficient of compensation in electric drive Lenze Series 530 is adjusted by "I×R" potentiometer.

In Fig. 7 shows electromechanical characteristics which obtained at laboratory equipment. Analysis of graphs confirms the adequacy of the results obtained on the model and at the real drive.

At Fig. 6, *b* shows the graphs obtained in the model, which contains the loop with only angular speed feedback. Loop also includes proportional to P-controller with gain $k_{S.R}$ = 36. The current control loop is adjusted at technical optimum, angular speed control loop is adjusted at symmetrical optimum with the selected regulators.

In Fig. 8 shows electromechanical characteristics which obtained at laboratory equipment. Analysis of graphs confirms the adequacy of the results obtained on the model and at the real drive.

The process is similar to the previous simulation. The simulation results of the electric drive are shown at Fig. 9. According to adjusted value of speed the limits are set: for the speed up to $0{,}8\omega_0$, and for the current up to – $1{,}3I_N$. Numerical model accurately tracks established limits, as we can see from electromechanical characteristics (Fig. 9, *a*).

CONCLUSIONS

1. Simple investigation of the characteristics of the industrial DC drives with TCV is possible using numerical models. Easiest programming tool for this purpose is MATLAB, that gives a possibility to build models in structural form. The numerical model in MatLab with TCV Lenze series 530, which provides limits of the maximal and minimal speed, limit of armature current, stabilization of adjusted speed, regulation of transient time gives a possibility to research a characteristic of the "TCV-DC motor" system without using a physical equipment.

2. There are two modes of work of DC drive, which can be easily defined from the models. At the mode of saturation of the speed controller, drive system forms absolutely sort electromechanical characteristic, that gives a possibility to limit a armature current and, consequently, the torque of motor. At the second mode both feedbacks, namely current feedback and voltage (speed) feedback are work properly, so rigidity of electromechanical characteristics becomes bigger. Same way using numerical model it is easy to obtain the transients of speed and armature current.

3. This is especially important when analyzing the speed, because of armature current and voltage can be measured by expensive oscilloscope, while measuring of speed can be done only at the case of mechanically installing the speed sensor on the motor shaft.

4. A comparison of the transients and characteristics, obtained from numerical model and real drive system, confirmed the adequacy of simulated transients with real behaviour of electric drive.

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The analyses of marketing strategies for innovations

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Abstract. Nowadays, innovations are necessary conditions for enterprise sustainable development. Moreover marketing strategy is the crucial element of ensures diffusion of innovation. The purpose of marketing strategy is to conduct market analyze, segment the market, develop marketing approach, right product portfolio and finally marketing plan. This article highlights the comprehensive role of marketing strategies for innovations. The results show, that marketing analyze for marketing strategy enables enterprises to go beyond the solely understanding of customer needs, thus enabling them to develop unexpected innovations. Marketing strategies also help companies to overcome barriers, associated with innovation commercialization. At the same time innovations can be a trigger for new marketing methods and instruments.
Key words: innovations, marketing strategy.

INTRODUCTION

The economic growth of most of the developed countries heavily relies on new technologies and innovations. According to McKinsey Global Survey [1], 84% of executives, say that innovations are extremely or very important to their company's growth strategies. However as the result of vanishing market borders, market internationalization, shorter product life cycles and more sophisticated customer demands, innovation products and services must be commercialized in much shorter time frames, than before. [2] The only possible solution to this dilemma is to develop effective marketing strategy, which is able at the shorter time frame to bring innovation to the market.

The role of marketing for the development and successful implementation of innovation products and services is high. According to Aron and Liem [3] entrepreneurial orientation, market orientation, marketing capability and innovation capability are the prerequisites for higher competitive advantage and higher marketplace performance. Firms apply innovation capabilities to create innovations and market capabilities to be able to sell innovations effectively. In fact the alignment of both capabilities enables firm to develop high competitive marketing strategy for innovations and thus is giving firm a higher competitive advantages. The key characteristics of marketing strategy for innovations are: becoming market orientated, determining distinctive capabilities, matching customer's value requirements to capabilities and achieving superior performance. [4] Marketing strategies play dubious role for innovations. Firstly marketing analyze enables companies to look closer for the market demand and thus identify the customer desirable products and services. At the same time such factor as demand together with openness, public research, and entrepreneurship, access to finance, competition and skills is one of the main sources for innovations.[5] The analysis of demand can bring interesting insights about consumer preferences, market features and market trends. This information can be taken in consideration while developing the innovations. Here we can state, that during the process of doing marketing analysis for marketing strategies unexpected innovations can appear. Secondly, well developed marketing strategies enable companies to overcome market barriers associated with innovations. Innovations are characterized as unexpected random events which

are not always immediately accepted by customers, even if they show higher superior performance. For some innovations, as radio or automobile it took decades to be mass customized. The problem of such constraints is the wrong marketing approach to innovation commercialization. The right approach to the development of marketing strategy can considerably facilitate the process of innovation penetration to market and it wide acceptance by customers. Thirdly innovation products and services also can give a rise to innovative marketing approaches. According to Eurostat [6], in Germany around 50% of all innovative companies apply also innovation marketing methods. In this case innovations can influence the development of marketing strategies.

This article is designed as follow. Firstly we will analyze the influence of marketing analysis regarding the development of innovations. We will highlight the main theoretical models, which underlie marketing research techniques, which can predict or contribute to innovation development. Then we will look closer to the main barriers, which constraint innovation commercialization. In this part we will also highlight the characteristics of marketing strategies, which can overcome these barriers. Finally we will stress the impact of innovations for innovative marketing methods. In conclusion we will summarize our results and put all main findings together.

MARKET ORIENTATION, AS A PREREQUISITE FOR INNOVATION CREATION

According to Piercy and Cravens [4], market orientation is one of the main elements of marketing strategy. Market orientation is comprehensive function of marketing department, which also has a positive impact on firm's performance.[7] Market orientation consists of three main elements: consumer, competitor and interfunctional orientation.[8] All three elements are important for collecting market relevant information and thus are the prerequisites for innovation creation. In particular, Gatignon and Xuereb [9] states, that competitor orientation is important, when firm wish to develop innovation with lower costs and thus to create superior competitive advantages. On the other hand consumer orientation is useful when market demand is relatively uncertain. But how can marketing analysis develop innovations? It can be done through marketing analysis instruments, which include: days on shop floor, bespoke client interaction, market sensing and customer feedback (NESTA).[10] They give firm a certain kind of marketing intelligence [11], which includes not only the research of customers needs, but also the identification of factors, which underlie their needs: governmental regulations, social changes, technological advances, socio-cultural relationships. Thus going beyond the only understanding of customer needs enables organization to contribute to innovations.[12] Figure 1. presents in details the market orientation – innovation – performance relationship.

Especially marketing analysis is powerful source of innovations in so known *proliferation* phase.[13] "Proliferation phase is the time when projects are put to the test on the market and undergo changes, with customers adding on elements that research never had in mind."[13] During this phase innovations can blossom in many different directions.

The evidence of the high importance of market driven factors for innovation creation is also strongly supported by data of Europeans enterprises. In Sweden, the share of all innovative companies making the high use of sources for innovation from information received from customers during 1998-2000 was 48,34%, in Germany and France this number was 34,58% and 34,18% respectively.[13] Such standpoint, that marketing is the element of innovation development can bring some controversies to the traditional view, that innovations are solely responsibility of research and development department. Neither R&D and of course not the marketing department can separately achieve high innovation results. To achieve full innovation capabilities it is important to have the cooperation between two departments. [14]

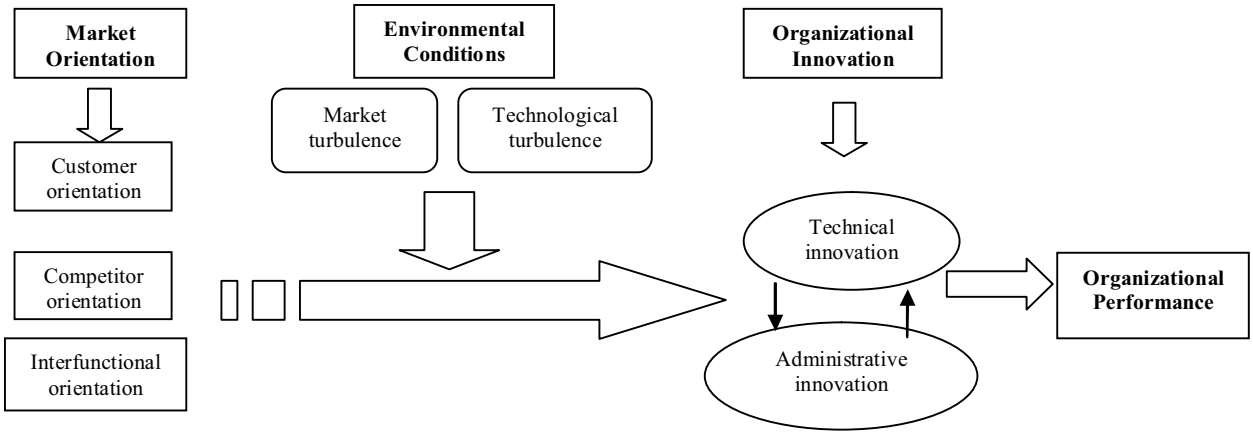

Fig. 1. Market orientation – innovation – performance relationship [12]

INNOVATION COMMERCIALIZATION. BARRIERS AND SOLUTION

The process of innovation commercialization is characterized as long and resource consuming processes with the high risk of final customer rejection. The adoption of innovation or innovation diffusion may last for several years or even decades, before it can be finally accepted by customers. For flash memory, the pre-diffusion period lasted for 13 years – from its invention in 1988, till it achieved its mass customization in 2001. For the industry of mobile telephony it took 37 years (from 1946 to 1983). The time of innovation adoption depends directly on the extent of customer resistance to purchase innovation.[15] Customer resistance in turn is directly caused by barriers, which innovations create. Ram et al.[15] identifies between two main groups of innovation barriers: functional and psychological. The list of all functional and psychological barriers is presented in Table 1.

Until customer is not fully aware of all advantageous and disadvantageous of certain innovation he will be not ready to purchase it. The development of successful marketing strategy for innovation products and services requires identification and overcoming of all aforementioned barriers. However the important aspect is also to identify the time of innovation adoption by customers. Innovations have a propensity to appear unexpectedly, randomly and not always at right time. Several examples at the beginning of this chapter signalized, that some innovations were introduced too earlier and customer were not ready to purchase them or they didn't understand their full potential. For most of the radical innovations, such as steam engine, radio, computers, genetic food it took decades, before their full benefits became evident. For marketing it is extremely important to identify the time of innovation diffusion to develop relevant marketing strategies. Marketing is "perfectly applicable when there are products to manage and markets to analyze, but soon reveals its limitations when product definition is still rather hazy and the market too young".[13, 3] So far it was impossible to accurately foresee the innovation behavior on the market, mainly because of the lack of data, however partly it is possible to solve by using the diffusion models. "The objective of diffusion model is to represent the level of spread of innovation among a given set of prospective adopters in terms of a simple mathematical function of time that has elapsed since the introduction of innovation".[17] Diffusion theory focuses on the spread of new ideas, technologies and practices within social system or in other words how fast innovation can be diffused in specific environment. The most acknowledged diffusion models where developed by: Bass [18], L.A. Fourt and J.W. Woodlock [19, 363] , Mansfield [20]. Diffusion models are the fundament of modern marketing analysis and can significantly influence the success of marketing strategy for innovations.

Innovation barriers however vary between different social and cultural groups. For the development of marketing strategies for innovations it also important to identify which customers will be willing to purchase innovation earlier than other and which later. This right identification of such customer groups is the precondition for the efficient marketing segmentation for innovations. Bohlen and Beal [21] identifies between next groups of customers: early adopters, early majority, majority and laggards (or non-adopters). Customers from the group of early majority are ready to undertake risks and purchase innovation relatively earlier than other groups. In contrast non adopters have the strongest resistance for innovations. The result of Bohlen and Beal research was the innovation adoption life cycle, which has a form of parabolic curve, where all aforementioned groups of customers are situated from the left to the right, starting from early adopters and ending with non-adopters. The innovation adoption life cycle enables to see which group of customers starts to adopt innovation at the moment. For example such innovation technologies such as iPhone or Vimeo, are only adopted by early majority nowadays. From the innovation adoption life cycle it is visible, that company can achieve the highest sales, when innovation is adopted by late majority. Important point of this model is stage called "Chasm" – a stage between early adopters and early majority. The success of marketing strategy depends on the ability of innovation to overcome the "Chasm" stage.

The aforementioned factors suggest that innovations require specific approach of strategic marketing. Marketing should develop special strategies, which are aimed to overcome existing innovation barriers, predict time of innovation penetration, do market segmentation and finally to commercialize innovation efficiently. The effective framework of marketing strategies for innovations was presented by Ram and Sheth [15]. The whole framework is presented in Table 2.

The examples of aforementioned marketing strategies are visible in everyday life. Most of firms in IT industry always use free trial marketing strategies to push their technological innovations, by offering customers a certain new products for free. Thus they are able to overcome the risk barrier, associated with the unknown features of new products or services. The success of several disruptive innovations, developed by Apple, such as iPhone or iPod is due to the well known brand name of the company, which is associated by customers with a high degree of reliability. Well developed marketing strategies play an important role for innovation commercialization. According to McKinsey global survey [1] on innovation and commercialization, 50% of companies, said that they have a lot of good ideas, but only few of them are commercialized successfully. Marketing strategies for innovations should foresee all risk and challenges, which innovation bear, in order to successfully introduce innovation on markets.

Table 1. Classification of environmental forces, functional and psychological barriers of innovation adoption*

Type of Barrier	Explanation	Example
Environmental forces barriers:		
Political barrier	Emerges as the result of government regulations, international agreements, political situation	Decision of Ukrainian government about the direction of political development in 2013 (EU versus custom union)
Economic barrier	Macroeconomic factors (inflation, unemployment, exchange rate, business activity), specific factors of country innovativeness	General decrease of world business activity in 2008-2009
Behavioral barrier	Administrative and managerial styles, personal attitude to changes	Company inclination to pay dividends or to invest into commercialization of innovations
Social barrier	Cultural features, social inequality	Inclination of some/specific social groups to accept innovations
Technological barrier	Technological ability to provide mass production of inventions	Most of scientific results Ukrainian scientist technically cannot be implemented by Ukrainian companies
Functional barriers:		
Usage barrier	Appears because of the incompatibility of innovation with the already existing customer's workflows, practices or habits.	Steam engine, automotive industry, airspace technologies, web shopping
Value barrier	Associated with the lower value of innovation in comparison to other existing products or services	Automatic teller machine (ATM), first PC, almost all "green technologies"
Risk barrier	Associated with a certain financial, physical or psychological risk of innovation	First innovations in automotive industries, video cameras, genetic food
Psychological barriers:		
Traditional barrier	Associated with the cultural change, which can be created by innovation	Social networks, certain popular food and drinks
Image barrier	Associated with unwillingness to adopt innovation, because of the negative image, which is linked to it	Medicines or machine equipment from not developed countries
Loyalty barrier	Associated with customer unacceptance of product changes	Customer habit to use things for certain purposes

* developed by [15,16]

Table 2. Classification of marketing strategies for innovations*

Marketing Strategy / Source of Barrier	Product strategy	Communication Strategy	Pricing Strategy	Market Strategy	Coping Strategy
Environmental forces barriers		Company transparency about its manufacturing facilities			Respect country ecological norms
Usage Barrier	Develop a system perspective (packaging). Integrate innovation with preceding activity			Mandate usage	
Value Barrier	Improve product performance and positioning		Reduce price by lowering costs		
Risk Barrier	Use a well known brand name	Elicit endorsements and testimonials		Increase market exposure. Facilitate trial	
Tradition Barrier		Educate customers. Use change agents			Understand and respect traditions
Image Barrier	Borrow a good brand (image)	Create a positive image of innovation			

* developed by Ram & Sheth [15]

NEW WAYS OF MARKETING. MARKETING INNOVATIONS

While introducing new products and services, companies usually face with a need to develop innovative marketing methods. The challenges of nowadays marketing, such as: globalization, oversaturated markets, interchangeable and diverse services force business to make a choice, either to put more efforts and use already existing marketing instruments, which will result in lower output or to use innovation marketing strategies.[2] In most of the cases innovative enterprises try to connect innovative marketing strategies together with their innovative products and services. According to Eurostat [6] 51,4% of innovative enterprises in Germany introduced significant (new) changes to aesthetic design or packaging, 53,5 introduced new media or techniques for product promotion, 53,0% introduced new methods for product placements; 38,9 introduced new methods for pricing goods and services. It can be also seen in the changes of marketing budgets. According to research done by Belz [2] the biggest fraction of marketing budget is spend on personal sales, market and customer information systems (databases), customer relationship management, internet and media, marketing research and marketing projects. Here we can make the conclusion that innovative technologies, such as internet and media communications also shape the nowadays marketing.

The results of analyzing 1000 innovation companies [25,26] showed that all innovations strategies can be divided into three types:

1) need seekers are concentrated on involvement of customers to product development;

2) market readers implement incremental changes into the product;

3) technology drivers are concentrated on implementation of quantum changes into the products.

Arnold [23] distinguishes between next important shifts in marketing nowadays. Firstly it is the overall increase of digital marketing strategies, which include the application of the wide range of innovative devices. Digital marketing begins from E-communication marketing strategies and ends with the usage of digital strategies orientated on customer online buying services, such as mobile marketing or smart finance. Digital marketing is also associated with the hardware and software appliances, which support marketing database, such as cloud marketing, which became increasingly popular nowadays. Cloud marketing technology is also a good example of innovative marketing method which originated from innovation technology. In our case cloud marketing was born by cloud computing technologies. Secondly it is the increase of personal marketing in contrast to mass marketing. This approach includes also the so known evangelism and referee marketing strategies. Final membership diversity which stress the importance of firms to pursue the intercultural approach of leading business. In the light of fast globalization, borders between countries have literally been vanished and most of the developed countries nowadays inhabit representatives from different cultural groups. That's why modern marketing should also be concerned with the grasping of wide range of customers, without discriminating any of them.

In the light of the recent environmental problems a lot of companies and organizations proclaimed their intentions to move towards the sustainability. This resulted into the number of green innovative technologies as well as new ecological products and services. In this perspective Leonidou, Katsikeas, and Morgan [24] emphasize on the increasing role of green marketing nowadays. Authors show the positive impact of green products and services on firm's performance and its return of assets. In this perspective organizations started to develop innovative marketing approaches to promote their sustainability actions among customers. New green marketing approaches resulted into innovative ways of marketing, such as elaborating of firm's sustainability reports, distribution of products and services through more eco-orientated distributors, adjusting firm's value chain to the one which is more sustainable orientated.

As the result of marketing strategies for innovations and innovation strategy the requirements for market tools were elaborated:

1) coverage of large numbers of consumers;

2) speedy and timely dissemination of information about innovation;

3) provision of feedback;

4) easiness of understanding advantages of innovations for the customers.

Proposed requirement permit to overcome the barriers presented above.

CONCLUSIONS

In the light of tremendous social and economic changes innovations play the important role for acquiring stability and higher competitive advantages for companies nowadays. Innovations are the main elements of firm's portfolio and very often determine long term strategies for companies. On the other hand innovations are associated with high consumer barriers and long time of market penetration. The successful commercialization of innovations depends on formalized decision processes and effective marketing strategies. In this article we analyzed the important role of strategic marketing towards the development and commercialization of innovations. Marketing strategies enables companies to gain a certain kind of market intelligence, and thus look behind the primary customer needs and finally develop innovations. Marketing strategies also enables companies foresee the time of innovation adoption by mass market and to identify customer groups which are willing to buy innovation first. And finally marketing strategies enable

companies to overcome customers barriers, associated with innovations.

Another importing finding of this article is the reverse influence of innovations on marketing strategies. The latest marketing trends and advancing of information technologies gave rise to non-traditional marketing methods and strategies, such as green or internet marketing.

The developed requirements for market tools assist a better understanding marketing strategy development process for innovation. It may be viewed as theoretical basis for facilitation of innovation commercialization. In addition the results of our research can serve as practical guidelines for the developers of innovation market strategies.

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Decreasing of error probability in telecommunication access networks by using amplitude modulation of many components

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Abstract. The paper addresses the research of data transmission technologies in telecommunication access networks. These networks are characterized by limited bandwidth and are suitable for high speed data transmission. Particular attention is paid on the data transmission technologies in telecommunication access networks based on symmetrical telecommunication lines. Paper proposes the method of adaptive data transmission in telecommunication access networks using amplitude modulation of many components. The results of mathematical modeling are presented, which allows estimating the bit error rate decrease in telecommunication access networks using this method.
Key words: telecommunication access network, data transmission, bit error rate, quadrature amplitude modulation, amplitude modulation of many components.

INTRODUCTION

An important characteristic of quality of telecommunication access networks for data transmission is the error probability. Error probability decrease allows improving the quality of telecommunication access networks, in particular to increase the adequacy of received data. Among the factors that have influence on the appearance of errors in telecommunication channels or networks, an important place is occupied by the selected signal modulation methods and correcting coding methods.

Telecommunication access networks based on symmetrical telecommunication lines are rapidly developing among modern telecommunication networks designed for high speed data transmission. In such networks that are characterized by limited bandwidth, in order to achieve maximum data transmission rate, types of multiposition phase and amplitude-phase modulation are used mainly.

In telecommunication access networks based on symmetrical telecommunication lines with limited bandwidth, group of xDSL technologies (Digital Subscribe Line) is used mostly for data transmission. The most high speed type of xDSL is VDSL2 technology (Very High Speed Digital Subscriber Line 2) [1]. It is designed to transmit audio and video messages, data, broadcast high definition television and provide interactive software games.

According to the recommendation G.993.2 of the International Telecommunication Union (ITU), it is possible to transmit data in asymmetrical and symmetrical telecommunication lines with a total rate of downstream and upstream up to 200 Mbps using channel with a bandwidth up to 30 MHz by using VDSL2 technology. When length of telecommunication line is 0.5 km, data transmission rate is reduced to 100 Mbps and when its 1 km – up to 50 Mbps. Thus, VDSL2 reaches higher rate compared with previously developed VDSL technology (Very-high Speed Digital Subscriber Line) [2]. When length of telecommunication line is more than 1.8 km, the data transmission rate using VDSL2 technology is approximately equal to the rate using the most modern version of asymmetric data transmission technology ADSL2+ (Asymmetric Digital Subscriber Line 2) [3].

The data is divided into parts, each of which is transmitted by means of single subchannel using xDSL technology. The number of transmitted information by subchannel depends on the noise level in bandwidth of subchannel and the selected modulation. Binary phase shift keying (BPSK), quadrature phase shift keying (QPSK) and M-ary quadrature amplitude modulation (8-QAM, 16-QAM, 32-QAM, 128-QAM) [1-5] are used mainly.

The feature of multiposition phase and amplitude-phase modulation types is an increasing of the error probability in telecommunication line or network at increasing of number M of symbols that can be transmitted during one informative cycle. However, modulation types with the same number M of transmitted symbols and the same E_b / N_0 (ratio of the energy of one bit of information to the power spectral density of white noise) can be characterized by different error probability. So actual task is to develop new or improve known modulation types, which at certain E_b / N_0 will provide data transmission with a given rate with the lowest possible error probability. A lot of papers are devoted to this issue [6-17], but it requires further researches.

The aim of this work is to decrease the error probability in the telecommunication access network that are characterized by limited bandwidth by using the proposed amplitude modulation of many components (AMMC).

THE RESEARCH OF TELECOMMUNICATION ACCESS NETWORKS CAPACITY WITH LIMITED BANDWIDTH CONSIDERING NOISE

The basics of the telecommunication network are telecommunication channels, so data transmission rate over a network will greatly depends on these channels capacity. In general, the channel capacity C_c (bps) is determined by the well-known K. Shannon formula:

$$C_c = F_c \log_2 (1 + P_{s_{av}} / P_{n_{av}}), \quad (1)$$

where: F_c – channel bandwidth, Hz; $P_{s_{av}} / P_{n_{av}}$ – ratio of average signal power to average noise power in channel, dimensionless value.

The following equation is used to research the selected telecommunication channel capacity C_c (bps) [18]:

$$C_c = \int_{f_l}^{f_h} \log_2 \left(1 + \left| \dot{S}_s(f) / \left[\dot{S}_n(f) \cdot 10^{\left[|\alpha(f)| / 10 \right]} \right] \right| \right) df, \quad (2)$$

where: f_l, f_h – the lowest and highest frequencies of channel bandwidth, Hz; $\dot{S}_s(f)$ – power spectral density of signal at the channel input, W/Hz; $\dot{S}_n(f)$ – power spectral density of white noise at the channel output, W/Hz; $|\alpha(f)|$ – modulus of loss in channel, dB; f – current frequency, Hz.

Modulus of loss $|\alpha(f)|$ in the researches channel mainly depends on the modulus of loss $|\alpha_l(f)|$ of the symmetrical or coaxial telecommunication line, which can be calculated using the following equation:

$$|\alpha_l(f)| = 10 \lg \left(1 / \left[a (1 + b \cdot f)^c \right]^{1 / l_{max}} \right), \quad (3)$$

where: l – length of the telecommunication line; l_{max} – maximal length of telecommunication line for which coefficients a, b and c are determined.

This formula allows decreasing of the computer simulation time in comparison with the use of complex mathematical models of telecommunication line. Such formula is suitable for use under condition $l \le l_{max}$.

To calculate the capacity of telecommunication access network based on xDSL technologies with n subchannels, the following formula is proposed:

$$C_{TAN} = \sum_{i=1}^{n} F_i \log_2 \left[1 + \frac{P_{s_i}}{P_{n_i}} 10^{-|\alpha_{av_i}| / 10} \right], \quad (4)$$

where: n – the number of subchannels; F_i – bandwidth of i-th subchannel, Hz; P_{s_i} – transmitter signal power of i-th subchannel at the telecommunication line input, W; P_{n_i} – noise power in bandwidth of the i-th subchannel at the telecommunication line output, W; $|\alpha_{av_i}|$ – modulus of average loss in telecommunication line in bandwidth of the i-th subchannel, dB.

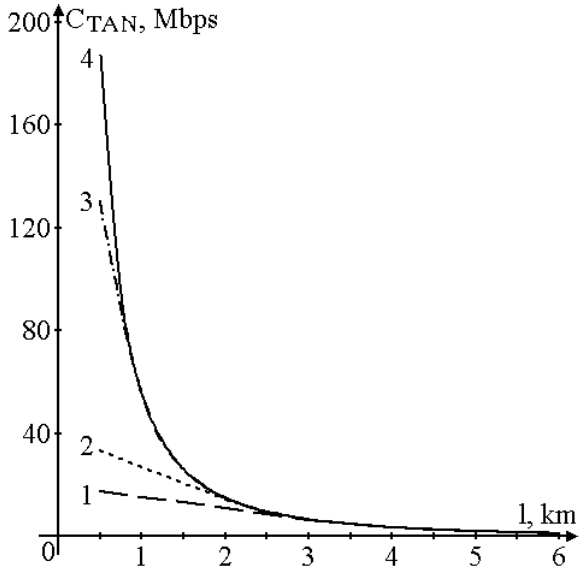


Fig. 1. Dependence of telecommunication access network capacity C_{TAN} from the symmetrical line length l in bandwidth: 1 – 1,104 MHz; 2 – 2,208 MHz; 3 – 12 MHz; 4 – 30 MHz

Table 1. Modern types of xDSL technologies

Technology	Bandwidth, MHz	Numberof subcannals	Maximum total rate in both directions, Mbps / length of the telecommunication line, km
ADSL	1.104	256	8.875
ADSL2	1.104	256	15.5
ADSL2+	2.208	512	25.216 / 1
ADSL2+M	2.208	512	27.5 / 1
VDSL	12	2783	64
VDSL2 (12b)	12	2783	68
VDSL2 (17a)	17.664	4096	100 / 0.5; 50 / 1
VDSL2 (30a)	30	3479	200

Mathematical models [18] and Eqs. (1)-(4) was used for development of an improved model of telecommunication access network based on symmetrical and coaxial lines. The influence of the symmetrical line length on capacity of telecommunication access network based on symmetrical lines using the group of xDSL technologies was researched by means of such an improved model. Mathematical modeling is performed at the constant power spectral density of signal $S_s(f) = 1 \cdot 10^{-8}$ W/Hz and the constant power spectral density of white noise $S_n = 2,25 \cdot 10^{-14}$ W/Hz. Research is performed in bandwidths 1.104 MHz (for ADSL and ADSL2), 2,208 MHz (for ADSL2+ and ADSL2+M), 12 MHz (for VDSL) and 30 MHz (for VDSL2). Specifications for modern types of xDSL technologies are given in Table 1. The calculation results are shown on Fig. 1.

It is evidently from Table 1 and Fig. 1, that VDSL2 technology is the most perspective for use in telecommunication access networks.

THE RESEARCH OF THE BIT ERROR RATE IN THE TELECOMMUNICATION ACCESS NETWORKS

Output power of telecommunication transmission equipment is regulated by international organizations (in particular International Telecommunication Union). Noise level in the telecommunication channel can be decreased to a certain value by using shielded cable lines. Therefore, modern telecommunication access networks operate under certain ratio P_s / P_n that is very difficult to increase. This influences on the achieved bit error rate in telecommunication access networks for data transmission.

It is advisable to apply new modulation methods and correcting coding methods in order to decrease the error probability. These methods provide data transmission with a certain rate and less bit error rate in telecommunication access network at the certain ratio P_s / P_n (or ratio E_b / N_0).

In modern telecommunication access networks the amplitude-phase modulation types are actively used for high rate data transmission, including QAM. Traditionally, QAM signal is represented as a sum of two orthogonal components – in-phase and quadrature [19]:

$$u_{QAM}(t) = U_0 a_I u_{mI}(t) \cos(\omega_0 t + \varphi_0) + \\ + U_0 a_Q u_{mQ}(t) \cos\left(\omega_0 t + \varphi_0 - \frac{\pi}{2}\right), \quad (5)$$

where: U_0, ω_0, φ_0 – amplitude, angular frequency and initial phase of the carrier oscillation; a_I, a_Q – proportional coefficients for in-phase I and quadrature Q channels; $u_{mI}(t)$ – modulating signals on in-phase I and quadrature Q inputs of modulator.

Euclidean distance between adjacent signal points in the signal constellation for M-QAM (Eq. (5)) in case of amplitude modulation of each component by the modulating signals with maximal possible amplitude $U_{s_{max}}$ (V) and number M_U of equally distant levels of amplitude is calculated using the following equation:

$$d = \sqrt{2} U_{s_{max}} / (M_U - 1). \quad (6)$$

By the implementation of such M-positional modulation $\log_2(M)$ bit of information is transmitted during the continuance of one informative symbol.

To increase data transmission rate or to decrease bit error rate in telecommunication access networks, which use QAM, new modulation group based on amplitude modulation of many components (AMMC) is proposed to use. Modulated AMMC signal is formed as a sum of N harmonic components that differ in initial phases φ_n. It is [20]:

$$u_{AMMC}(t) = \sum_{n=1}^{N} U_0 a_n u_{m_n}(t) \cos(\omega_0 t + \varphi_0 + \varphi_n), \quad (7)$$

where: a_n – proportional coefficients for the n-th channels of modulator; $u_{m_n}(t)$ – modulating signals at the n-th inputs of modulator.

We obtained equation to calculate the Euclidean distance d (B) between adjacent signal points in the signal constellation for AMMC with $N = 3$, the initial phases of components $\varphi_1 = 0$ radian, $\varphi_2 = \pi / 3$ radian, $\varphi_3 = 2\pi / 3$ radian and the maximal possible amplitude of the modulated signal $U_{s_{max}}$ (V) in case of amplitude modulation of each component by modulating signals with number M_U of equally distant levels of amplitude:

$$d = U_{s_{max}} / (M_U - 1). \quad (8)$$

The number of unduplicated AMMC signals that can be unambiguously demodulated (hence the effective number of symbols) is:

$$M_{eff} = 3M_U (M_U - 1). \quad (9)$$

The total number of symbols that can be obtained using all possible combinations of modulating informative signals at arbitrary initial phases of components is calculated using the following equation:

$$M_{all} = (M_U)^N. \quad (10)$$

During one informative symbol $\log_2 M_{eff}$ bit of information can be transmitted.

With the modulator and demodulator AMMC it is possible to form and process AMMC signals (Eqs. (7)-(10)) with a various signal constellations. A signal constellation of AMMC signal with N components is inserted in polygon with $2N$ angles. From a practical point of view constellation of AMMC signals with three and six components are interesting. In particular, the signal constellation of AMMC signals with $N = 3$,

$M_U = 3$ equally distant levels of amplitude of modulating signals with displacement of amplitude levels using 16 points (16-AMMC with displacement of amplitude levels of the modulating signals) and $M_U = 4$ equally distant levels of amplitude of modulating signals with displacement of amplitude levels using 32 points (32-AMMC with displacement of amplitude levels of the modulating signals) are shown on Fig. 2, d and Fig. 2, e. Also, the signal constellation of AMMC signal with $N = 3$, $M_U = 4$ and 36 points (36-AMMC) is shown on Fig. 2, f. For comparison, there are shown the signal constellation of widely used modulation types 16-QAM (Fig. 2, a), 32-QAM (Fig. 2, b) and 36-QAM (Fig. 2, c).

Let us compare the properties of 36-QAM modulation (Fig. 2б c) and 36-AMMC modulation (Fig. 2, f) with the same number 36 of signal points. Using both types of modulation it is possible to transmit the same number of information during one informative symbol.

The Euclidean distance between adjacent signal points in the signal constellation of 36-QAM signal with the maximal possible amplitude $U_{s_{max}} = 1$ V and $M_U = 6$ equally distant levels of amplitude of modulating signals according to Eq. (6) is $d = 0.28$ V. By the implementation of 36-AMMC at $U_{s_{max}} = 1$ V and $M_U = 4$ the Euclidean distance according to Eq. (8) is $d = 0.33$ V. Thus, provide the same robustness during data transmission period using 36-AMMC it is needed 1,43 dB less ratio P_s / P_n in the telecommunication channel compared to using 36-QAM.

For implementation of AMMC it is necessary to use offered AMMC modulator and demodulator [20]. Their feature is in a possibility to perform modulation and demodulation BPSK, QPSK, M-PSK, M-QAM and modulation group based on AMMC. Thus, for implementation of BPSK by AMMC modulator it enough to use only one multiplier, and for QPSK, 8-PSK, M-QAM – two multipliers and one phase return device on $\pi/2$. For demodulation of BPSK by AMMC demodulator it is enough to use only one multiplier and one low-pass filter, and for QPSK, 8-PSK, M-QAM – two multipliers, two low-pass filters and one phase return device on $\pi/2$.

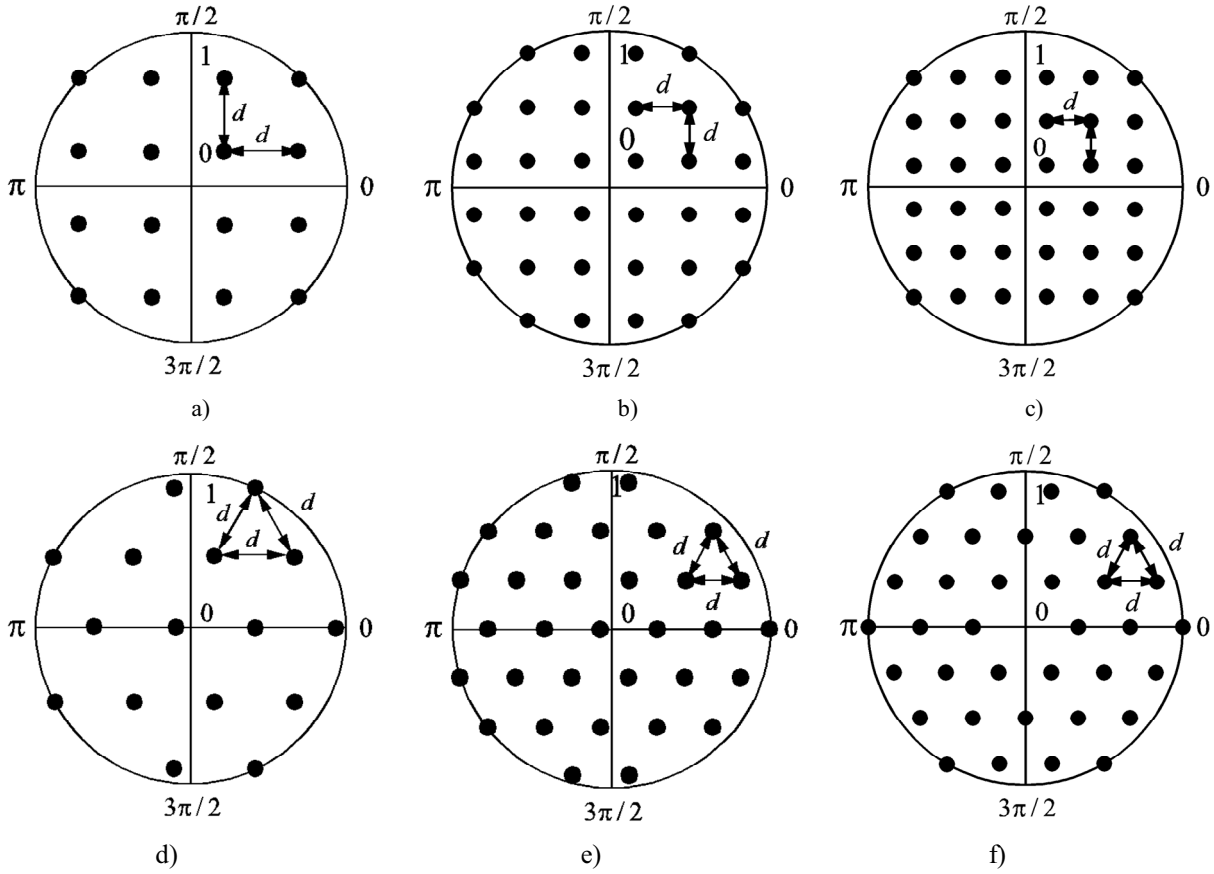
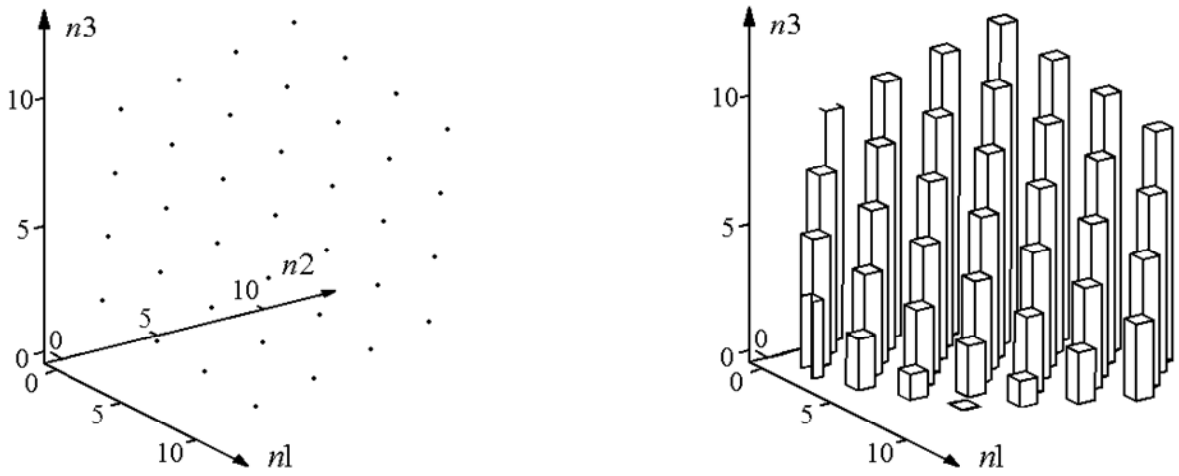


Fig. 2. Signal constellations: a) 16-QAM; b) 32-QAM; c) 36-QAM; d) 16-AMMC with displacement of amplitude levels; e) 32-AMMC with displacement of amplitude levels; f) 36-AMMC



a) b)

Fig. 3. Demodulation space for 37-AMMC

Table 2. Bit error rate in telecommunication access network using different types of signal modulation

$E_{b_{av}} / N_0$, dB	12.95	14.68	15.93	16.91	17.72
Modulation	Bit error rate P_b				
16-QAM	$2.662 \cdot 10^{-5}$	$4.728 \cdot 10^{-7}$	$8.170 \cdot 10^{-9}$	$1.385 \cdot 10^{-10}$	$2.317 \cdot 10^{-12}$
16-AMMC with displacement of amplitude levels	$1.128 \cdot 10^{-5}$	$1.160 \cdot 10^{-7}$	$1.149 \cdot 10^{-9}$	$1.109 \cdot 10^{-11}$	$9.291 \cdot 10^{-14}$
32-QAM	$5.474 \cdot 10^{-4}$	$4.148 \cdot 10^{-5}$	$3.135 \cdot 10^{-6}$	$2.362 \cdot 10^{-7}$	$1.776 \cdot 10^{-8}$
32-AMMC with displacement of amplitude levels	$3.840 \cdot 10^{-4}$	$2.098 \cdot 10^{-5}$	$1.137 \cdot 10^{-6}$	$6.123 \cdot 10^{-8}$	$3.283 \cdot 10^{-9}$
36-QAM	$1 \cdot 10^{-3}$	$1 \cdot 10^{-4}$	$1 \cdot 10^{-5}$	$1 \cdot^{x} 10^{-6}$	$1 \cdot 10^{-7}$
36-AMMC	$7.576 \cdot 10^{-4}$	$5.732 \cdot 10^{-5}$	$4.325 \cdot 10^{-6}$	$3.253 \cdot 10^{-7}$	$2.433 \cdot 10^{-8}$

During demodulation of QPSK or QAM signals each signal point can be represented on the proposed demodulation plane in a Cartesian coordinate system with coordinates equal to the signals amplitude at the outputs of the first and second low-pass filters. During demodulation of AMMC signals with N components we should use the proposed N-dimensional demodulation space. All signal points of AMMC signal in such space have N coordinates, each of which is proportional to the signal amplitude at one of N outputs of AMMC demodulator. It is possible to use normalized coordinates, which are equal to possible amplitude levels at the outputs of the AMMC demodulator. Signal constellation in three-dimensional demodulation space with axes $n1$, $n2$, $n3$ is presented in case of 37-AMMC signal with three components as shown on Fig. 3. At each output of AMMC demodulator signal may be present with one of 13 possible levels of signals amplitude.

It is found that Eq. (12) is suitable for using amplitude phase keying (APK), QAM and AMMC to calculate the bit error rate that does not exceed 0.1.

To evaluate AMMC advantages in comparison with other well-known signal modulation varieties, a research of bit error rate in telecommunication access network depending on the applied modulation type was conducted. The results of error probability in the telecommunications access network with limited bandwidth in case of noise when using different types of signal modulation for different values $E_{b_{av}} / N_0$ (ratio of the average energy of one bit of information to the power spectral density of white noise) are shown in Table 2.

The AMMC application decreases the bit error rate at the output of deciding device of telecommunication channel or telecommunication access network compared to the use of QAM at the same number of symbols M that can be transmitted during one informative cycle as can be seen from Table 2. This phenomena cause by distance increasing between signal points on the signal constellation. For example, using 16-AMMC with displacement of amplitude levels of the modulating signals, bit error rate is 2.36 times less compared to 16-QAM when ratio $E_{b_{mid}} / N_0 = 13,95$ dB and 24.94 times less when ratio $E_{b_{mid}} / N_0 = 17,72$ dB.

According to obtained results, we determined that bit error rate in telecommunication access networks may

be decreased by application the proposed method of adaptive data transmission in telecommunication access networks based on symmetrical and coaxial telecommunication lines using AMMC. The method bases on the adaptive selection of modulation types, which at appropriate ratio of signal power to noise power will provide the lowest bit error rate for a given transmission rate. We should apply one of the modulation types – BPSK, QPSK and M-positional varieties modulation 8-PSK, M-QAM or M-AMMC. Correcting coding should be used in order to decrease the bit error rate.

CONCLUSIONS

To increase data transmission rate or to decrease bit error rate in telecommunication access networks, which use QAM, new modulation group based on AMMC is proposed to use.

The proposed AMMC increases the distance between the signal points on the signal constellation, thereby decreasing bit error rate in the telecommunication access network to 25 times compared to the use QAM with the same maximum power of modulated signal and the same number of symbols M that can be transmitted during one informative cycle.

The proposed method of adaptive data transmission in telecommunication access networks based on symmetrical and coaxial telecommunication lines using AMMC is an adaptive selection of modulation types that ensures the lowest possible bit error rate during data transmission at some ratio of signal power to noise power. The modulation types BPSK, QPSK, 8-PSK, M-QAM, M-AMMC and correcting coding should be used in order to decrease the bit error rate.

The proposed AMMC and adaptive data transmission method is useful in design of modern telecommunication access networks for data transmission.

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The formation of the enterprises rating activity system on the criterion of investment attractiveness

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Abstract. The value of rating activity usage in terms of evaluation of enterprises investment attractiveness is grounded. There is proved the necessity of enterprises rating evaluation within financial, economic, technological, productive, HR and market areas and it is outlined the indicator content of each area to provide multi-criteria rating activity.
Key words: investment attractiveness, enterprise, rating activity, rating, ranking, rating evaluation, polycriterial rating activity, system of indicators.

INTRODUCTION

An effective functioning of the enterprises is impossible without powerful investment of money, both in-house and loan, which should be directed into the development of productive, technical and technological, innovative and other strategic business spheres. Hereby, in the conditions of present economic crisis the companies' owners are increasingly turning to the financing of their production and business activities by means of external sources, primarily investment recourses. As long as investment activity is inevitably accompanied by the financial risks with the probability of large-scale losses and bankruptcy, banks and other financial-credit organizations, public authorities, enterprises and other potential investors as a strong argument for the investing in a particular object consider a level of compliance with certain characteristics, that is investment attractiveness. To solve this task they are increasingly turning to the enterprises rating activity methods and methodics. As a result of their application both external users and top managers of researched enterprises receive ratings, which in a compact form represent the position of these enterprises among the others, analogous by the key characteristics, and lay the foundations for the multidirectional decision-making including investment. Together with this, the current approaches to the enterprises evaluation on the rating basis do not allow to trace the cause-effect relations between the value of generalized rating and the effectiveness of the certain areas of activity (productive, financial, technological, marketing etc.). Though such information has a dualistic worth, so long as, on the one hand, it warns enterprises owners about spheres of activity which are the most in need of financing for resolution of current problems or further development, and from the other – allows potential investors the decision-making according to the practicability of cooperation with enterprises within the investing in these spheres. Considering everything mentioned above, it is necessary to form the multiple view indicator system for the enterprises investment attractiveness evaluation on the rating basis.

ANALYSIS OF THE LITERATURE ON THE PROBLEM

The urgency of the enterprises investment attractiveness evaluation is being confirmed by the large interest on this problem of Ukrainian and foreign scientists. An important contribution into the theory of investment, evaluation of investment efficiency and investment attractiveness is represented in the works of

O. Andrash [1], I. Blank [2], L. Borshch [3], Z. Herasymchuk [4], T. Mayorova [5], G. Pidlisetskyy [6], A. Peresada [7], A. Yepifanov [8], V. Zaharchenko [9] etc. The unique role of rating instruments implementation in the sphere of investment attractiveness evaluation is emphasized in the researches of S. Ishchuk [10], A. Nechyporuk [11], A. Shcherbak [12], I. Simenko [13], I. Sklyar [14] and others. They have offered to use the statistical rating methods (firstly, elements of the fuzzy logic theory and its interpretation on the basis of Harrington scale), which make it possible to consider objectively and comprehensively diverse quantitative and qualitative indicators of enterprises activity by transforming them from a natural form into the dimensionless one with the desirability scale. Despite of these advantages, such approaches to evaluation of enterprises investment attractiveness may be too much complicated with mathematical apparatus for unequipped interested users [15]. Ratings of investment attractiveness are also represented the main products of domestic and international rating agencies. Among them, according to experts and analysts, the highest level of Ukrainian users confidence earned methods of such world-known rating companies as Moody's, Fitch Ratings and Standard & Poor's, as well as national rating agency "Credit-Rating". The peculiarities of mentioned above companies rating methods are the exclusive ponderability of expert methods during the evaluation of rating informational resources array as long as the formation of integrated ratings with dominant account of qualitative parameters of rating activity object (industry practices, state of the market influence, external social-economics and political risks, enterprise management condition etc). In addition, the prerequisite of rating formation by the rating agencies is, first of all, the commercial interest. This very aspect is the reason why the most of rating methods and methodics are confidential: the access to databases with ratings of enterprises and organizations becomes available only on the paid basis, and the disclosure of rating evaluation means and techniques, which, at the same time, are the elements of rating agencies intellectual property, is limited or completely absent. That is why there exists the paramount necessity of creation of scientifically grounded, understandable polycriterial rating activity system. The results of its functioning will serve for potential investors as a criterion for investment project choice as long as will form the guidelines for the enterprises development with the aim of their investment attractiveness increasing.

THE PURPOSE OF THE PAPER

The purpose of the article is the formation of methodical recommendations according to the substantiated development of rating activity system of enterprises investment attractiveness on the basis of the most significant multilevel system of indicators.

PRESENTATION OF THE MAIN RESEARCH MATERIAL

The investment attractiveness of the enterprise is a complex, multiple-aspect, integral category. It represents the sum total of enterprises finance-economical, social, material and technical, productive, market and other characteristics subject to investment attractiveness rating of the country and region of enterprises location, as long as the branch of its functioning, which ensure the competitive advantages of the enterprise in the struggle for investment recourses [16]. A real or financial investor is guided by the considerable list of criteria in the process of investing his financial, material, intellectual and other kinds of recourses into the certain enterprise while evaluating significant components and the level of its investment attractiveness from the position of further return of investment. In the rating-diagnostic context a weighty role represent the factors of enterprise investment attractiveness formation as they determine its parameters character, their stability and duration. The factors of external environment represent the conditions of enterprises functioning in the certain geo-economic system, but they are not always crucial for a specific individual investor, because there isn't any country in the world with perfect conditions for business activity.

However, practice shows that investors are investing not only in the enterprises from highly developed countries, but also into the companies of developing and low-developed ones, which are characterized by the unfavorable investment climate. This is an evidence of the priority for a particular investors group of investment attractiveness parameters of the enterprise, not the conditions and environment of its functioning. Within this approach a special emphasis gets identification of internal environment factors, which form the investment attractiveness of the certain enterprise regardless of adverse investment climate in the region of operation. On the basis of realized investigations, we propose to typologize the internal environment factors of investment attractiveness formation on the semantic basis on the following groups [17]:

- industrial-engineering factors (the level of moral and physical depreciation of enterprises fixed assets, innovation and efficiency of manufacturing technologies, production facilities, the level of technical provision etc.);
- financial-economic factors (profitability, liquidity, solvency, financial independent of the enterprise; the level of bankruptcy danger; creditworthiness of the enterprise; capital productivity ratio; investment risks etc.);
- social factors (qualification of enterprise personnel; the level of average wages; working conditions; social packages; employee turnover; the level of conflicts on the enterprise etc.);

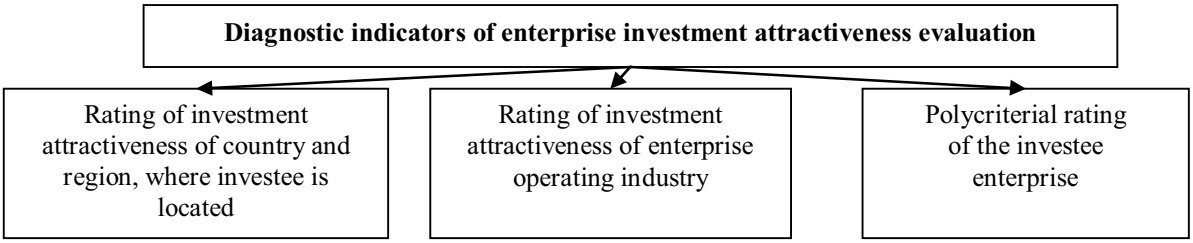

Fig. 1. Diagnostic indicators of enterprise investment attractiveness evaluation

- commodity factors (competitive ability of enterprise production; existence and recognition of trade mark; the uniqueness of production etc.);
- property factors (ownership of ground area, property complexes etc.);
- administrative factors (business form; form of ownership; legal position etc.);
- management factors (the level of management system development; the level of management processes automation; the level of managers qualification, leadership style etc.);
- distinctive factors (enterprise image; brand; market reputation etc.);
- info-communication factors (presence of established contacts with suppliers, consumers, financial and credit institutions; the development of marketing communications; the usage of up-to-date info-communicational technologies; presence of the enterprise in international and native ratings and rankings etc.).

The developed typologies of enterprises investment attractiveness formation factors generated the preconditions for creation of integral fundamental method of diagnostics in this sphere. Thus, the realized researches allow stating that it is unreasonably to evaluate the enterprise investment attractiveness on the basis of some integral indicator, as long as this indicator doesn't reflect the weaknesses of the enterprise and may give the biased information about its development potential. In order to this we propose to perform such an evaluation within the multiple-vector approach, which is based on the following indicators system of investment attractiveness evaluation (Fig.1).

Since rating of the investee enterprise is directly dependent on manufacturing, technology, personnel and other internal factors of its activities, a major challenge in this study is the development of an objective rating of the company. So in order to perform functions of complex diagnostic indicator of enterprise investment attractiveness, rating must be based on carefully selected and adequately worked out set of indicators and evaluation criteria that give the most clearly reflection of rating object (investee) efficiency in all sphere of its functioning [18]. Therefore, the indicator-criterial filling is crucial in rating activity, because exactly the approaches to selection and generalization of financial-economic, productive-innovational, technological and marketing indicators make the significant influence on the success of rating procedure as long as objectivity of its outcome - ratings and rankings.

In these conditions we propose to select indicator groups for the creation of enterprises rating evaluation systems in accordance with the following fundamental principles [19]:

1) a complex balance (involves quantitative and qualitative content of key groups of indicators that provide multidimensional consideration of all companies areas of functioning peculiarities and the relationships between them);

2) the completeness and accuracy of the input data base (the presence of coherent information system to calculate the ranking performance and, at the same time , the use of only official and/or thoroughly tested information sources);

3) formalization (all indicators should be measured, and the indicators of qualitative and descriptive nature should be limited to the estimated species);

4) comparability (all figures should be comparable to each other , that is to have identical units of measurement);

5) criterion validity(the ability to establish a clear range of selected indicators values for identifying and unambiguous clarification of the development dynamics);

6) combating multicollinearity (removing from the indicators list of those factors that are closely interrelated or overlapping);

7) conformity (to the selected method and the rating activity methodics);

8) the optimal number (the quantity of parameters in each group should be minimal , but sufficient for the construction of adequate rating assessment);

9) predictability (the selection of indicators should be carried out so as to ensure not only diagnose the current state of operation of the entity , but also to enable prediction of future trends of its change);

10) adaptability (adjustment toward expanding or narrowing according to users requirements).

Adopting a set of specified principles, we can proceed with the immediate formation of the complex indicators system for the rating evaluation of the enterprises.

After analyzing the literature and the results of many years methodical and methodological developments of rating agencies specialists, it should be noted that the rating activity is proposed to use a broad set of different indicators and coefficients. Thus, it is appropriate to note that the vast majority of them are focused on clarifying of the rating objects creditworthiness and solvency. Determining the level and permanent monitoring of the performance-based payments of so-called credit rating is undoubtedly an extremely important area within the financial and economic management of the company, as this is accompanied by the formation of well-timed and objective information on the effectiveness of the enterprise cooperation with external partners (customers, suppliers, creditors, shareholders etc.). The accent on the suitability of rating activity usage in the conditions of evaluation of enterprise ability to reckon with credits and other debt obligations we can also trace in rating activity regulatory support. This applies to international regulation of rating activity, which is reflected in the regulations of the International Organization of Security Commissions (IOSCO), and national legislation.

So from the above mentioned we can conclude that in today's conditions the significance of rating activity is underrated. The problem is that existing rating activity methods and developed on their basis methodics are not representative. It is related to the fact that, firstly, during the ratings creation there are used mainly financial and economic results of the studied objects without filling with the results of industrial, technological, market, personnel areas that cannot be an argument for the complexity of the rating assessment. In addition, only the final rating scores are being reflected, while the weight of intermediate results (partial ratings) is smoothed over, though often it is much more important (particularly in terms of evaluation of investment attractiveness) than the composite index.

To solve this problem, we propose first of all to consider the multifaceted dimension of the rating objects functioning (on the example of industrial plants) by these countervailing areas: economic and financial (Ф), productive (В) , technology (Т), HR (К) and market (Р).

In justifying the rating assessment validity of the rating objects financial and economic sphere of functioning, it should be noted that the peculiarities of the accumulation and distribution of cash assets in order to provide industrial enterprises timely and adequately with resources that are necessary for the smooth implementation of production and commercial processes play a crucial role in today's survival and progress of these industrial structures in local economic conditions. Thus , the results of extensive research has shown that a clear list of financial indicators for evaluation is absent, and in some cases the same parameters are provided by different formulas for calculation. So none of the official regulatory methodics can be prescriptive (taken as the standard) while wearing only recommendation character. The key areas which are analyzed during the survey of the financial situation on the enterprises are the level of financial stability, liquidity (solvency), the state of business activity (turnover) and profitability of functioning. It is well-known that the range of indicators for the evaluation of these areas is extremely broad: the practice of American financial analysis found about two thousand, domestic researchers and practitioners offer over 200 options for financial evaluation. Therefore, in order to respect the principle of optimal number and to avoid the risk of multicollinearity, which increases significantly with the use of a large number of indicators, there were chosen the most representative indicators within the financial and economic vector as follows: rate of financial independence, the current liquidity, capital productivity ratio and return on equity (ROE).

Among the indicators of financial stability there was selected the coefficient of financial independence (hereinafter - Φ_1), which indicates the level of enterprise assets provision with the internal funds, that is diagnoses whether there is a risk of transfer of rights associated with the company property management from its owners to lenders (standard value: 0.5-0.8). The choice of this indicator is due to the fact that today, according to official statistics, industrial enterprises are faced with the acute problem of financial autonomy loss, as in the period from 2007 to 2012 only in 2007 the ratio was investigated within the standard value ($\Phi_{1(2007)}$=0.53). Over the next 5–years period there was observed the permanent reduction of Ф1 an average of 6 % per year, which in 2012 established at the level of 0.356 and was a signal that de facto the control of the domestic industry today doesn't carry by their owners, but by the lenders.

To assess the solvency of rating objects (industrial enterprises) there was selected the coefficient of current liquidity (liquidity ratio) (hereinafter - Φ_2), which in general is calculated as the ratio of current assets of the company to the value of its current obligations for a certain period (standard value: 1-2). In contrast to other indicators of liquidity (quick and absolute), Φ_2, in addition to cash support, which is investigated within the absolute indicator of liquidity, takes into account the influence of the accounts receivable and inventory holdings, which today form the most significant share of the industrial enterprises current assets (64 % and 25 %, respectively, as of 30.09.2012). The constant increase in the value of these indicators over the last three years is one of the very problematic sides in industrial enterprises functioning, as it leads to permanent payments crisis, especially in the short term period, as well as the "washout" of money from circulation and losses due to their gradual impairment because of disuse. That is why we consider that Φ_2 characterizes the most fluently the adequacy of the company financial resources for the implementation of accrued liabilities. In addition, the activity of industrial enterprises should

be directed for at least this indicator of liquidity achievement in the conditions where none of the solvency indicators meet the normative value.

The reasonability of capital productivity ratio (hereinafter – Φ_3) allocation is conditioned by the fact that being the ratio of the net proceeds from sales to the average value of assets it demonstrates the overall effectiveness of the enterprise property use excluding sources of its formation, and that in how quickly invested capital is compensated by the made and sold products of enterprises. The cost of industrial enterprises capital is the highest of all sectors of the Ukrainian economy (1,255,392.9 million hryvnias, representing about 30% of domestic enterprises total assets, according to official statistics as of 31.12.2012). Accordingly, the high cost of industrial enterprise property requires permanent tracking of the capability to ensure its funding through the implementation of product sales results and the expediency of such provision with regard to how much income from the sales brings 1 hryvnia of capital invested in it (this indicator should always be greater than zero and increase in dynamics).

The profitability indicators have always had a high priority in terms of analyzing the activities of business organizations, as they reflect the level of their operations effectiveness, indicating the possibility and expediency of the further implementation of industrial and commercial procedures in the selected direction. In the proposed list of financial and economic indicators for rating needs we consider that it is appropriate to calculate the level of return on equity (hereinafter – Φ_4). This indicator informs how much hryvnias of added value we can get by investing in it 1 hryvnia of equity capital. For industrial enterprises, similarly to other branches, Φ_4 is important because it shows whether it is possible only through its own funds to provide effective functional development of the rating object, or there is a need for appealing external funds. In the 2009-2012, according to the results of statistical surveys, the level of unprofitable industrial enterprises has steadily increased, changed from 33% in 2009 to almost 42 % at the end of analyzed period. According to experts of the enterprises, it was the result of insufficient own financial resources provision and automatically caused the increasing of these enterprises expenses for the cost of obtaining and servicing of loan capital (in the last 3 years, the amount of short-term banking credits increased more than 1.2 times granted to financing of the domestic industrial sector).

Another area of research within the formation of the complex rating indicators system is productive sector (B). The main reason of including the indicators of this type into the complex rating index is that production (operating) activity is a crucial component of industrial enterprises economic development, where, in comparison with other sectors, is concentrated the largest share of obtainable subjects and means of labor (operating expenses of industrial enterprises amounted to 40.263% of their total cost in 2012, and more than 55% - in the total operating costs of domestic entities). We suggest setting the following key indicators within the productive area of functioning: production profitability, the coefficient of production rhythmicity, fraction defective in sales and the coefficient of production renovation.

Production profitability (hereinafter - B_1) as the ratio of operating income to the value of the total cost requires tracking in order to determine whether the amount of total costs incurred for resource support of the production process is economically reasonable. In today's environment, there is often a tendency of company management to overstate expenses forming production costs (primarily to reduce the size of tax payments) which, according to experts, is another factor of increasing the number of unprofitable business organizations in the industrial field.

The coefficient of production rhythmicity (hereinafter - B_2) indicates coordination of all phases of the production process at the enterprise, reflecting the level of uniformity of production in the planned scope and assortment according to the schedule. If production activity is unrhythmical, on the one hand, it creates a negative impact on sales volume, as the discrepancy in the volume of output to current demand on a certain date will inevitably lead to loss of customers (both real and potential) and, consequently, to deficiency of profits and development slowdown. If irregularity causes overproduction on a certain date, then, again due to mismatch of demand, it will result in significant overstocking of warehouses, leading to rising of production costs, reducing profits, and aggravation of enterprise financial conditions.

The fraction defective (hereinafter - B_3) is an important indicator of product quality so its share in the sales volume should be taken into consideration in the context of clarifying its impact into the productive sector effectiveness. As the current practice of the domestic industrial enterprises argues, the main reasons for defectiveness are: the lack of qualified workers, the equipment operating irregularity, poor quality of tools and other production stock, errors in the technical documentation, the negligence of workers and low labor discipline etc. In most developed countries in industrial production there is a maximum acceptable level of defectiveness (an average of 2-3 % of the output volume). However, the best results in the area of defective products minimization show Japanese companies, where the main efforts of managers at all levels are focused on maximizing the reduction of the share of products with defects by using modern highly efficient quality management systems (fraction defective and frequency of breakdowns of Japanese cars, televisions and other industrial products, according to experts, is 10 times lower than similar results of

European companies). Touching the Ukrainian experience, according to Article 138 p.138.7 "Costs structure and the order of their recognition" of the Tax Code of Ukraine (№ 2755 -VI from 02.12.2010), it is stated that enterprises are required to establish their own norms of losses from defects, but they may be included in the cost only if there is an economic justification for their predesigned size. Thus, it is clear that defective products are a significant burden for the industrial enterprise, as its high level, besides reducing the efficiency of the financial and economic activities, will not allow domestic enterprises to provide a decent competitive position, especially in the process of international economic relations setting up.

The coefficient of production renovation (B_4) is one of the key indicators of enterprise innovation activity, which reflects the level of its funding appropriateness, as indicates the portion of developed innovative products which, subject to the effective functioning of the marketing trend, is characterized by a high level of competitiveness and provides augmentation of overall ability to compete and develop effectively in today's environment.

Evaluation of technological sphere T, which is primarily important in analyzing of the industrial enterprises production, provides for a generalization of yield of capital investments, capital-labor ratio, and coefficient of fixed assets renewal, extensive and intensive equipment loading. These indicators reflect the level of technical and technological support of the production process by means labor. Yield of capital investments T_1 characterizes the efficiency of means of labor use, as indicates how many units of output produced by a unit of enterprise fixed assets. Speaking about the capital-labor ratio index (T_3), it should be noted that it reflects the level of technical equipment of work, pointing to a fixed assets value used by each worker. The growth of capital-labor ratio is the basis for productivity increasing, which should grow relatively faster. Otherwise, T_1 decreases and, accordingly, the use of fixed assets becomes worse. The conditions T_3 growth are increasing of operation rate, automation of production, active updating of computer hardware and software, personnel professional development, the use of high quality materials, raw produce etc. To analyze the efficiency of available equipment use in time measures we use T_4 indicator, which also reflects the coherence of the main production equipment work. The intensive load of production capacity, offered to analyze in terms of T_5, leads to a reduction of fixed costs and, consequently, the cost of production, which in turn enables the increasing of productivity. However, given indicator reflects the nature of the production and technological process in much greater degree than T_4. As regards the indicator of fixed assets renewal T_2, along with the B_4 it is another innovative feature of the industrial enterprise economic activities that reflects the security of its technical level and describes the company's ability to manufacture products using advanced production technics and technology that provides the increasing of quality parameters.

Analysis of HR area (K) is based on calculating of the coefficients of labor productivity, turnover, utility of working time fund usage and the average wages. Labour productivity (K_1) shows the growth performance and the progressive development of the enterprise. It is directly related to reducing the complexity of production labour intensiveness, optimum use of manpower, personnel training, the rationality of organization and motivation. The level of turnover that characterizes the rate of K_2, reflects the movement of personnel in the organization/ It is caused by dissatisfaction of employees of any elements of the production situation or by owner dissatisfaction with the employee productive behavior. K_2 indicates the stability and coherence of the industrial enterprises personnel performance. The value of the average wages K_3 allows revealing the level of enterprise expenditures on remuneration for employee self-employment and serves as an indicator of labour motivation. Utility of working time fund usage K_4 indicates the amount of time spent directly on the performance of basic work provided in the duties of the employee, and indicates clearly the reasonability of further cooperation with them.

The market area (P), which reflects the efficiency of the enterprise performance in the external economic environment, should be analyzed on the basis of the calculation of the following indicators: share of the market (P_1), return of sales (P_2) , the level of the enterprise capitalization (P_3) and maturity of accounts receivable and payable (P_4 and P_5). Indicator P_1 allows evaluating the competitiveness of the company in terms of its market potential. Generally, with company market share increasing it position becomes more stable and the company, respectively, becomes more competitive. Comparing the overall market potential with the company share or its nearest competitors positions, we may define "market shares" learning which the company can expand its range of market impact. As for the coefficient of P_2, it is the basis for tracking of the enterprise functioning efficiency at stage of manufactured products realization, as indicating the level of profitability of the company selling and therefore the correctness of its actions in planned realizable policy and ensuring a competitive market position. The enterprise capitalization level (P_3) is another indicator of the competitiveness of an entity that reflects the real value of the business property in the marketplace and, therefore, is closely related to the effective use of all its inputs. P_4 and P_5 coefficients are chosen for the evaluation of industrial enterprises market area because they provide the opportunity for tracking the level of the company financial flows managing ability. They reflect the most completely the level of effectiveness of enterprise collaboration with key counterparts in the market - debtors and creditors.

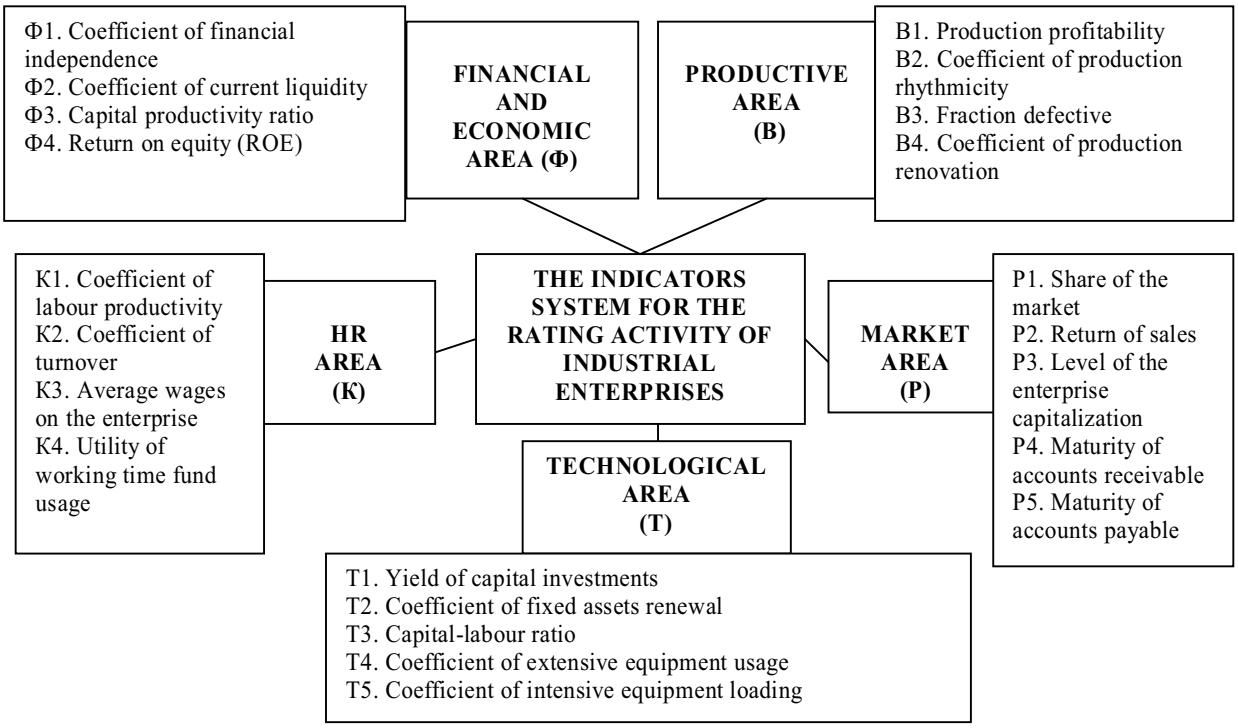

Fig. 2. Indicators system for the rating activity of industrial enterprises*

- *developed by the authors*

Generalization of pointed indicators (Fig. 2) using the specially selected method creates the most adequate and complete picture of the effectiveness of the researched objects functioning in the form of complex rating as a key outcome of the implementation of the rating activity on the enterprise [20].

CONCLUSIONS

A detailed analysis in the sphere of rating activity indicator provision showed that all the achievements of domestic and foreign scholars, as long as the results of practical activities of credit rating agencies and normative standards of state regulatory authorities aim to calculate the ratings, reflecting mainly the results of financial economic activity of the researched objects (indicators of profitability, business activity, solvency etc.).

However, this approach is too limited and nonrepresentational in terms of rating activity on industrial enterprises. With this in mind, there was developed a system of indicators for polycriterial rating evaluation (on the example of industrial enterprises) based on the decomposition of the financial and economic, industrial, technological, HR and market blocks. This indicators structure makes it possible to provide a partial rating activity in key areas of rating objects functioning and identify the strengths and weaknesses of each of these areas in order to determine their impact on the overall efficiency of industrial enterprise functioning. Thus, the presence within each of the areas indicators that characterize the effectiveness and prospects of business entities functioning by the various parameters, suggests the reasonability of usage of the introduced indicators system for polycriterial rating activity as an objective tool for enterprises investment attractiveness integrated evaluation.

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Theoretical Backgrounds of Organizational Changes Fulfillment in an Enterprise Management System

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Abstract. The entity of the notion of organizational changes in an enterprise management system has been developed in the given paper. The theories of organizational changes fulfillment have been considered. The process of the actualization of organizational changes in an enterprise management system has been formed. The importance of implementation of the organizational changes in the company was revealed. Were reviewed conceptual approaches to organizational development of the company. A number of suggestions for the successful implementation of organizational changes in the management were formed. Were analyzed different approaches of the implementation of organizational changes in the company. Were reviewed conceptual approaches to organizational development of the company. Certain features of the implementation of organizational changes in the management of the company were analyzed. Also were analyzed some problems that can occur in various management systems of the organization and developed some proposition to resolve them.

Key words: Organizational changes in an enterprise management system, organizational changes, process of changes management.

INTRODUCTION

The importance of changes within enterprise management system can't be overestimated today since one of the most essential vehicles of successful activity of any company is its management core. The interrelation between managerial links of a company should be extremely optimized and the staff being on managerial positions should be extremely competent in problems solutions which they face.The changeability of the environment a company exists in, the limit of resources and customers' needs make a company react immediately making a company change and get accustomed to the given conditions. Managerial decisions play an urgent part in such changes and their timely adoption and advisability towards the given problems are the main constituent of a successful activity of any company.

MATERIALS AND METHODS

A large number of national and foreign scientists attached importance to the problem of organizational development of a company and organizational changes on it. It is worth considering the papers by K.Levin who described various theories of organizational changes fulfillment [2,6,7], O. Gaydey considered the definition of the reasons and methods of their management [1], O. Kuzmin and O. Melnyk considered theoretical backgrounds of a company management[3], I. Bagyn, G.Tarasyuk, O. Dashkevska and O. Grabchuk, who described the processes and methods of changes management at a company[6,7,8,910] and others. It is worth noting that organizational changes within the system of company management have not been investigated enough nowadays and demand further considering.

The development of modern enterprise is not possible without implementing changes for adaptation of its activity to the functional environment. Present ideas of implementing different changes and modifications of the enterprise are founded on development and leadership theories. Such theories provide for planned phased changes in order to achieve the objectives. Different theories and phases of organizational changes

management, including processes of planning and implementation of changes are the subject of scientific research of foreign and national scientists [7,8,9].

Organizational development, its aspiration of improvement cause new problems for the enterprise executives. As a rule, the major cause for changes is the external environment of organization. Its influence is not significant; however, afterwards the enterprises must implement changes into the production methods, employees' motivations, methods of competitors control and develop its new development strategies, having changed not only the objectives, but also the organizational target.

Scientists define three major phases of organizational changes, which took place in XX century and are of great importance. The first phase is the separation of administrative functions from the owners and establishment of the professional activity such as the management. Second phase is occurring, beginning from the twenties, of the command-and-control organizations with the vertical hierarchy and high level of solutions centralization. Third phase is the transition to organizations with the dominance of horizontal structures and relations, information technologies, which are based on widespread use of special knowledge and systematic methods of decision-making [6].

With the beginning of 60-ies of XX century a vast operation of conceptions of company management and organizational changes actualization started. The research in the direction of management process with the application of systemic methods of analysis led to the formulation of systemic approach in management. The essence of the process lies in the considering the company as a unified system with interrelated components, where the change of one leads to the alterations of others. The very process was made up for excluding all possible problems which can occur in different elements of a system as a result of changes implementations on one of them. We speak about managerial decisions coordination of all links of company management system with the aim of getting rid of the problems which occur as a result of organizational changes implementation.

Under the term "organizational changes" we imply any change in one or a few elements of a company (the level of occupation, the range of control, duties distribution and coordination mechanisms) at any stage of its life cycle which can occur in altering of a company power and in the change of size, range and aims of its activity[1].

According to Kuzmin O.Ye., Melnyk O.H., organizational changes are the totality of changes within the organization which cause the innovations implementation and can move in different directions: the change of a company goals, of structure, of responsibility , of the division into departments , services, subdivisions, committees and so on and so forth; the changes of machinery, of technological processes, of production, the modification of possibilities or workers' behavior (the preparation to communication, the shift of positions, promotion, groups formation, work evaluation, etc);the change in production activity management[3].

Organizational changes are those in the management system which are included into documents of management system and are concerned with subordination, positional duties and staff responsibility of the company[4].

Concerning the notion of changes in the management system of a company, they are connected to a process which is directed to the improvement of activity and the interaction of management services of a company with the aim of receiving the goals of a company.

Kurt Levin is considered to be the founder of the theory of organizational changes at a company. In 1947 the entrepreneur projected the theory of organizational changes, according to which two groups of vehicles which support and contradict changes, contradict one another. According to that theory the notion of «changes» is compared to the notion of «stability». When these groups of vehicles are in balance, the company is in the state of stability and no changes occur [6].

According to the theory of organizational changes by K.Levin, an organization implements changes in three stages. The first stage – "Defrosting". At the given stage a company seeks problematic items which need changes and identifies changes. The second stage – "Movement"at this stage a company implements all necessary changes in a way of applying actual resources' and possibilities and making proper managerial decisions. The third stage is a final one or "Frosting", having taken into account the results of changes implementation and their evaluation a company fixes the given changes or returns to the first stage.

We differentiate between two conceptions of organizational development. The authors of these conceptions, respectively called"E theory" i "O theory", are prominent scientists, professors of Harvard School of Business Michael Beer and Nytin Norhia."E theory " considers financial goals and is oriented on their effective achievement taking into account permanent pressure of share holders "O theory " considers an organization as a system able to self-develop and mostly oriented onto a corporation culture, goals and motive power of co-workers of a company.

The managers who follow the "E theory" apply rather hard methods as a rule, dwelling upon changes fulfillment up and down and attaching importance to the creation of certain structure, which means that mechanistic approach is applied.

The followers of "O theory" – are mostly oriented to the staff training and development, changes of corporation culture and the changes up and down. The characteristics of these theories are presented in Table 1.

Table 1. The Characteristics of "E theory" and " O theory"*

Characteristics	"Theory E" (authoritarian style of management)	"Theory O" (democratic style of management)
Changes Goal	Income Rise (economic goals)	The Development of Organizational changes
Leadership	Is spread according to the principle up and down	All Links are Involved
The Object of Changes	The Structure and System ("hard" elements)	Organizational structure ("soft" elements)
Changes Planning	Programmed Planned Changes	Spontaneous Changes(the reaction to possibilities which occur)
Changes Motivation	Financial stimulus	The Combination of Different stimulus
The Consultants Part	Consultants apply ready technologies and decisions	Staff Involvement into the decision making process
According to an approach to organizational changes fulfillment in the system of company management	The Formation of Measures for Organizational Changes in the System of management of higher link of managerial staff	All Management Links Involvement to form the measures concerning organizational changes in the system of company management

* Completed by the author on the basis of sources considered [2,7]

Having analyzed the above mentioned models and conceptions of organizational development, the essence of organizational changes, we can form the notion and the process of organizational changes fulfillment within the management system of a company.

RESULTS AND DISCUSION

The process of organizational changes within the system of management is an exact management function which is actualized through general management functions, planning, organization, motivation, controlling and regulating with aim of goals receiving, company purpose and effective further developing and functioning.

The efficiency of such changes implementation is evaluated according to the results of these changes and also according to possible perspectives which were created as a result of their implementation.

Generally, organizational changes appear under the influence of external and internal factors. That is why it is arguable, that influence factors both for organizational changes in enterprise management is the same. External factors are related to the environment specifics, where organization is functioning, more specifically – to the changes, occurring in such environment constituents: in economic situation; in technological component; in state regulation; in social and cultural components; in international aspects; competitors; suppliers; customers etc. The majority of such factors have small influence on the organization and do not cause significant changes in it, but the last, such as (competitors; suppliers; customers) are the key factors for the implementation of the enterprise organizational changes. As for internal factors, target, objectives, resources, technologies and structure of the organization should be noted [1,2,4].

All factors, influencing the organization should be grouped according to the following categories:

- Based on importance of influence on process of planning and implementing of changes (only those factors must be considered in the first place, which significantly influence the process of organizational and administrative changes).
- Based on reaction immediacy (factors must be grouped into such, influence of which is currently immediate for the organization and such, which are not urgent for today).
- Based on the range of future changes-(factors must be grouped into factors of not significant, significant and radical influence, requiring accordingly minimum, average or extensive changes of organizational and administrative character at the organization).
- Based on changes object (groups here are divided according to the criteria of factor influence on changes in organizational, technological or financial plan of the organization).

The fulfillment of organizational changes within the management system of a company directly depends on keeping to the stages system the actualization of the changes process. It is not advisable to implement changes without previously analyzing of possible consequences and an evaluation of all possible alternatives, since further development greatly depends on it.

The peculiarity of organizational changes implementation at a company is a permanent process of cyclic type. As it is important don't stop the process of such changes to achieve new ones and improving the existing ones.

The process of organizational changes implementation is drawn on the picture 1and looks the following way(three stage model of organizational changes system by Levin and the conceptions of organizational development by Michael Beer and Nytin Noriah were taken as a basis).

It is necessary to note that to achieve effective results and such process implementing we need to make the following steps:

1) To identify the place at a company where the problems occur;

2) To form the process of organizational changes fulfillment within the system of company management for a particular problem solution.

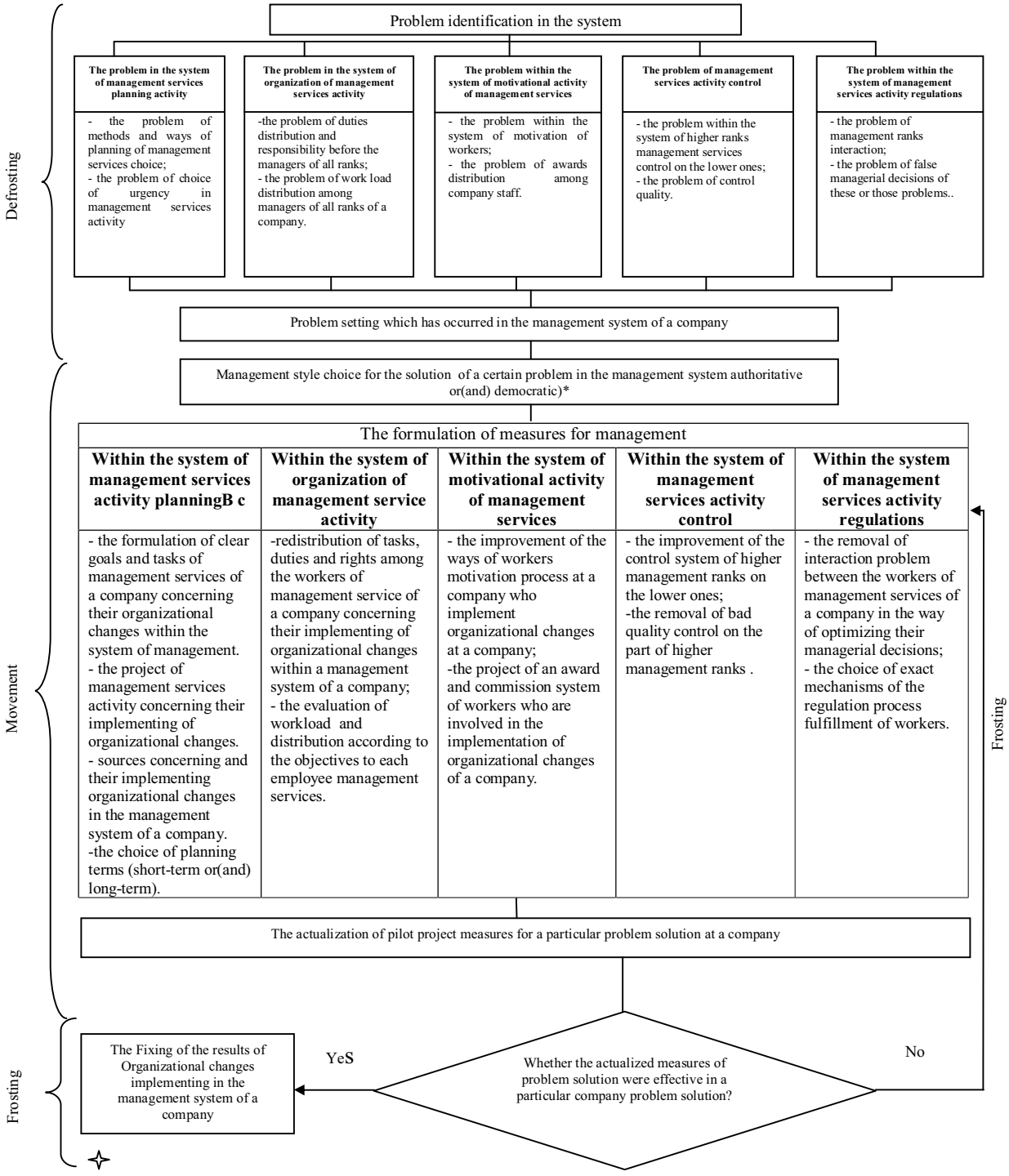

Fig. 1. The process of organizational changes implementation in the system of company management
* The choice of style of management and whether its fulfillment depends on a particular problem to be solved.
Projected by the author on the basis of analyzed sources [2,3,8,11,22]

An effective management of changes at a company is rather important element of company management. Any changes come across a number of factors which have negative or productive character of their implementation. From the point of view of changes in management system of a company, the main factor is human interests and perspectives.

CONCLUSIONS

Nowadays the life of a company is impossible without changes implementation which will ensure a long-term and stable development of a n organization on the whole. Technological progress development only makes companies implement new technologies and

methods of management. In the process of economics transformations in the countries crisis occurs , which is impossible to beat without company activity correction.

The suggestion in the process of organizational changes implementation lies in the dependence of such changes on the management style which is respectively actualized (according to "O theory" and "E theory" of authoritative or democratic) according to two directions:

- the formation of measures of organizational changes depending on management style;

- management choice of style for particular measures realization for certain changes implementation.

Each manager must understand the need for change. It is important to be in the company dynamic and constantly improve and develop. This should be carried out not only in the production unit, but also in the enterprise management system. Important wires rotate among managerial staff for bringing new views and ideas on solutions to problems that arise during the organization at all levels of management.

To the company could effectively exist in today's environment must be kept under control not only managed enterprise system but also the control system. This will more effectively to the impact of changes that occur during the existence of the organization. Change management staff or allow its rotation to form some leadership ability and character of the winners are not only higher levels of management staff and general managers in all organizations.

The manager must be able to correctly apply their skills, know the strengths and weaknesses as a team, managed, and himself. Constantly working to improve their skills and move forward without fear of making a mistake. Effective leadership can make the team better suited to the process of change to implement such a process without strong resistance from employees and as efficiently as possible, to introduce a new strategy for the organization and a new culture. Such activities should take into account the precise structure of the organization, defining the functions of the manager and the rights and obligations of its employees.

Further researches of the matter will allow to investigate the efficiency of organizational changes implementation at a company depending on management style(authoritative or(and) democratic), and also to investigate the practical value of received results of exact managerial decisions concerning problem solving which occur in the management system of a company.

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Improving administrative management costs using optimization modeling

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Abstract. It is important to determine the optimal level of administrative costs in order to achieve main targets of any enterprise, to perform definite tasks, to implement these tasks and not to worsen condition and motivation of the workers. Also it is essential to remember about strategic goals in the area of HR on the long run. Therefore, the main idea in using optimization model for assessing the effectiveness of management costs will be to find the minimum level of expenses within the given limits.
Key words: administrative costs, optimization model, levels of management.

INTRODUCTION

Optimization involves finding the best index of the selected function in a particular opportunity set. Thus the solution of the optimization model means finding its optimal solution or proving that there is no solution [3, 4, 8]. Optimization models are arranged in two categories: minimization problems and maximization problems. In our research, we will use the second category in order to find the optimal level of management costs for the enterprises of gas industry.

MATERIALS AND METHODS

The peculiarity of the formation of the optimization model is to determine the efficiency unit. We must install the effectiveness of administrative costs for the selected unit. Many recent studies on construction and solving of optimization models have focused on choosing such measurement units as: product unit, unit of cost, unit of sown area, etc. [5, 20]. However, it is not irrelevant to take into account these units of measurement as administrative costs are not included into production costs [10]. We therefore propose to calculate administrative costs per head of the company. Thereafter, the function will have the following expression:

$$F(x) \rightarrow min, \quad (1)$$

where: x – number of administrative employees.

However, the analysis of gas industry enterprises proves the importance of assessing the effectiveness of the administration costs on various levels of management, as there is a kind of asymmetry in terms of allocation of administrative expenses. Taking into account this problem we should specify the objective function as follows:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \rightarrow min, \quad (2)$$

where: a_1, a_2, a_3 – average amount of administrative costs per top manager, middle manager, low line manager accordingly, thousands of UAN; x_1, x_2, x_3 – number of top, middle and low line managers accordingly.

Further investigations are needed to choose the most important limits to solve the optimization model. The choice of factors depends on the main objectives and personnel management strategies as well as administration costs of the company. Analysis of the domestic gas sector companies showed the following priority objectives for HR management and administration costs, which can be displayed in the limits of the optimization model:

- development of chief executive officers, including their qualifications, practical skills, managerial skills

and competence [14], active participation in retraining, advanced training and re-qualification;

- rejuvenation of staff, particularly managers of industrial subdivisions;

- reducing losses because of making inaccurate management decisions and improving of management decisions in the company;

- increasing the loyalty of chief executive officers [1, 6, 9] and reducing the number and level of risk and risk of personnel activity [16];

- reducing the number of duplicate management structures, units and chiefs;

- improving the quality of labor input through the effective selection of personnel;

- reducing bureaucracy and corruption;

- increasing salaries and wages and reducing a number of employees;

- low turnover level of administrative employees;

- reducing administrative costs to raise competitive capacity of a company.

Thus we represent the schematic model of optimization of management costs at the enterprises of gas industry (Fig. 1).

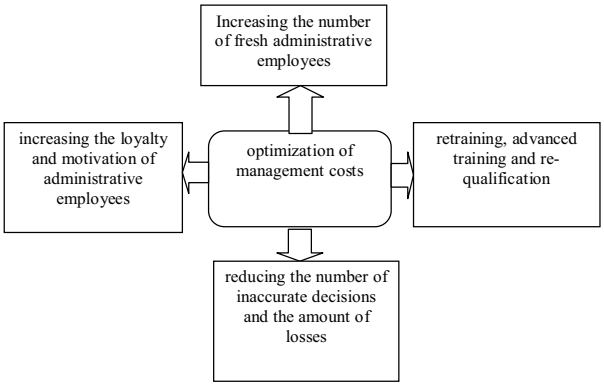

Fig.1. Directions of optimization of an enterprise management costs

The first limit to optimize administrative costs is a wages fund, which on the one hand should be as low as possible in order to reduce administrative costs and on the other one, it should be sufficient enough to meet the demands and to stimulate employees. The other aspects of the wages fund are to ensure sufficient loyalty of administrative employees, to avoid the loss of top managers, to create the decent staff reserve [2, 15]. Thereafter, the wages fund function will have the following expression:

$$b_1 x_1 + b_2 x_2 + b_3 x_3 \le D, \quad (3)$$

where: b_1, b_2, b_3 – average administrative costs for wages per top manager, middle manager, low line manager accordingly, D– wages fund.

According to the priority objectives in the field of personnel management and administrative management costs, it is important to ensure a continuous process of employees training. Any company budgets the expenditures on conducting of training. These limits will be as follows:

$$c_1 x + c_2 x + c_3 x \le K_{max}, \quad (4)$$

$$c_1 x + c_2 x + c_3 x \ge K_{min}, \quad (5)$$

where: c_1, c_2, c_3 – average management costs for training, advanced training and re-qualification of administrative employees; K_{min}, K_{max} – expenditures on training, advanced training and re-qualification of administrative employees, minimum and maximum accordingly.

A significant amount of administrative losses is associated with the correction of errors and defects as a result of inaccuracy of management decision-making. Therefore, we should set the maximum expenditure level that would be aimed to eliminate wrong decisions and minimize their number various levels of management. The amount of additional costs for revisal is the time spent on their average wages. The function will be as follows:

$$e_1 x_1 + e_2 x_2 + e_3 x_3 \le P, \quad (6)$$

where: e_1, e_2, e_3 – average management costs spent by top, middle and low line managers on elimination of the result of inaccurate management decisions; P – highest possible management costs spent on elimination of the result of inaccurate management decisions.

Studies have shown that loyalty of staff has a direct impact on productivity and the result of the company's activities. It is therefore important to increase staff loyalty and set clear limits on the level of expenditures on the following measures:

$$g_1 x_1 + g_2 x_2 + g_3 x_3 \le L, \quad (7)$$

where: g_1, g_2, g_3 – average expenditures for increasing the level of loyalty of top, middle and low line managers; L – highest possible level of expenditures on increasing the level of loyalty of administrative employees of the company.

In general, proposed optimization model will be as follows:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \to min,$$
$$\begin{cases} b_1 x_1 + b_2 x_2 + b_3 x_3 \le D \\ e_1 x_1 + e_2 x_2 + e_3 x_3 \le P \\ g_1 x_1 + g_2 x_2 + g_3 x_3 \le L \\ c_1 x_1 + c_2 x_2 + c_3 x_3 \le K_{max} \\ c_1 x_1 + c_2 x_2 + c_3 x_3 \ge K_{min} \end{cases} \quad (8)$$

In present years, researchers have become increasingly unanimous in declaring that there is no balance between different levels of management costs. Particularly, they are more considerable and often unnecessary at the top levels of management and significantly lower than it is should be at the middle and lowest line levels of management of gas industry enterprises. Especially, this misbalance is observed with the administrative costs of the state gas producing companies. Therefore, the objective function will remain

the same as in the previous optimization model. Only limits will be changed for the optimization model:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \rightarrow min. \quad (9)$$

The system will consist of six inequalities that set the maximum and minimum amount of administrative costs for the three levels of management - institutional, administrative and manufacturing [11,12,13]. Expenditures are planed and budgeted by the administration of the company. It is possible to establish the amount of administrative costs for each level of management by an expert way. Hereby, the amount of management costs of each level of management should provide staff development for each of the studied levels and motivate to perform their tasks and goals on the one hand, but on the other hand, it should eliminate duplication, bureaucracy, corruption in the system of management at the enterprises of gas industry. The system of limits can be written as follows:

$$\begin{cases} l_1 x_1 + l_2 x_2 + l_3 x_3 \geq R_1 \\ l_1 x_1 + l_2 x_2 + l_3 x_3 \leq R_2 \end{cases}, \quad (10)$$

where: R_1, R_2 – minimum and maximum amount of administrative costs for providing the work of administrative employees at the institutional, administrative and manufacturing (technical) level; l_1, l_2, l_3 –amount of administrative costs per top manager, middle manager, low line manager accordingly.

The process of balancing of administrative costs can be carried out not only with aggregate expenditure of each management level but also with the elements of management costs to ensure stable work of each level of management at the enterprises of gas industry. Our research will explore how to balance administrative costs at three levels of management: material costs, wage bill, amortization, cost of social charges and other administrative costs. These costs at different levels of management will have different amount. Therefore, the proposed model will be as follows:

$$a_1 x_1 + a_2 x_2 + a_3 x_3 \rightarrow min,$$

$$\begin{cases} d_1 x_1 + m_1 x_1 + z_1 x_1 + s_1 x_1 + f_1 x_1 \geq R_{11} \\ d_1 x_1 + m_1 x_1 + z_1 x_1 + s_1 x_1 + f_1 x_1 \leq R_{12} \\ d_2 x_2 + m_2 x_2 + z_2 x_2 + s_2 x_2 + f_2 x_2 \geq R_{21} \\ d_2 x_2 + m_2 x_2 + z_2 x_2 + s_2 x_2 + f_2 x_2 \leq R_{22} \\ d_3 x_3 + m_3 x_3 + z_3 x_3 + s_3 x_3 + f_3 x_3 \geq R_{31} \\ d_3 x_3 + m_3 x_3 + z_3 x_3 + s_3 x_3 + f_3 x_3 \leq R_{32} \end{cases}, \quad (11)$$

where: d_1, d_2, d_3 – management costs for wages of top, middle and low line management levels; m_1, m_2, m_3 – material management costs for providing the work of top, middle and low line managers; z_1, z_1, z_3 – amortization of assets and facilities used for the activities of top, middle and low line management levels; s_1, s_2, s_3 – costs on social payroll at top, middle and low line management levels; f_1, f_2, f_3 – other management costs for providing the work of top, middle and low line managers.

We should also develop database to record administrative management costs. Thus, the use of ABC analysis is intended to allocate costs in accordance with the activities of management and to identify factor that influence these costs [7, 19]. Thereby, ABC analysis or also called functional and value analysis [17], allows us to track the connections between expenditures and their reasons.

Having examined the peculiarities of activities of the enterprises of gas industry, it is reasonable to set the appropriate grouping of departments of management according to the joint functions. We can specify the following centers: the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the research centre, the centre of manufacturing service, the centre of personnel management.

1. The finance and economic centre (accounting department, planning and economic department, financial department, investment department);

2. The centre of production (manufacturing department, technical department, drilling department, the department of capital construction);

3. The centre of legal aid and monitoring (law department, safe-custody department, internal audit department);

4. The centre of manufacturing service (department of chief engineer, department of purchasing, administration department and secretariat, the department of power and water supply, department of occupational safety and health, department of information support and computer service);

5. The research centre (department of geology, laboratories, budgeting department);

6. The centre of personnel management (department of work organization and wages, personnel department).

It is important to identify factors that impact the expenses of the selected centers in the process of their formation. The factors of expenditures of the finance and economic centre can be the number and size of reports (administrative and financial), the number of documents that needs processing , organization of record-keeping, the number of mistakes and errors made by employees and identified in the process of different revisions, the amount of fines imposed due to errors of employees.

The factors of expenditures of the centre of production can be the number of oil wells, the regional location of oil fields, and the production volume of gas, oil and other related products. It is necessary to introduce the value coefficient of complexity and the level of infrastructure development of the area where energy resource are mined.

The factors of expenditures of the centre of legal aid and monitoring can be payment discipline, reliability of suppliers and contractors, the level of prevention of theft

and abuse, the amount of leakage of commercial information and the level of losses due to it, the level of physical and psychological protection of workers (measured in points by inquiry).

The factors of expenditures of the centre of manufacturing service can be the number of suppliers, the regional location of facility, the size of suppliers and supply chains length, width of supply chains, infrastructure of the area, the number of discounts and amount of resource savings obtained as a result of discounts.

The factors of expenditures of the research center can be the number of projects, the number of objects of geological research, the complexity of geological research, peculiarities of projects accomplishing (joint activity, economic way, and outsourcing), the number of confirmed reserves and successful projects.

The factors of expenditures of the centre of personnel management can be the number of personnel, qualifications and structure of staff, turnover rate of personnel, experience in the company and the industry, the amount of documentary support for each of the employees, the number of training programs and advanced training courses, their frequency and methods of their conduct (internal, inviting outside experts/trainers and mixed), the number of social programs and programs of developing loyalty in the staff.

Having divided administrative management costs into the groups of the centres, we may follow their dynamics in accordance with the factors of expenditures. For example, we may trace the change of expenditures of the finance and economic centre in case of the introduction of a new accounting program or electronic document control, the change of expenditures of the centre of manufacturing service in case of closing down the parts of wells temporarily, the change of expenditures of the centre of personnel management in case of changing the number of employees, etc. In addition, this division will help to optimize management costs, to balance them between centres, to save costs, to improve the structure of organizational management and to develop the company.

Certainly, the expenditures of the centres can not proportionally be altered according to changes in the factors of expenditures, and it is obvious that the change takes time. The changes happen with some delay, there are lags. It is important to consider the time factor while finding the connection between the amount of expenditures and factors influencing them [18].

It is important to create a sharp system of organizational and informational support to administer management costs for the responsibility centres. We suggest appointing responsible persons to the centres to ensure a high level of administration (they can be deputy chief in the functional areas). They should be in charge of performing system monitoring the level and the pattern of expenditures (previous, current and final) according to changes in the factors related to the centres of administration management costs.

The proposed division into centres of administration management costs can be used to construct an optimization model to balance administrative costs. This criterion of separation of administrative costs determined the structure and quality of the staff in each of the proposed centres. Therefore, the proposed model will be as follows:

$$q_1y_1 + q_2y_2 + q_3y_3 + q_4y_4 + q_5y_5 + q_6y_6 \to min, \quad (12)$$

where: q_1, q_2, q_3, q_4, q_5, q_6 – average amount of management costs per workers in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; y_1, y_2, y_3, y_4, y_5, y_6 – average number of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management.

Limits of the optimization model should be formed according to expenditures for providing the work of each of the established centres for administration of management costs. Therefore, the system of limits will be as follows:

$$\begin{cases} d_{c1}y_1+m_{c1}y_1+z_{c1}y_1+s_{c1}y_1+f_{c1}y_1 \le \Psi_1 \\ d_{c2}y_2+m_{c2}y_2+z_{c2}y_2+s_{c2}y_2+f_{c2}y_2 \le \Psi_2 \\ d_{c3}y_3+m_{c3}y_3+z_{c3}y_3+s_{c3}y_3+f_{c3}y_3 \le \Psi_3 \\ d_{c4}y_4+m_{c4}y_4+z_{c4}y_4+s_{c4}y_4+f_{c4}y_4 \le \Psi_4 \\ d_{c5}y_5+m_{c5}y_5+z_{c5}y_5+s_{c5}y_5+f_{c5}y_5 \le \Psi_5 \\ d_{c6}y_6+m_{c6}y_6+z_{c6}y_6+s_{c6}y_6+f_{c6}y_6 \le \Psi_6 \end{cases}, \quad (13)$$

where: d_{c1}, d_{c2}, d_{c3}, d_{c4}, d_{c5}, d_{c6} – managements costs for payment for administrative employees work in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; m_{c1}, m_{c2}, m_{c3}, m_{c4}, m_{c5}, m_{c6} – financial management costs for providing the work of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; z_{c1}, z_{c2}, z_{c3}, z_{c4}, z_{c5}, z_{c6} – amortization of assets and facilities used for the activities of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; s_{c1}, s_{c2}, s_{c3}, s_{c4}, s_{c5}, s_{c6} – costs on social payroll for administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; f_{c1}, f_{c2}, f_{c3}, f_{c4}, f_{c5}, f_{c6} – other management costs for

providing the work of administrative employees in the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management; $\Psi_1, \Psi_2, \Psi_3, \Psi_4, \Psi_5, \Psi_6$ - maximum level of management costs to provide the work of the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management.

In such a model it should also be established the minimum amount of management costs to ensure the performing of necessary tasks and work. Therefore, the model takes the following form:

$$\begin{cases} \chi_1 \le d_{c1}y_1 + m_{t1}y_1 + z_{c1}y_1 + s_{c1}y_1 + f_{c1}y_1 \le \Psi_1 \\ \chi_2 \le d_{c2}y_2 + m_{t2}y_2 + z_{c2}y_2 + s_{c2}y_2 + f_{c2}y_2 \le \Psi_2 \\ \chi_3 \le d_{c3}y_3 + m_{t3}y_3 + z_{c3}y_3 + s_{c3}y_3 + f_{c3}y_3 \le \Psi_3 \\ \chi_4 \le d_{c4}y_4 + m_{t4}y_4 + z_{c4}y_4 + s_{c4}y_4 + f_{c4}y_4 \le \Psi_4 \\ \chi_5 \le d_{c5}y_5 + m_{t5}y_5 + z_{c5}y_5 + s_{c5}y_5 + f_{c5}y_5 \le \Psi_5 \\ \chi_6 \le d_{c6}y_6 + m_{t6}y_6 + z_{c6}y_6 + s_{c6}y_6 + f_{c6}y_6 \le \Psi_6 \end{cases}, \quad (14)$$

where: $\chi_1, \chi_2, \chi_3, \chi_4, \chi_5, \chi_6$ - minimum level of management costs to provide the work of the finance and economic centre, the centre of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre and the centre of personnel management.

We will find the solution of this model using the data of the gas manufacturing department "Lvivhazvydobuvannya". The function with data will be written as follows:

$$156457y_1 + 160963y_2 + 129917y_3 + 141060y_4 + 146912y_5 + 177716y_6 \ min,$$

$$\begin{cases} 3730904 \le 156457 y_1 \le 5577701 \\ 2971625 \le 160963 y_2 \le 4442579 \\ 1299171 \le 129917 y_3 \le 1942261 \\ 4991342 \le 141060 y_4 \le 7462057 \\ 2373190 \le 146912 y_5 \le 3547919 \\ 956933 \le 177717 y_6 \le 1430616 \end{cases} \cdot \quad (15)$$

RESULTS

The solution of the optimization model makes it possible to establish the crucial number of employees for each of the centres of administration management costs: the finance and economic centre - 23 persons, the center of production - 18 persons, the centre of legal aid and monitoring - 10 persons, the centre of manufacturing service - 35 persons, the research centre - 16 persons, the centre of personnel management - 6 persons.

Our research has proved that this number of administrative employees will lead to reduction of expenditures and the number of managerial staff by combining the individual functions and optimization of interaction processes. The quality and amount of work performed will not be reduced, and in some centres will be increased by improving the social and psychological environment, eliminating duplication of functions, decentralizing operations and improving of productivity. Our research has revealed that reduction of the staff is: the finance and economic centre - 8 persons, the center of production - 4 persons, the centre of legal aid and monitoring - 4 persons, the centre of manufacturing service - 11 persons, the research centre - 5 persons, the centre of personnel management - 1 person. Total staff reduction may reach 28 % and reduction of management costs by 30%.

CONCLUSIONS

Optimization models will enable managers to balance the functioning of different levels of administrative employees, to optimize management costs, and thus to increase productivity and staff loyalty, to reduce economic risks and turnover rate of personnel, to develop staff reserve and to improve other financial and economic indicators of enterprises. We have elaborated the model of optimization of management costs spent by top, middle and low line managers, composed the optimization model for the three levels of management - institutional, administrative and manufacturing. Using ABC analysis, another optimization model has been formed to administer management costs at the basis of specialized centres: the finance and economic centre, the center of production, the centre of legal aid and monitoring, the centre of manufacturing service, the research centre, the centre of personnel management.

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Commercialization of high-tech products: theoretical-methodological aspects

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Abstract. Based on theoretical knowing of modern, economic concepts of innovation, systems theory, management and information and also on the practice of their using in the management system of enterprises, in this case was proposed a new solution of scientific problems. It was the development of theoretical and methodical applied principles concerning the commercialization of high-tech products industry.
Key words: Commercialization, high-tech product, diffusion, effectiveness, innovativeness, evaluation.

THE PROBLEM STATEMENT

With the reforming of the national economy the strengthening of integration processes in industrial plants that produce high-tech products is a problem of commercialization. There are objective and subjective motives. To begin with, all these plants are established during the Soviet time, they worked traditionally for the state offering and had state financing. In case of the changing usual circumstances they would be unready to the survival of the presence competition. Secondly, in a context where the national market demand for high-tech products is low, food-analogues of foreign production have appeared. Consumer demands are increasing, so there is a need extending the professionalism in the study of demand, usage of competitive pricing and permanent efforts for the improving quality of finished high-tech products. In order to meet these requirements personnel of industrial enterprises, especially managers must possess methodological tools commercialization of high-tech products. Thirdly, in the market conditions, due to the foreign practice, the process of commercialization is based on partnerships manufacturers of high-tech products with risky financial industries. The success depends on control of allocation of property rights to commercialization. In Ukraine, unfortunately, the law of intellectual property rights only emerging, venture organizations are slow to invest in Ukrainian high-tech projects through unfavorable investment climate. As a result, the problem of commercialization of high-tech products by industrial enterprises is in the lack of systematic theoretical and methodological conditions concerning rational and administrative decisions which is connected with supplying effectiveness in commercialization of high-tech products.

In most scientific papers of conceptual and methodological commercialization of high-tech products are as a component of the national innovation system and at the same time as the final stage of interaction of educational, research and industry within technology parks, innovation clusters or other structures. In turn, in the works that are more applied nature of the problem of commercialization are considered in terms of marketing, including tactical tools to promote these products to consumers.

Existing theoretical, methodological and practical developments in the commercialization of high-tech products industries are characterized by fragmentation, unsystematic ideas about causal relationships that arise between the subjects of the commercialization of high-tech products. Researches have unnoticed: the methods to identify the diffusions high-tech products in the

process of commercialization, methods of evaluation in the level of innovation high-tech enterprise, methodological approaches to determine the level of effectiveness of the commercialization of high-tech products, the sequence of construction phases of the commercialization of high-tech products and industries.

The research was conducted for the development theoretical and methodological-applied statements due to the commercialization of high-tech products of industrial enterprises.

THE MAIN MATERIAL AND RESULTS

According to the results of the research above is approved that the features of high-tech products are its capacity of knowledge and complexity of the technology. The level of high-tech complexity of production characterizes spatial and time coordination of realization high-tech operations, capacity of knowledge and uniqueness of the work. Also it characterizes specificity program complexes and devices, which is necessary for the management technological units, especially its interaction.

Commercialization of high-tech products is a process of establishing, selling and progress on the market of high-tech products, which supplies the expected economic effect to the industry. Analysis of statistical, expert and empirical data suggests that it is the commercialization of high-tech products, and not its creation is a problem for domestic industry. The Lack of government involvement in the formation of effective demand for high-tech products, expand markets for these products abroad, and also without adaptability of enterprises to competitive conditions are the main reasons that the part of high-tech products in total industrial output of enterprises is low and constantly decreasing.

Studies have shown that the additional feature of high-tech products is its innovativeness. It doesn't mean that all high-tech products are innovative, but today on the market of high-tech products is a significant number of innovative products. The higher level of innovation is characterized by activities the more likely it is to ensure the effectiveness of commercialization. With information additional position when choosing the best options for commercialization of high-tech products the business leaders advisable to use a classification of commercialization (Table 1) [1,3,9,11-15,17-20].

The proposed classification can serve as logical structure for the construction of databases related to the preparation and implementation of decisions related to the production and promotion of high-tech products on the market.

Analysis and synthesis of information on the practice of commercialization of high technology products in different countries has shown that a key role in the development and establishment of high-tech products is played by Multinational Corporation; All without exception Multinational Corporations stimulate the creation of small venture enterprises in its structure that are funded by domestic venture capital funds; geographical location of the place of research centers and venture companies depends on the financial benefits of administrative regions as well as the level of skills development in the region; the vast majority of venture capital firms focused in technical parks, business incubators and other innovative structures, a key role in the creation of innovative structures such as technology parks and technopolis play the governments; commercialization of high-tech products starts when Multinational Corporations would include regional differences in demand for a new product and ensured all conditions for rapid return on investment.

Table 1. The types of commercialization

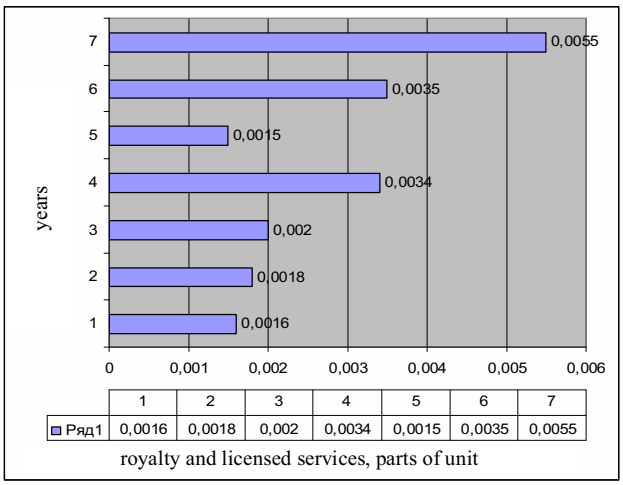
Classification	The types of commercialization
By contents	The commercialization which goes by subject, which is an entity that acts as a developer of high-end products, its manufacturer and seller of one person; Commercialization, which is the entity that owns intellectual property rights to the high-tech product through licensing business partners; Commercialization, which is the entity that owns intellectual property rights to the high-tech product using franchising agreements; Commercialization, which is the entity that owns intellectual property rights to the high-tech product using the lease; Commercialization, which is the entity that owns intellectual property rights to the high-tech product through a combination of the above methods of commercialization
In terms of efficiency	Commercialization of high-tech product, which provided the expected economic effect; Commercialization of high-tech product, which did not provide the expected economic benefits
The number of subjects	Mono-subject commercialization of high-tech product; Bi-subject commercialization of high-tech product; Poly-subject commercialization of high-tech products
By geographical coverage of subjects commercialization	Commercialization of high-tech products in the national market; Commercialization of high-tech products in the foreign market; Commercialization of high-tech products both nationally and in foreign markets
By way of financing	Commercialization of high-tech product, which occurs at the expense of banks and venture capital funds; Commercialization of high-tech product, which occurs at the expense of budgetary and extra-budgetary funds; Commercialization of high-tech product which is using its own funds of commercialization; Commercialization of high-tech product which is due to funds from various funding sources

Notes: Developed by authors of article

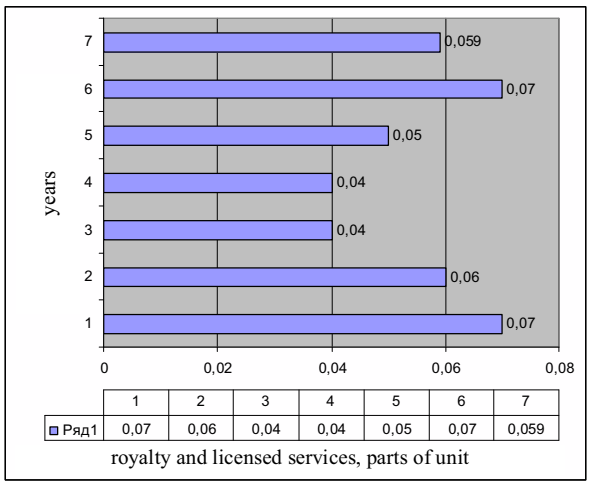
Thus, in Ukraine, despite some real steps taken to create a national innovation system the prerequisites are absent for activation of processes of production and commercialization of high-tech innovation. First of all, the investment climate is not favorable for the coming strategic foreign venture capital investors, including those that are transnational. Secondly, the existing innovation infrastructure in Ukraine has too little in common with traditional, by world standards, innovative formations, in particular such as techno-parks, techno-polis, innovation clusters. They are almost devoid of tax and administrative privileges. Thirdly, the base of high-tech manufacturing and commercialization of innovative products are high local concentrations of skilled, mobile staff. They can retrain and do intellectual operations.

In the economy of Ukraine during the commercialization of high-tech products in the industry there are a number of common problems. Among them are the problems that require adaptation of enterprises to the environment and the problems where the source of problems is the same company, such as decision makers. Studies have shown that solving these problems is possible only if commercialization of high-tech products subject to the following principles: information security, protection of intellectual property rights to the product and diversification the source of funding of commercialization, making business plans for commercialization of high-tech products in the pessimistic scenario, reaching flexibility in the selection and implementation of the strategy and tactics of the commercialization of high-tech products, the use of differentiated in time and space pricing mechanism.

The study of statistical information and exploring data of enterprises showed that the commercialization of high-tech products can be made as based on the use of know-how and the basis of the patents. This applies to cases of promotion of high-tech products in Ukraine, and in the case of exports. Studies have shown that out of a total population of industrial enterprises in Ukraine only about 1,600 companies produce high-tech products, these are the processing and engineering industries. More than 400 companies, more than 12% of industrial enterprises develop and implement innovations while in developed countries the share of enterprises in 4-5 times higher. Most of these businesses are unevenly distributed by region of Ukraine, and most innovations are not patented. Commercialization is mainly based on relationships, based on know-how, which significantly reduces the organizational and legal positions of commercialization entities in defending their economic interests in interaction with business partners. Innovative high-tech products exports 36.2% of enterprises. With only a third of its volume of production is new for the market, all other high-tech products exported belong to some innovation [2, 4-8, 10, 16]. The Analysis of information of payment balance showed that the structure of export and import volume licensing and royalty services for Ukraine is traditionally very small. It is far less than 1%, while there is a steady excess of import licenses and royalties on their exports (Figure 1). The third part of post-Soviet countries are potential domestic consumers associated with high-tech products. Thus, there is no doubt that for the activation of processes of commercialization of high technology products and increase the level of geographic differentiation of its sales, it is necessary to update its quality, provide it with evidence and protect the rights of ownership of its production.



A) The part of export



B) The part of import

Fig. 1. Dynamics of particles royalties and licensing services in the structure of exports and imports of services during the 2005-2011

Notes: The authors constructed it according to the State Statistics Committee of Ukraine and the National Bank of Ukraine. Marks: 1 – 2005 year, 2 – 2006 year, 3 – 2007 year , 4 – 2008 year, 5 – 2009 year, 6 – 2010 year, 7 – 2011 year.

The tax preferences, the sources of funding for the commercialization of high-tech products, the level of interest rates on bank loans and the conditions of their provision, the value sector of the market, which is oriented for the manufacturing high-tech products, the chosen strategy of promoting high-end products, etc. are factors that influence the effectiveness of the commercialization of high-tech industrial products enterprises. Their economic content, the links between them and the total impact must be considered when forming a strategy and tactics of the building commercialize high technology products.

In order to obtain the expected economic results from the commercialization of high-tech products, the manufacturer should permanently monitor the parameters that characterize the effectiveness of commercialization, it is necessary to neutralize the factors that affect the commercialization of high-tech products or adapt to them. Due to the analysis was developed the method of evaluation of economic efficiency commercialization of high-tech products. It is based on the calculation of several groups of indicators. There are: indicators of economic efficiency commercialization of high-tech products; indicators of market opportunities subject of commercialization of high-tech products; gaining comparative advantages during the commercialization of high-tech products, performance completeness and timeliness of the plan commercialization of high-tech products.

The set of indicators that reflect the effectiveness of the commercialization of high-tech products, in a formalized form can be written as:

$$E^n = \bigcup_{i=1}^{a} e_{f_{1j}} \cup \bigcup_{j=1}^{b} e_{f_{2j}} \cup \bigcup_{x=1}^{c} e_{f_{3x}} \cup \bigcup_{z=1}^{z} e_{f_{4z}}, \quad (1)$$

where: (n) – is a total number of indices that characterize the effectiveness of the commercialization of high-tech products in the context of all groups; e_{f_1} – the indices that characterize the economic efficiency of the commercialization of high-tech products; a – the quantity of indices in plural (number); e_{f_1} ; e_{f_2} – the indices that characterize the realization of market possibilities of subject in commmercialization of high tech products; b – the quantity of indices in plural(number); e_{f_2} ; e_{f_3} – the indices that characterize the gaining of industry comparative advantages during commercialization of high-tech product; c – the quality of indices in plural(number); e_{f_3} ; e_{f_4} - the indices that characterize the completeness and timeliness of the plan commercialize high-tech products; d - number of indices in the set e_{f_4} .

Each component of the constructed set is a subset of those that consist of a number of interacting elements. Consider the relationship between them:

1) a subset of economic efficiency commercialization of high-tech products:

$$\bigcup_{i=1}^{a} e_{f_{1_i}} = \left\{ \begin{matrix} 2 \\ e_{f_{1.1_\alpha}} \\ \alpha=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.2_\beta}} \\ \beta=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.3_\chi}} \\ \chi=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.4_\delta}} \\ \delta=1 \end{matrix} \right\} \cup$$

$$\cup \left\{ \begin{matrix} 2 \\ e_{f_{1.5_\varepsilon}} \\ \varepsilon=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.6_\phi}} \\ \phi=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.7_\varphi}} \\ \varphi=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.8_\gamma}} \\ \gamma=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{1.9_\eta}} \\ \eta=1 \end{matrix} \right\}, \quad (2)$$

The subset of indices of market opportunities subject commercialization of high-tech products:

$$\bigcup_{j=1}^{b} e_{f_{2_j}} = \left\{ \begin{matrix} 2 \\ e_{f_{2.1_\iota}} \\ \iota=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{2.2_\kappa}} \\ \kappa=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{2.3_\lambda}} \\ \lambda=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{2.4_\mu}} \\ \mu=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{2.5_\nu}} \\ \nu=1 \end{matrix} \right\}, \quad (3)$$

3) Subset of parameters that characterize the acquisition of companies comparative advantage in the commercialization of high-tech products:

$$\bigcup_{x=1}^{c} e_{f_{3_x}} = \left\{ \begin{matrix} 2 \\ e_{f_{3.1o}} \\ o=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{3.2_\pi}} \\ \pi=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{3.3_{\varpi}}} \\ \varpi=1 \end{matrix} \right\} \cup$$

$$\cup \left\{ \begin{matrix} 2 \\ e_{f_{3.4\theta}} \\ \theta=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{3.5_\vartheta}} \\ \vartheta=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{3.6\rho}} \\ \rho=1 \end{matrix} \right\}, \quad (4)$$

4) A set of indices completeness and timeliness of the plan commercialization of high technology products company:

$$\bigcup_{z=1}^{d} e_{f_{4z}} = \left\{ \begin{matrix} 2 \\ e_{f_{4.1\sigma}} \\ \sigma=1 \end{matrix} \right\} \cup \left\{ \begin{matrix} 2 \\ e_{f_{4.2_\varsigma}} \\ \varsigma=1 \end{matrix} \right\}. \quad (5)$$

Multi proposed method will identify resources needed to increase the efficiency of the commercialization of high-tech products; to establish the activation of creative and management initiatives for projects commercialization of high-tech products; to provide the mark of phenomena and tendencies inside, outside surroundings of industry of high tech products; to show the feasibility of the establishment license in respect of the transfer of the production and promotion of high-tech products to third parties; justify the timing of the life cycle of high-tech products and more.

The process of commercialization of high-tech products is inevitably accompanied by diffusion, in other words the distribution of these products on the market. Despite the efforts of manufacturers to control the diffusion of the probability of turning it into a natural phenomenon always is present. However, businesses can evaluate the diffusion and application of certain measures for its restriction or guidance in the right direction. Studies suggest that alternatives of morphological analysis are the discriminant and cluster analysis, in particular isomorphic and isotopic, functional analysis, the method of construction of network graphs, and analysis by constructing cognitive maps, in particular Petri nets. In (Table 2) shows the comparative characteristics of alternative types of analysis that can be used for assessing the effect of diffusion on the effectiveness of commercialization of high-tech products.

Table 2. Comparison of alternative types of analysis that can be used for assessing the effect of diffusion on the effectiveness of commercialization of high-tech products

Type of analyses	Common characteristics	Different characteristics
Morphological analysis	-Focus on the objects, that have common features; -using the formalization as higher level of abstraction; - predict the point of explored phenomenon on independent parts and establishment of some relations between them	- Characterized by descriptiveness; - Making possible the transition from decomposition to recomposetion and vice versa
Discriminant analysis		Let the possibility to identify the studied object to a class of objects
Cluster analysis		Allow to form the structures of elements of explored phenomenon
Functional analysis		Provide the information about line connections between factors, that influenced on effective indices and let set the reserves of improvement meanings of these indices in future
Analysis method for constructing network graph		Allow to set the optimal way of established goal and also to find the time reserves of optimization
Analysis by constructing cognitive maps, in particular Petri nets		Make possible simplified modeling of connections between key parameters

Notes: Done by authors of the article

Critical analysis of existing approaches of evaluating the phenomenon of diffusion suggests that the greatest benefits of evaluation are based on the morphological analysis (Fig. 2). Morphological analysis provides a decomposition of the diffusion parameters of high-tech products, which allows on its basis of essential characteristics to identify causal relationships between the factor and effective signs that are quantitatively and qualitatively characterize this phenomenon.

Summary of background information of morphological analysis can be used to improve the results of commercialization of high-tech products. This task should be used by morphological synthesis, which is based on the binary morphology. Morphological synthesis allows to identify set of vectors that point the way of improvement in the results of commercialization of high-tech products, analysis the events that have a material impact on the results and commercialization of high-tech products to transform their qualitative characteristics in quantitative and form a so-domain data for inputting the clearly information.

Research has shown that generalization of the original morphological analysis of information should be based on the so-called morphological synthesis. Morphological analysis of the phenomenon of diffusion of high-tech products is a decomposition process of extracting the essential characteristics of diffusion to determine causal-effect relationships between factors that led to the phenomenon of diffusion. Diffusion is inextricably linked with the commercialization of high-tech products. To identify stocks of commercialization important are to synthesize input data derived from morphological analysis. The synthesis involves bringing together disparate information in total. If the analysis builds a tree structure in the form of dendrites so during the synthesis of dendrite morphology will be a set of vectors that point the way to improve the results of commercialization of high-tech products. Automating the process of developing the management solutions with improvement results of the commercialization of high-tech products on the basis of morphological analysis and synthesis is possible on the basis of provisions of binary morphology display, which represents an ordered set of data symbols marked as "0" and "1". Binary morphology allows produce the events that have a material impact on the process and results of commercialization of high-tech products, to transform their qualitative characteristics in quantitative. The incoming information should be classified. This will increase the level of argumentation in development management of decisions and expedite the process of their formation. It is essential to achieve the expected results of commercialization of high the products.

From the standpoint of economic efficiency commercialization of high-tech products important is to provide to this product as a lot of innovations. The Urgency of this task increases when high-tech products have the analogues on the market. Under these conditions, if the company that sells high-tech products commercialization can provide some of its innovations, it is essential competitive advantage. Studies have shown that innovation can be seen from the perspective of destination product, its functionality, quality and price used in its production materials (Fig. 3).

The method of innovative high-tech production enterprise is based on innovative features of high-tech production in enterprise including the commercialization, levels of diffusion and phases of the life cycle of high-tech production. Using this method business leaders get to track the changes in innovative high-tech enterprise. It is important for reasoning of necessary management decisions concerning investments in the improvement or modification of the product or collapse of the project in its production.

As a result of the studies was demonstrated that the process of commercialization of high-tech products is a manageable phenomenon, an artificial system that is formed by business leaders to achieve specific economic goals. The elements of this system are high-tech products as an object of commercialization, consumers of innovative products, supply and demand for it, the cost of commercializing of innovative products and its price. In Fig. 4 is built a graphical model of commercialization of high tech company.

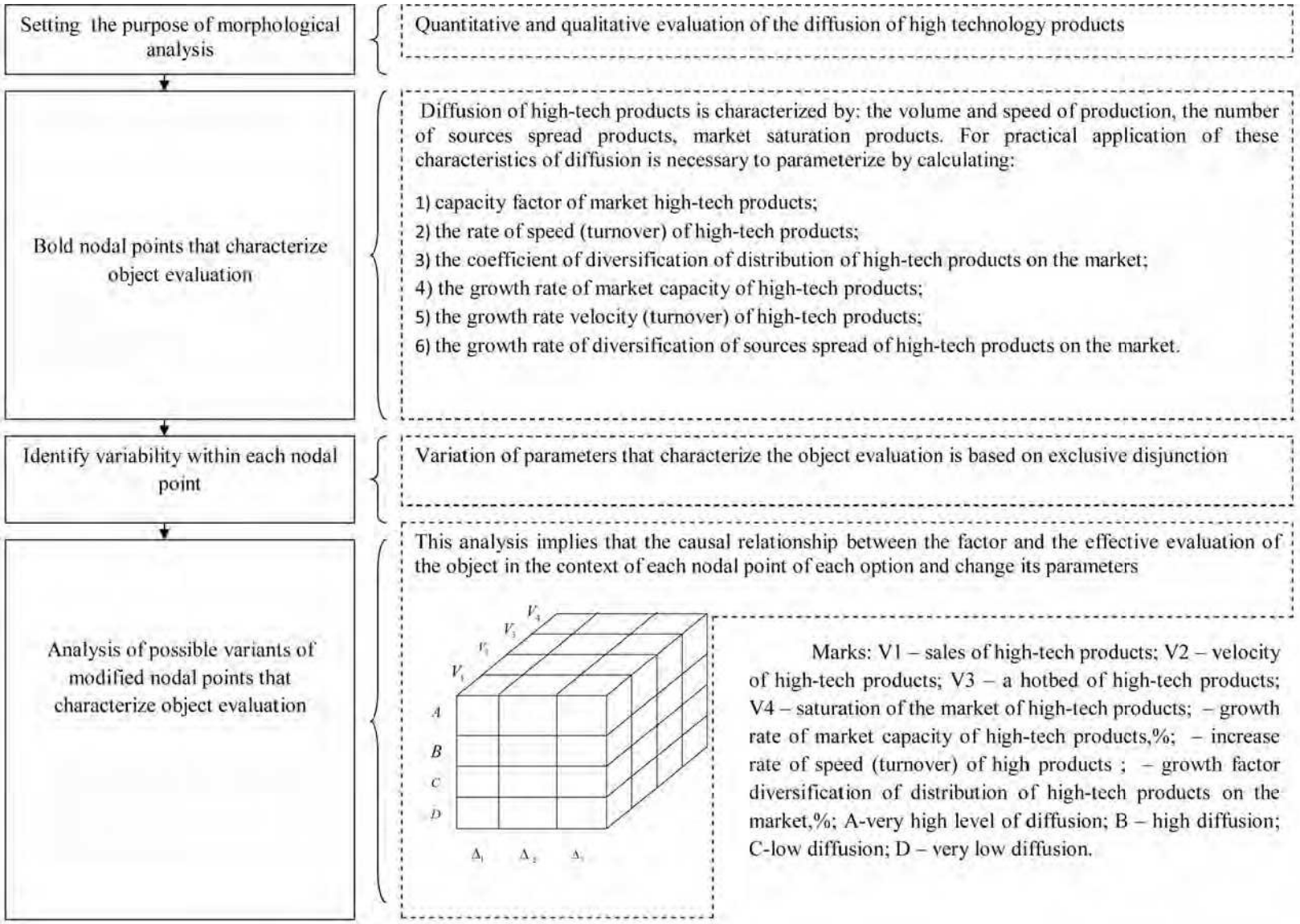


Fig. 2. Stages of Evaluation diffusion of high technology products through the use of morphological analysis

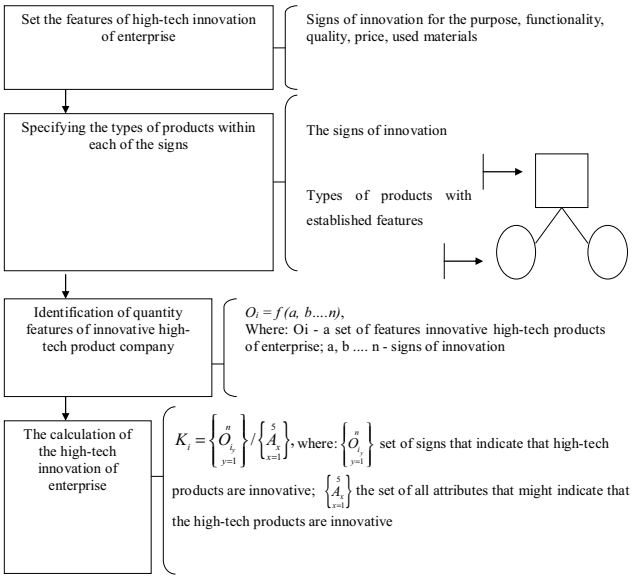


Fig. 3. The sequence of stages evaluation of innovative high-tech products of company
Notes: Done by authors.

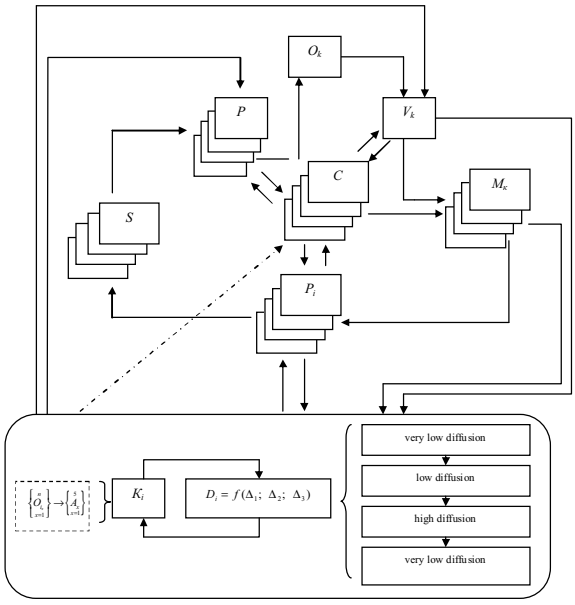


Fig. 4. Diversified system in space commercialization of high-tech products
Notes: Done by authors.

Under the influence of enterprise management solutions, which is a manufacturer of high-tech products of elements of the system to each other and the environment are aimed at increasing innovation of high-tech products. The growth effects of diffusion will contribute to the economic efficiency of the process of commercialization.

CONCLUSIONS

Based on the problem commercialization of high-tech products, policies to address them, as well as factors that affect the commercialization of high-tech products industry proven that assessment commercialization of high-tech production enterprise should carry through the calculation of economic efficiency indicators of market opportunities subject commercialization of high-tech products, gaining comparative advantage indices company during the commercialization of high-tech products, performance completeness and timeliness of the plan commercialization of high-tech products. Using this method of control subjects commercialization of high-tech products are able to reasonably make tactical decisions, organizational and marketing nature regarding adjustment of the commercialization of high-tech products.

Basing on the problem commercialization of high-tech products, principles of their solution and factors that influence on the commercialization of high-tech products industry was proven that assessment commercialization of high-tech production enterprise should be carry through the calculation of economic indicators of market opportunities on commercialization of high-tech products, gaining a comparative advantage indices company during the commercialization of high-tech products, performance completeness and timeliness of the plan commercialization of high-tech products. The phenomenon of diffusion that accompanies the commercialization of high-tech products is necessary realize objective justification for the choice of commercialization.

The Proposed method made by F. Tsvikki is based on morphological cube. The method of diffusion allows the project managers of commercialization of high-tech products to establish causal relationships between the factor and the effective diffusion characteristics of high-tech products in the context of each nodal point and each option of parameter changing. It reduces the level of commercialization of high-tech products.

It is shown that in a diffusion that is often uncontrollable phenomenon of objective reality for ensuring the effectiveness of commercialization of high-tech products is necessary to implement the measures aimed at ensuring a certain level of innovation. The innovative method of high-tech products based on the number of changes in the number of innovative features. Awareness of managers about the change in the level of innovation of high-tech products in time and also the increasing of reserves shall help of effective commercialization of high-tech products.

Stages of the construction of the commercialization of high-tech products selected taking into account the relationship between the diffusion phenomenon that accompanies the process of commercialization and the level of innovation of high-tech products. The system of commercialization of high-tech products is necessary to form diversified in space and time. There are certain principles in this case: (information security, protection of intellectual property rights, business planning of high-tech

products, flexibility in the selection and implementation of strategies and tactics commercialization of high-tech products; differentiate pricing scheme in time and space) will allow them to avoid common problems that arise during the commercialization of high-tech products.

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Freelancers in Ukraine: characteristics and principles of their activity

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Abstract. In the article the main results of a survey conducted by the authors in Ukraine were considered. Some results of the survey have been compared with data of similar surveys that have been conducted abroad. The basic characteristics of average statistical Ukrainian freelancer, including the e-lancers distribution by gender, level of education, and the distance between their residence and the nearest big city have been considered. Also, according to the survey, the distribution of Ukrainian freelancers by types of activities and gender has been done. The structure of Ukrainian freelancers by the way of freelance combination with other types of activities has been determined. Distribution of working hours by gender of Ukrainian freelancers has been done.
Key words: freelancer, freelance, online job boards, the market of freelance services.

INTRODUCTION

A significant increase is noticed every year in the number of freelancers, who are logged and working actively both in Ukrainian and in the global online freelance job boards, and that allows to conclude that the number of Ukrainian freelancers is growing. However, freelancing, as a form of business in Ukraine, is still not researched by scientists in a proper way. Also freelancers are not considered in Ukrainian legislation and statistics.

It is necessary to conduct a sociological research of Ukrainian freelancers for more objective freelance market evaluation and analyzing. Especially to which category of the population is prone to freelance, belongs barriers to which freelancers front at efficient work and what is the level of development of Ukrainian business.

MATERIALS AND METHODS

Similar researches have been conducted on the best known online freelance job boards. Freelancers from all over the world, and also from Ukraine, took part in these surveys [1]. But the amount of Ukrainian freelancers in these surveys is too low. One of such global surveys of freelancers activity has been conducted by Amanda Heckwith and online job board “Freelance Switch Jobs” [5]. Another one has been conducted by scientists of the State University - Higher School of Economics and online job board “Free-lance.ru” headed by Russian scientists D. Stebkov and A. Shevchuk. They interrogated Russian speaking freelancers from such countries and regions: Russia (76%), Ukraine (15%), Belarus (3.4%), and Kazakhstan, Moldova, Central Asia, the Baltic countries etc. (less than 2% of respondents from each country) [19, 20].

THE PURPOSE OF THE STUDY

The aim of this paper is to analyze the data collected from survey of Ukrainian freelancers with the purpose to determine the average statistical freelancer and the principles of his activity in Ukraine.

RESULTS AND DISCUSSION

Therefore, we propose to make a "portrait" of Ukrainian freelancer. According to the data of freelancers survey that we have conducted in Ukraine, the gender structure of freelancers is somewhat different from the results of similar international surveys.As we can see from the Figure 1 only 36.5% of freelancers in Ukraine are men, and 63.5% are women, in Russia that index is 67% and 33% respectively [3, 19]. One of the leading international online freelance job boards “Elance” (there are registered over than 2.5 million freelancers from over than 170 countries) consists of 58% of registered men freelancers and 42% - women [13, 14, 15, 16].

We have developed a questionnaire and conducted a survey of Ukrainian freelancers using existing methods of sociological research [4, 8, 18, 19, 21].

These differences in structure may be caused by the fact that freelance began to develop in Ukraine recently, and later comparing to the developed countries such as USA, Canada and some countries of the EU [8]. Freelancing is a comfortable type of activity, especially for women, who are on maternity leave, caring for children and have no opportunity to work in the office. Women are more prone to risk and experiments unlike men who are looking for stable income, and are less interested in distance employment. In our opinion, that are women who may try and evaluate all the advantages of freelancing in Ukraine, but eventually the proportion of men in the structure of freelancers may be higher, especially after the legalization and determination of the legal rules of freelancing as a form of business in Ukrainian law.

As we can see from Figure 2: 74.8% of Ukrainian freelancers are young people aged between 18 and 30 years old. They are prospective young people who want to work, tend to self-improvement and search for the alternative ways of their own income sources forming.

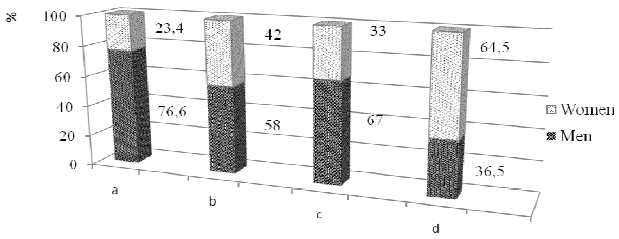
The amount of freelancers of the oldest age is lower because freelancing is a modern type activity that demands from freelancer self-development, skills improvement and quick reaction to any changes in the freelance services market. It also requires the use of modern software and various communication facilities to provide working process, the searching of the projects, and communication with customers in order to remain competitive in the international freelance services market.

Also it should be noted that the most of freelancers are university graduates: 55.7% - have master's or specialist's degree, 20% - bachelor's degree and 1% are PhD (candidates or doctors degree) and only 13% of respondents have comprehensive secondary education, 6.1% - have specialization for a certain technical arias and 4.3% - have incomplete high education (Fig. 3).

Considering that 23.5% of respondents currently combined their freelancing activity with studying in universities, the process of getting the first or second education and improving their skills, we can conclude that the Ukrainian freelancers are highly skilled and competitive workers on the global freelance services market.

Foreign freelancers choose small towns for living as it is less expensive in smaller towns and villages working as freelancer is more often not limited geographically.

It is likely that Ukrainian freelancers eventually will live away from the big cities. It will have an influence on the reduction of urbanization level. Permanent increase in the number of the urban population relatively to rural is the reason of many economical, social and environmental problems [9]. Development of freelancing will have a positive influence on the process of urbanization in Ukraine.



a –Freelance Switch Global Freelancer Survey [5];
b - Research of online job board "Elance" [14];
c – "The first Russian freelancers census" [20];
d - The survey of Ukrainian freelancers, conducted by author.
Fig. 1. Comparison of research data about freelancers' gender distribution

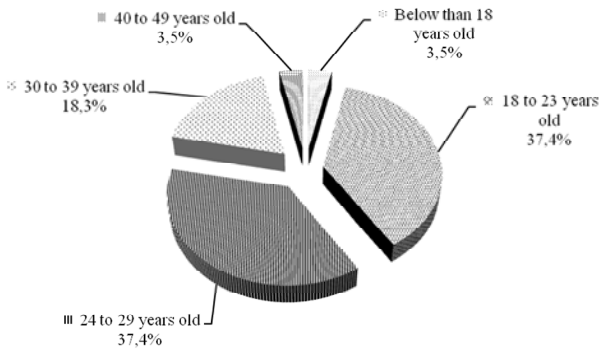


Fig. 2. The structure of Ukrainian freelancers by age

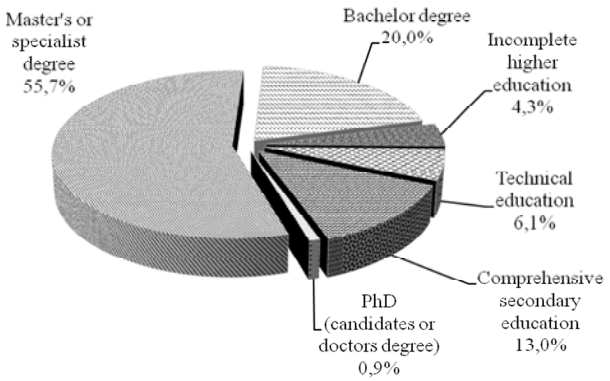


Fig. 3. The distribution of adolescents in Ukraine online job boards by the level of education

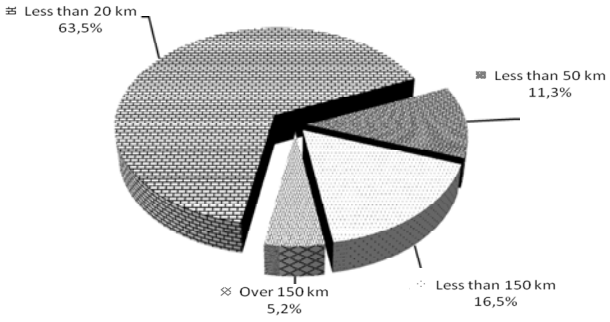


Fig. 4. The structure of distance from the freelancers' residence to the nearest big city

In Table 1 it is considered the distribution of Ukrainian freelancers by the types of work and gender. Thus, the most common specialization among Ukrainian freelancers is working with texts: copywriting and journalism.

In this area there is employed 34.8% of respondents, among them are: 82.5% of women and 17.5% of men. Among all women-freelancers 45.2% choose this specialization considering it as a main. Among the men the first place is taking by programming, serving of computers and networks – 21.4%, Internet advertising, developing and support of web sites - 19%. The least of all are men, who work with translations of foreign texts - only 4.8% and in management - 2.4%. Due to the results of this research we can argue that in Ukraine there are activities, where classic freelancers also work. They cannot do their jobs distantly, but they may use Internet only for customers searching. For example, welding and of radio electronic devices service is provided by 0.9% of respondents respectively.

As the survey was conducted with the use of online questionnaire, perhaps the amount of classic freelancers shown by the results of our research is lower than it actually is, and there are more types of work they perform. However, due to the dynamic development of computer technologies, that creates conditions for freelance services market development, there is noticed a gradual increase in the amount of possible types of activities and services, that can be provided remotely. Such a trend will increase the part of e-lancers in the whole structure of freelancers.

It should be mentioned that 40% of Ukrainian freelancers evaluate freelance as the main source of income and do not combine it with other types of employment. Rest of freelancers combine freelance with working at other organizations, getting higher education, maternity leave, and nearly 2% of respondents have a business and employees (Fig. 5).So freelance is such a flexible type of activity that can be combined with any other work or used as a way to create a primary source of income.

Such a high level of flexibility significantly reduces the freelance services market entering barriers. An employee has the opportunity to combine freelance with a previous type of employment and also create client database and get some experience that will be shown on the online job boards in the form freelancer rating. As a result, freelancers will have evidences to decide whether freelance may be a main type of activity and income source. Accordingly, it will affect the amount of potential freelancers among the unemployed and employed and that will reduce the level of unemployment in the country.

Thus, from Fig. 6 we can conclude that most freelancers use an opportunity to choose working hours themselves, and do not work as most employees with standard working hours from 9 am to 6 pm. Consequently Ukrainian freelancers usually work in the evening. Specifically about 50% of freelancers work from 6 pm to 9 pm, more than 56% - from 9 pm to midnight. Also, 24.3% of freelancers prefer to work at night, in the period from midnight till 3 am, 11.3% - from 3 am till 6 am and from 6 am till 9 am accordingly. So, freelancers activity increases in the evening and only 35-49% of freelancers work according to the same schedule as most employees with standard working hours.

Table 1. The distribution of Ukrainian freelancers by the types of work and gender

Types of works \ Gender		Men		Women		Total	
		Qty, units	%	Qty, units	%	Qty, units	%
Working with texts: copywriting, journalism	Qty, units	7	16,7	33	45,2	40	34,8
	%	17,5		82,5		100,0	
Online advertising, design and websites support	Qty, units	8	19,0	3	4,1	11	9,6
	%	72,7		27,3		100,0	
Dealing with graphics, design, illustration	Qty, units	6	14,3	10	13,7	16	13,9
	%	37,5		62,5		100,0	
Programming, computers and networks service	Qty, units	9	21,4	1	1,4	10	8,7
	%	90,0		10,0		100,0	
Translations of foreign texts	Qty, units	2	4,8	13	17,8	15	13,0
	%	13,3		86,7		100,0	
Management	Qty, units	1	2,4	2	2,7	3	2,6
	%	33,3		66,7		100,0	
Other:	Qty, units	2	4,8	1	1,4	3	2,6
	%	66,7		33,3		100,0	
Service of radio electronic devices	Qty, units	1	2,4	0	0,0	1	0,9
	%	100,0		0,0		100,0	
Welding	Qty, units	1	2,4	0	0,0	1	0,9
	%	100,0		0,0		100,0	
Several areas of activity	Qty, units	0	0,0	1	1,4	1	0,9
	%	0,0		100,0		100,0	
No answer	Qty, units	7	16,7	10	13,7	17	14,8
	%	41,2		58,8		100,0	
Total	Qty, units	42	100,0	73	100,0	115	100,0
	%	36,5		63,5		100,0	

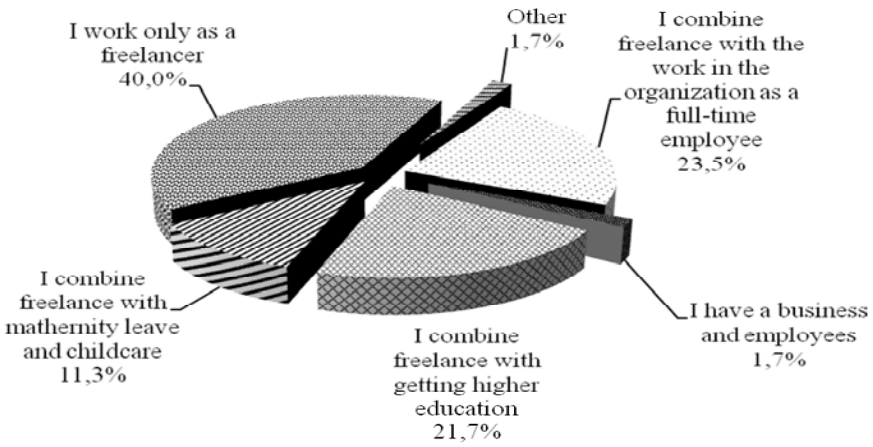


Fig. 5. The structure of freelancers divided by the way of combining freelancing with other types of activities

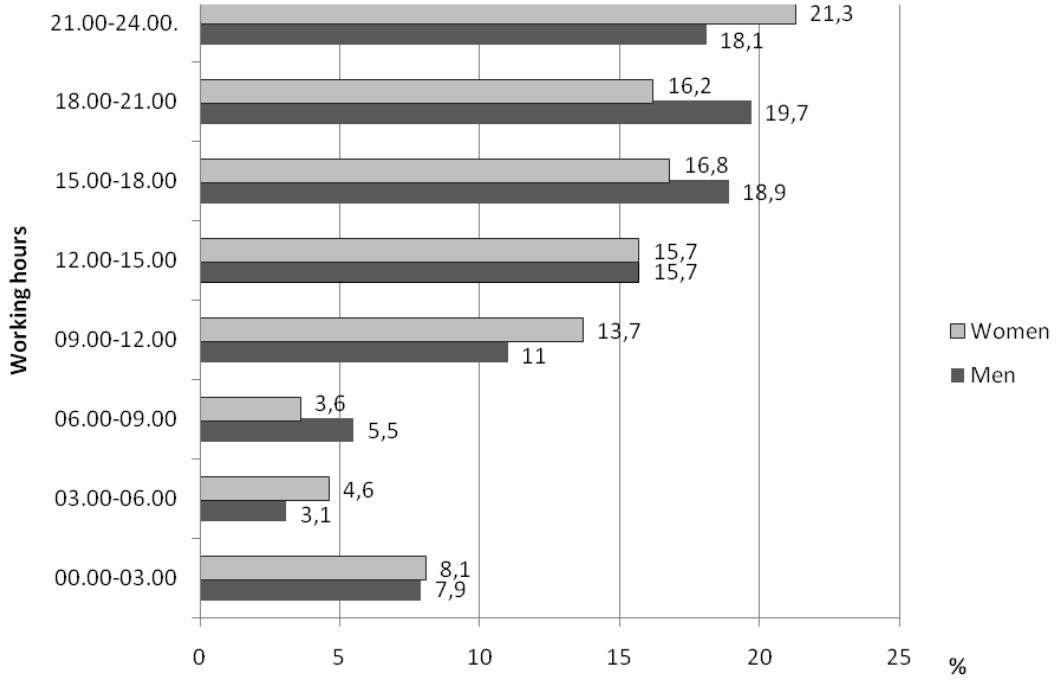


Fig. 6. The working time distribution of Ukrainian freelancers according to gender

According to gender distribution there is observed such a trend: the least amount of women work in the morning in the period from 6 am to 9 am, then their working activity gradually increases during the daytime and it's highest level (21.3%) is observed in the period from 9 pm till midnight. The least amount of men work in the period from 3 am to 6 am (3.6%), and then their working activity increases and reaches its highest level in the period from 6 pm to 9 pm (19.7%). Due to the flexible work schedule and the possibility of using the services of freelancers who live and work in different time zones the continuous work of a certain projects can be achieved. In some activities it is really advisable. As an example the attraction of freelancers who work with customers in online stores, those who are call-center operators, or those who work over complex projects, that demand the activity of several freelancers who take turns, working on parts of the project. Thus it is possible to achieve maximum reduction of project terms.

CONCLUSIONS

So, average statistical Ukrainian freelancer is a female, aged between 18 and 30 years and living in a big city. She has completed high education and is a qualified employee on the global market. Freelancing is the main source of income for average statistical Ukrainian freelancer, who does not combine freelance with other types of employment. Basic type of activity is working with texts: copywriting, journalism etc. Her schedule is flexible, so freelancer usually work in the afternoon and

in the evening (from 3 pm till midnight) using all the advantages of this flexibility.

Skills and education of Ukrainian freelancers is high enough but the cost of services is lower comparatively to their colleagues in developed countries. That's why the further development of this type of activity will possibly reduce the level of unemployment in Ukraine and increase standards of living. However, there should be hold some legislative changes in order to create favorable conditions for freelance development in Ukraine and also there should be improved the management of this activity.

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Geodistributed analysis of forest phytomass: Subcarpathian voivodeship as a case study

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Abstract. An approach to the implementation of spatial inventory of greenhouse gas sinks and emissions in forestry sector is presented. The algorithms for disaggregation of official statistical data on forests at the regional level, and formation of geodistributed database using the digital map of land use are proposed. As an example the forests of Subcarpathian Voivodeship of Poland were investigated. This study presents the results of modeling the flow of carbon in forest phytomass taking into account different tree species composition, age class and other characteristics. The 'regional' coefficients for phytomass and carbon deposited were clarified taking into account regional specificity. Also an algorithm for determining aboveground and underground phytomass of tree by its stock and forests of different types has been created. The correlation between the total area and stock for each species of forest-forming stands was analysed. The multilayer digital maps of deposited carbon, and greenhouse gas emissions in forests of Subcarpathian Voivodeship were created. For the spatial inventory of forest phytomass the territory of voivodeship was divided into square areas 2x2 kilometers in size, and stock phytomass in each such elementary area has been analised. Acheaved results were verified using GIS technology, and forest inventory data.
Keywords: information technology, digital maps, GIS, IPCC methodology, forest inventory, deposited carbon.

INTRODUCTION

The processes of carbon absorption by forest ecosystems intensively studied by many scientists especially in European countries. Project 'Carbo Europe' initiated series of new projects, which were aiming to develop a methodology to better understand the processes and implementation of quantitative assessment and verification of carbon balance. A forest valuation study collected considerable experimental material on the biological productivity of forest plantations, established patterns of distribution biomass components [1]. However, studies have not enveloped all the diversity of forest ecosystems, the available data do not give a spatial representation of the distribution of phytomass and accumulated carbon. Therefore, there is a unique opportunity based on data the remote sensing and of terrestrial observation, and data of measurements to create an effective tool for Geoinformation spatial research of complicated processes of carbon deposition in forest ecosystems and carbon balance assessment. Such an tool would be extremely useful for decision-makers, landscape planners and managers.

Poland is one of the most forested European country. At present, the forest cover in Poland is around 9,164 thousand ha, which corresponds to 29.3% of the country [1]. Forest cover in different provinces varies from 21.2% in Łódź to 49.1% in Lubuskie. The last forest inventory was carried out by Biuro Urządzania Lasu i Geodezji Leśnej to order Dyrekcji Generalnej Lasów Państwowych, completed in March 2011. The research results obtained mainly based on data from sample plots laid in 2006-2010 and it was a continuation of the first large-scale inventory of all forms of ownership of forests (for the period 2005-2010) [1]. According to the data Central Bureau of Statistics in 2010 from the previous, the forest area increased by 33 thousand ha, and since 1995, forest area in Poland has

increased by 365 thousand ha. Forest cover in Poland in 2001 was 28.5% (8.89 million ha). Over the past 50 years, it has increased by 7.7%, but has not yet reached the optimum level, which according to Polish experts should reach 33-34% [15]. The increase of total forest cover caused by afforestation of agricultural lands and natural process of afforestation. Stock of wood in the root was 1.73 billion m^3, the average current increase was 6.6 m^3/ha (in state forests - 8.5 m^3/ha). Average stock of wood per 1 ha for the last 35 years in state forests has increased from 145 to 211 m^3/ha in private and gmina forests - from 60 to 119 m^3/ha [1,10-12]. Increasing forest cover in Poland was a result of the introduction of "National Program of increasing the area of forests", developed by Forest Research Institute, adopted in June 23, 1995 by the Council of Ministers. The main goal of the program was to increase forest cover up to 30% by 2020 and up to 33% in 2050, and to ensure optimal spatiotemporal distribution of afforestation, creation of environmental and economic priorities and tools to accomplish it. The diagram (Fig. 1) shows the dynamics of change in forest cover of Subcarpathian Voivodeship in Poland within the program of increasing forest cover [12].

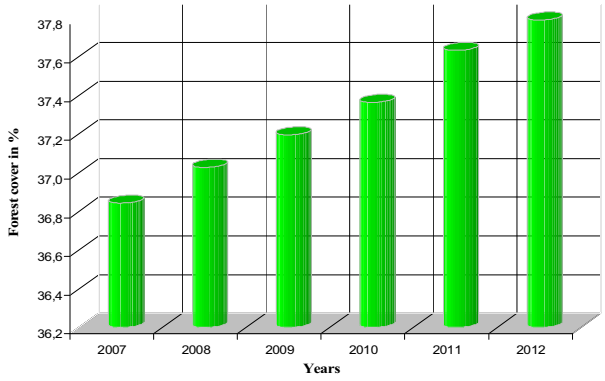

Fig. 1. Forests cover change in Subcarpathian Voivodeship, Poland (%)

Especially valuable natural forest ecosystems in Poland have certain protected status. In 2010 in Poland there were 1,441 nature reserves, including 671 forest, with total area of 61,000 hectares. It is usually highly productive old forests. The oldest and largest trees, which in 2010 totaled 10,800 units, have status of Nature Monument. Also in Poland there are national and regional landscape parks, which occupy 2.5 million ha, including 1.3 million hectares - wooded. In most cases, these forests are highly productive, they are protected, and the harvesting of wood is prohibited [14].

The objects of study in this article are the forests in Subcarpathian Voivodeship, Poland as reservoirs for deposited carbon. The subject of the study is to model the process of flow of carbon in phytomass of forest at different levels of spatial disaggregation from a single tree, to a stand level, and forest ecosystem level. The aim of the study was to develop GIS tools for spatial analysis and calculation of forest phytomass of carbon deposited in forests using statistics data, species composition, age class and other forestry valuation indicators. To achieve this goal the following tasks were:

- to develop the algorithms of estimation of aboveground and underground phytomass of a tree stem wood volume (stock) for forests taking into account different composition, age and site conditions;
- to clarify regional coefficients for phytomass and carbon deposited taking into account regional specificity;
- to form geodistributed databases and digital maps of forests as a result of spatial analysis of phytomass and deposited carbon.

METHODOLOGY

To determine phytomass and deposited carbon the methodology developed by the Intergovernmental Panel on Climate Change (IPCC) was used [7,18]. In these guidelines of National Greenhouse Gas Inventories the methods for estimating sources and sinks of CO_2 were proposed. National inventory should cover all forests, regardless of ownership and consider all forest activities ranging from growing plantations, implementing measures nature restoration care of forest crops, the workpiece firewood business and to use change [18]. According to the Guidelines, forest areas are divided into two subcategories, which have separate calculation methodologies: "forest land remaining forest land" and "non-forest land, converted to forest land". In the first case the lands that were forested for more than 20 years are considered. In the second case, the lands that were transferred to the forest area are considered, for a transitional period during which a change in carbon stocks due to land use changes takes place. By default, the length of the transition period is 20 years. The actual duration of the transition depends on the natural and ecological characteristics of a specific country or region, and may differ from 20 years [18].

The guidelines contain the methods for calculation of the the next reservoirs of carbon and other than CO_2 greenhouse gases:

- biomass aboveground and underground;
- dead organic matter (litter and wood overthrown);
- soil organic matter;
- other than CO_2 gases (CH_4, CO, N_2O, NO_x).

MAIN LEVELS OF GHG INVENTORY

IPCC Methodology recommends a three-tier general scheme for greenhouse gas inventory in the forest and land-use change. Methods of the first level are the simplest on the practical application. To evaluate emissions the appropriate formulas and parameters are

used by default (for example, the value of emission factors and changes in reservoirs). When using this level of inventory, data on economic activity at the national level are needed. Nevertheless in many cases only data on the activities assessed at a higher, sometimes even global, level are available (for example, the rate of deforestation, statistics, global maps of land cover, etc.). Therefore these data usually include low spatial resolution [6,19].

At the second level the same methodological approach as for the first level can be used, but applied emission factors and data on changes in stocks must be derived from the data for a particular country or a particular region (they can be identified by the country, and for the most important categories of land). As a part of the second level more detailed data are typically used on the activities with higher temporal and spatial resolution, in order to conform to the designated coefficients for specific regions and specialized land use categories [18].

As a part of the third level the special methods are applied, including models and systems of measurements for cadastres, adapted to specific national conditions. They can use the results of repeated measurements, and data on the activities of a better definition, including data disaggregated to the regional level. The data on economic activity at the level of separate enterprise can be applied, or a level of basic areas of a certain size, for example, 5km × 5km can be used. These methods provide an inventory of the highest order to obtain estimates of the value of a higher degree of certainty than at lower levels of inventory [2, 6, 13]. Such methods and systems may include a full inventory of the sample in the field, repeated at regular intervals or based on GIS systems, data on age class, productivity of the stand, soils conditions and other. The information about the activities in the field of land use and management, which combines the results of several types of monitoring, is also under consideration. Plots of land on which there is a change of land use, can usually be controlled with time, at least statistically.

Plant biomass, including above and underground parts, is the main reservoir for the capture of CO_2 from the atmosphere. Between the atmosphere and terrestrial ecosystems large amounts of CO_2 are moved, primarily through photosynthesis and respiration [9, 23].

Annual change in carbon stocks for each category of land use is defined as the sum of the changes in each layer within this category: $\Delta C_{LU} = {}_i\Delta C_{LU_i}$, where ΔC_{LU} is the changes in stocks of carbon for any category of land use (LU), *i* denotes a specific layer or unit within this category of land use. That is, the annual change in carbon stocks for any given layer of land use categories is defined as the sum of changes in carbon stocks in all reservoirs:

$$\Delta C_{LU_i} = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SO} + \Delta C_{HWP}, \quad (1)$$

where the subscripts denote the following carbon reservoirs: AB - aboveground biomass; BB – underground biomass; DW – wood overthrown; LI – litter; SO – soil; HWP – harvested timber. Specific emissions and removals of greenhouse gases (per hectare) vary depending on the characteristics of the land and other parameters, such as forest type, structure of plantation, current state of stand, and practice of management [16, 17, 22, 24]. An effective practice is to classify the forest areas by different subcategories with the purpose to reduce the variation in growth rate and other parameters of the forest, and to reduce an uncertainty [6]. National experts should use more detailed classification of forest lands, and regional factors estimation.

Sinks or depositions of carbon include the overall growth of biomass (aboveground and underground parts). Losses or removals of carbon include the billet of round timber, firewood, and losses from damage associated with fires, insects, diseases and other injuries also considered in the research. When such losses occur underground biomass is also reduced and converted into dead organic matter (MOU) [8, 20, 21]. Evaluation of changes in carbon reservoirs and stocks depends on the availability of data and models as well as the resources and opportunities to gather and analyze additional information [9, 23].

STUDY AREA, RESULTS AND DISCUSSION

Subcarpathian Voivodeship (‘Województwo podkarpackie’ in Polish) is located in the southeast of Poland between the rivers Vistula and San, the Sandomierz Basin and the foothills of the Carpathian Mountains. It shares borders with Slovakia in the South, and Ukraine in the East. Forest cover of Subcarpathian Voivodeship is one of the biggest in Poland and reaches 37.2%. The bigger share of forest cover has only Lubusz Voivodeship (48.9%). The area covered by forest in Subcarpathian Voivodeship is 663 797 hectares, and industrial wood supply is 194.7 million m^3, or 293.3 m^3/ha [4, 5]. In the southern, mountainous part of the region there are rich primeval forests of the Carpathian Mountains, dominated by mountain species: beech, fir and spruce (Fig. 2). The northern part of voivodeship is occupied by thick forests Sandomierz plain type. In the past, it was also dominated by beech and fir. Today, however, grows mainly pine, which was planted [3].

In terms of age structure in the Subcarpathian Voivodeship forests are predominant third and fourth age classes 25% and 21%, respectively. Little is left of seventh age class of forest, which are 120 years old and more. Distribution of forest area by age classes is presented in Fig. 3: 1 – not forested land, 2 – the first age class (up to 20 years), 3 – the second age class (21-40years), 4 – the third age class (41-60 years), 5 – the fourth age class (61-80 years), 6 – the fifth age class (81-100 years), 7 – the sixth age class (101-120 years), 8 – the seventh age class (over 120 years), 9 – KO forests, KDO, BP.

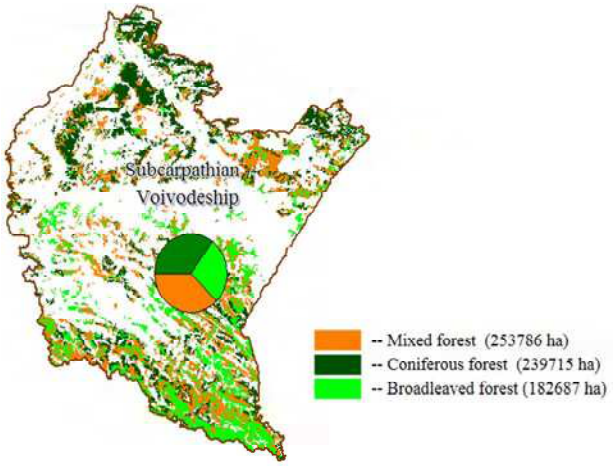

Fig. 2. Forest cover in Subcarpathian Voivodeship

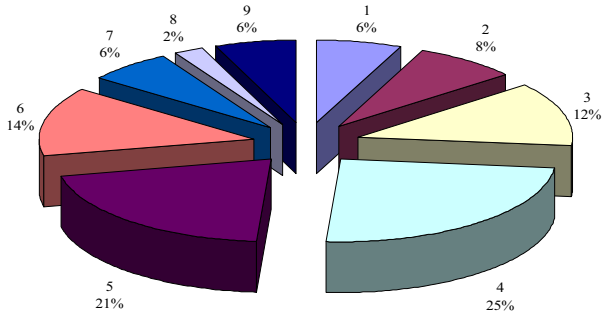

Fig. 3. Distribution of forest area by age classes

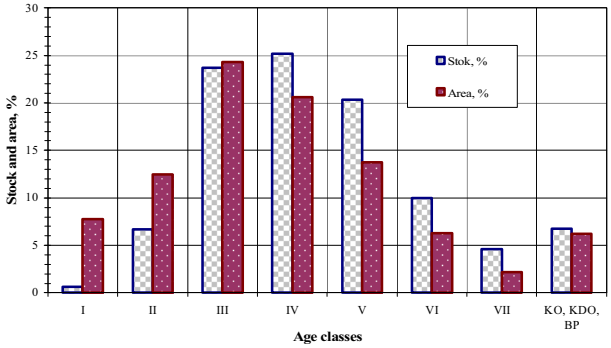

Fig. 4. Forest stands of different age classes, and forest phytomass formation

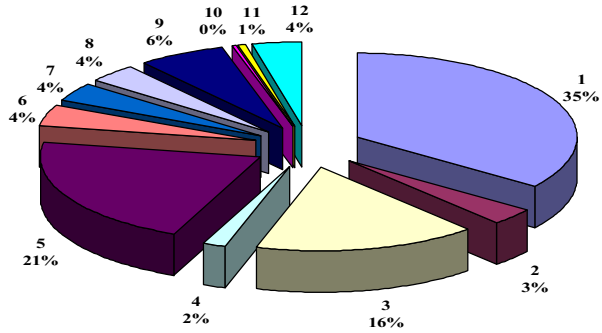

Fig. 5. Species composition of forests: 1 – pine, 2 – spruce (spruce), 3 – fir, 4 – other conifers, 5 – beech, 6 – oak, 7 – hornbeam, 8 – birch, 9 – alder, 10 – poplar, 11 – aspen, 12 – other deciduous

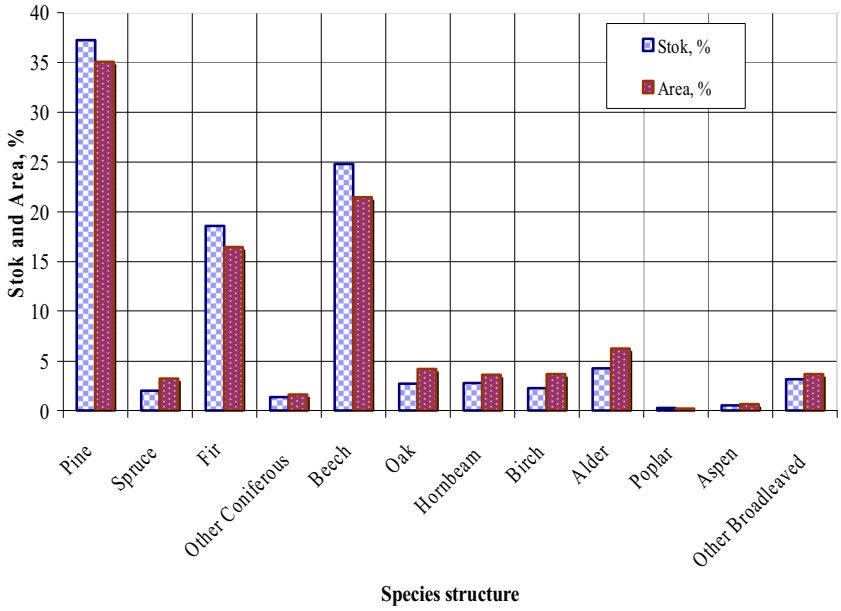

Fig. 6. Correlation between the total area and stock for each species of forest-forming stands

Share of different age classes in the formation of stem wood stock and, consequently, forest phytomass of Subcarpathian Voivodeship is shown on Fig. 4. Thus forest stands with III, IV i V age classes have the most significant impact. Young and old classes occupy a large areas of 7.75% and 12.47% of the total area covered by forest, but they make up a small proportion of forest phytomass 0.66% and 6.71%, respectively. Overmature forests VI and VII of age classes cover an area of 6.28 and 2.19%, and have a stake in forest phytomass 9.96% and 4.58%.

From 1945 to 2010 the Polish forest species structure changed significantly, in particular, the area of deciduous forest stands increased from 13 to 29.3%, but coniferous forest stands dominated and occuped 70.7% [1, 15]. In Subcarpathian Voivodeship share hardwood is much greater than in the whole of Poland and is 43.6%, while conifers occupy 56.4%. The predominant species here are: 35% – pine, 21% – beech, 16% – fir (Fig. 5). The northern part of the province is mostly flat, the south part is mountainous, there are 'islands' of preserved pine and beech forests. In the mountains mixed coniferous-deciduous forests are dominating.

The correlations between total area and stock for each species of forest-forming stands are different (Fig. 6). Thus, the area is covered with pine forests 35.6% of the total area covered by forests, and stem wood stock is thus 37.22% of the forests. Fir and beech occupy, respectively, the area of 16.43% and 21.44%, and the stock of phytomass -18.54% and 24.77%. At the same time, the breeds like spruce, oak, hornbeam, birch, and alder share space with 3.24%, 4.16%, 3.61%, 3.65%, 6.24%, and the share of the stock, respectively, 2.04%, 2.74%, 2.8%, 2.27%, 4.28%.

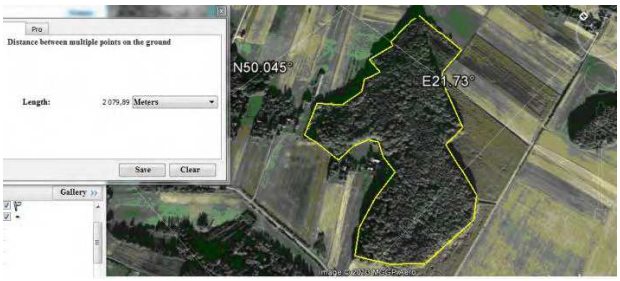

Fig. 7. Defining the perimeter of forest area

Fig. 8. Determination of parameters of forest areas for aerospace images

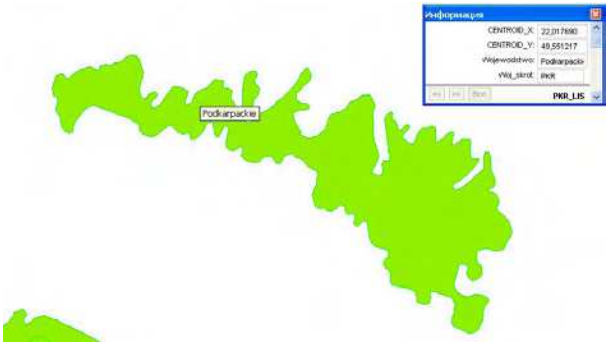

Fig. 9. Fragment of Corine Land Cover forest map with centroid coordinates E 22,017890º; N 49,551217 º

Fig. 10. Fragment of forest maps from Google Earth with the same coordinates

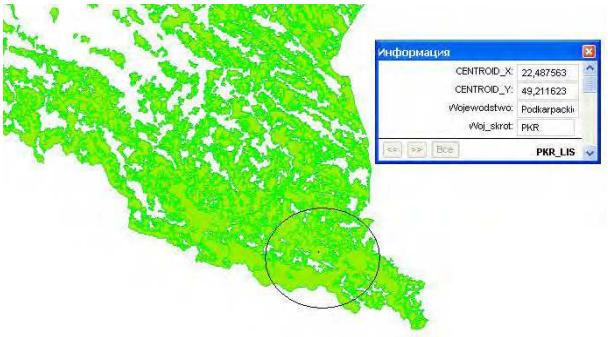

Fig. 11. Mountain forests in the Beskids (Corine Land Cover map)

Fig. 12. Satellite image of Beskids mountain forests ;in Google Earth

VERIFICATION OF RESULTS

Modern geoinformation technologies can be applied for analysis of forests using satellite sensing of the earth's surface, and aerospace and satellite images. Google Earth, and other tools for image viewing and analysis have means for measuring linear dimensions of forest areas: length, width, perimeter (Fig. 7) and area (Fig. 8).

The forest phytomass of Subcarpathian Voivodeship was defined according to the latest inventory [1, 11, 12], and digital maps of forests in Poland (Corine Land Cover, 2006). To verify this map the fragments of forests of Corine Land Cover map (see example in Fig. 9 and Fig. 11) were compared with actual satellite images of arrays of Google Earth (Fig. 10, and Fig. 12).

As a result, the digital map of forest vegetation of Subcarpathian Voivodeship was created. This map comprise 2510 elementary areas, including 725 coniferous forests sections, 703 deciduous sections, 1082 sections of mixed forests (Fig. 2).

MODELING COMPONENTS OF BIOLOGICAL PRODUCTIVITY OF FOREST STANDS

All indicators of phytomass in the forest stand are closely connected to the trees growth and their thickness. Distribution of trees in thickness is the main indicator of forest valuation of forest stand through which all other parameters of forest stand can be estimated [17]. In this paper, modeling of components of biological productivity of forest stands are made using techniques borrowed from the literature [16, 17, 22, 24].

Based on data of the latest forest inventory in Poland, and taking into account data on areas covered with forests, reserves and stem wood in forests of Subcarpathian Voivodeship by forest-forming species (pine, spruce, fir, other conifers, beech, oak, hornbeam, birch, alder, poplar, aspen and other deciduous), age groups, and corresponding mathematical models of fixed components of plants phytomass, the total phytomass of forest was estimated (with division on species as well as age groups of forest-forming species) by formula:

$$M_{j,v} = M_{j,d,100^{-1}} \sum_{i=1}^{n} P_{j,i} * k_{j,i}, \quad (2)$$

where: $M_{j,v}$ is the gross wood value of the *j*-th forest-forming species, which includes supply of industrial wood, green wood stock, and stock of underground biomass; $M_{j,d,100^{-1}}$ is 1% of the stock of commercial timber of the *j*-th species; $P_{j,i}$ is the percentage of trees of the *i*-th grade age in gross wood stock of the *j*-th species; $k_{j,i}$ is the factor which reflect the above-ground and underground part for the *i*-th age class, and $k_{j,i} = k_{dz,j,i} + k_{r,j,i}$; $k_{dz,j,i}$ is the coefficient, that reflect a part of green wood for the *i*-th class of age; $k_{r,j,i}$ is the coefficient, that reflect the proportion of underground part of wood in the *i*-th grade age; *n* is the number of classes of age in stands (in this case 7 age classes and forest KO, KDO, BP).

The total wood value of each province is calculated as:

$$M_w = \sum_{j=1}^{m} M_{j,v}, \quad (3)$$

where: *n* is the number of major forest forming tree species, that are taken into account in determining stock of biomass (pine, spruce, fir, other conifers, beech, oak, hornbeam, birch, alder, poplar, aspen and other deciduous).

The data of forest inventory in Poland include information across all provinces about the area covered by forest, species composition, age structure, and reserves of timber. Moreover, these reserves of commercial timber in Poland includes the stem wood in the cortex (including firewood), and thick branches, suitable for firewood [11, 12]. To calculate the forest biomass, it must be also taken into account the stock of thin twigs, leaves, pine needles, so-called green wood, and underground parts of the tree or vine. The amount of green wood depends on the conditions of growth, breed, age, quality of locality, and other factors [9, 21]. In the literature [9, 16, 17, 20-24], the methods of calculation of the amount of woody green depend on other forest valuation parameters (diameter at breast height, the height, stock, breed, age, etc.).

IPCC Guidelines [7, 18] recommend the universal coefficients for calculation of woody green forests. However, these coefficients and estimation algorithms are fairly common and universal for different regions of the world, and eventually they do not take into account the specific characteristics of these regions. The proposed emission and absorption factors vary sometimes in a very wide range. Therefore, the task of refining and applying coefficients, specific to particular areas, is very useful.

Table 1. Above-ground biomass of forests (recommended by IPCC)

Type of forest	Overground biomass (tons of dry matter per ha)
Deciduous forests aged > 20 years	200
Deciduous forests aged ≤ 20 years	15
Coniferous forests aged > 20 years	150-200
Coniferous forests aged ≤ 20 years	25-30

Table 2. The ratio of underground biomass to aboveground biomass (R)

Aboveground biomass	R [roots, tons of dry matter / branches, tons of dry matter]
Overground biomass of conifers <50 t / ha	0,40 (0,21 - 1,06)
Overground biomass of conifers 50-150 t /ha	0,29 (0,24 - 0,50)
Overground biomass of conifers > 150 t /ha	0,20 (0,12 - 0,49)
Overground biomass of deciduous < 75 t /ha	0,46 (0,12 - 0,93)
Overground biomass of deciduous 75-150 t /ha	0,23 (0,13 - 0,37)
Overground biomass of deciduous >150 t / ha	0,24 (0,17 - 0,44)

Recommended by IPCC Guidelines, the coefficients of stock biomass for different types of forests in Europe are presented in Table 1. Table 2 contains the coefficients to calculate the mass of underground biomass particles [7,18]. These coefficients are used for the first level of inventory, they are approximate and vary widely.Here the forests are divided only into two age groups: under 20, and over 20 years, and two groups in composition: coniferous and deciduous. Phytomass accumulation in coniferous young growth is faster than in deciduous, and after 20 years slowly. Therefore, for more accurate inventory we can apply smaller division, by class of age, which is commonly used in forestry.

Determination of underground phytomass in forest the IPCC Guidelines propose to estimate by the amount of aboveground phytomass known, guided by a certain ratio (Table 2).Based on these recommendations, and taking into account the results of studies described in the literature [8, 9, 20, 23], the improved coefficients were applied depending on the mass of green wood on the breed, and age of trees (Fig. 13). Constructed trendlines for calculating the coefficients of underground proportion of pine and spruce, demonstrate how they decrease with increasing age class.

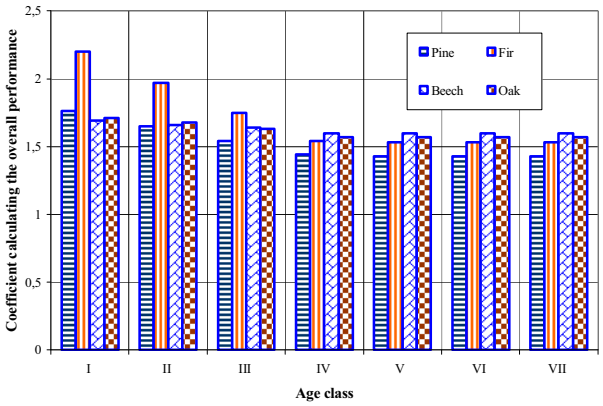

Fig. 13. Total underground and aboveground biomass of illiquid shares from age classes of forest stands

The root system of forest stands is little studied, and therefore various references present the different coefficients to calculate the biomass of the underground part of trees [8, 20, 21, 22, 24], which fluctuate within 14-35%. According to [17] the stock of wet, freshly dug roots, in the 22-year growth of pine is 19.6% of the aerial parts of the stand. The share of moist root system in the total weight of trees decreases with increasing of thickness, while the total weight of aerial parts increases. Thus, if the root system to the power of 12 cm is 19.2% of the total phytomass of trees, the extent 20cm its composition is reduced to 14.1%, at the same time there is a relative increase in phytomass aerial parts of trees from 80.8 to 85 9% [17].

Based on data of the latest forest inventory in Poland, especially data on area covered by forests, and stem wood in forests of Subcarpathian Voivodeship, the amount of total forest phytomass in province was estimated. The main indicators of silvicultural-forest valuation of forest-forming major species (pine, spruce, fir, other conifers, beech, oak, hornbeam, birch, alder, poplar, aspen and other deciduous species), the age groups, and mathematical models for calculation of the main components of phytomass were took into account. Within each forest area the species composition, and age group of forest stands were considered.

MODELING OF ANNUAL GROWTH

In determining the magnitude of growth in the forests of Poland the data of Banku Danych o Lasach [10] were used. This database contains information on the current increase of ten main forest-forming species, depending on the age classes, separately for each voivodeship. Current annual growth of trees of a certain species per unit area depends primarily on biological features the species and can vary by several times. For example, in the first age class the annual growth is 0.36 m^3/ha for hornbeam, 0.70 m^3/ha for oak, 0.80 m^3/ha for beech, 1.28 m^3/ha for pine, 2.73 m^3/ha for birch, and up to 4.66 m^3/ha for alder. At different ages, each species also has a different annual growth, such as pine in the second age class has 9.23 m^3/ha, in the third class has 8.09 m^3/ha, in the fourth class has 6.78 m^3/ha, and in the seventh class has 3.56 m^3/ha. Edaphic, phytopathogenic, and hydrothermal factors, light regime, stand age structure, length of growing season, landscape features and other factors affect the annual growth. Depending from the geographical location of the forests, the impact of separate factors can be different. For example, in Scandinavia the growth of forest stands are more limited by temperature than precipitation, in Poland, Romania and Italy more precipitation than temperature effects on the annual growth of forest stands [18].

Stand composition and age structure in each province were taken into account in calculating the average growth coniferous, deciduous and mixed forests:

$$Z_s = \sum_{l=1}^{L} z_l p_l / 100 , \quad (4)$$

where: Z_s is the average increase; z_l is the average (taking into consideration age classes) increase of the *l*-th breed; p_n is the proportion of the *l*-th species in stand composition (%).

Similarly, the average growth of mixed forests was calculated, on the base of the share of coniferous and deciduous forests in voivodeship stand, i.e.:

$$z_m = (z_b p_b + z_c p_c)/100, \quad (5)$$

where: z_m is the average growth of mixed forest; z_b is the growth of deciduous forests; p_b is the share of deciduous forests in forest stand of province (%); z_c is the growth of coniferous forests; p_c is the share of coniferous forests in forest stand of voivodeship (%).

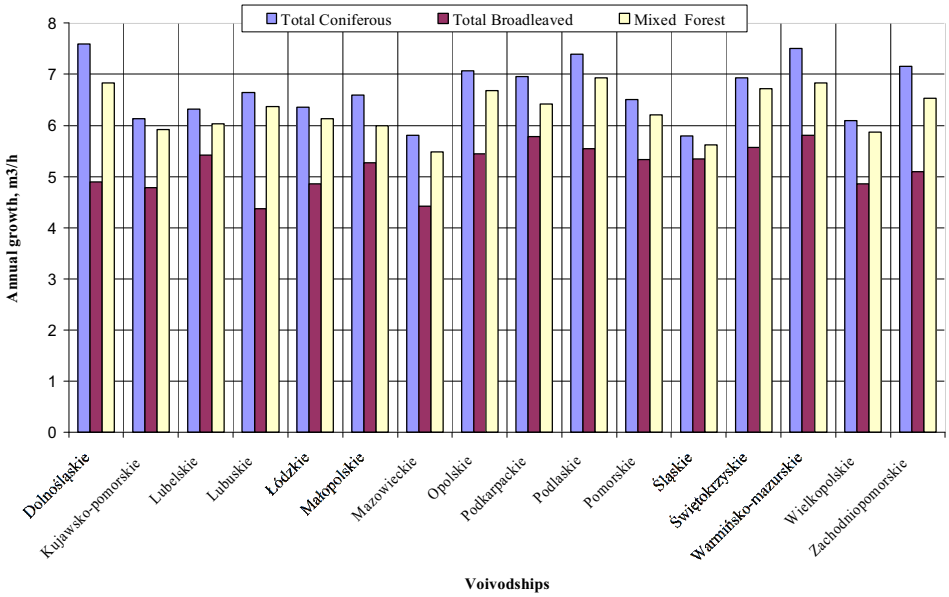

Fig. 14. Specific growth of wood in coniferous, broadleaf and mixed forests in the Polish provinces (m^3/ha)

Table 3. Main indicators of phytomass, and forest carbon deposited in Subcarpathian Voivodeship, 2010

Index	Value	Data unit
Area	17846,66	km^2
Forest	37,2	%
The area covered by forest	663797	ha
The area covered by coniferous forest	374240	ha
The area covered by deciduous forest	289557	ha
Gross industrial wood	194,68	million m^3
The gross volume of business softwood	115,21	million m^3
The gross volume of business hardwood	79,47	million m^3
Number of separate areas of forest on a digital map	2510	units.
The average stock of biomass per 1 hectare of forest	455,14	m^3/ha
The average stock of biomass of coniferous forests per 1 hectare	473,80	m^3/ha
The average stock of biomass of deciduous forests per 1 hectare	435,93	m^3/ha
Average stock of deposited carbon per 1 hectare of forest	115,35	t / ha
Average stock of deposited carbon per 1 hectare of coniferous forests	100,76	t / ha
Average stock of deposited carbon per 1 hectare of deciduous forests	134,22	t / ha
Gross stock of forest biomass	302,12	million m^3
Stock in absolutely dry biomass	153,14	million tons
Stock of deposited carbon in forest biomass	76,57	million tons

The diagram on Fig.14 presents the specific annual growth of coniferous, deciduous and mixed forests in Poland by voivodeship. The diagram shows that the largest annual growths are in coniferous forests of Lower Silesian (7.59 m^3/ha), Warmiano-Masurian (7.5 m^3/ha), and Podlaskie (7.39 m^3/ha) voivodeships. The largest growths of deciduous forests are in Warmian-Masurian (5.8 m^3/ha), and Subcarpathian (5.78 m^3/ha) voivodeship, and for mixed forests in Warmian-Masurian (6.86 m^3/ha) and Podlaskie (6.82 m^3/ha) voivodeship.

Fig. 15 shows the graphs of the current increase of the main forest-forming timber and classes ages. The highest productivity has spruce of II, III and IV classes of age (11.62, 16.42, 11.58 m^3/ha, respectively); fir of II, III classes of age (11.31, 11.38 m^3/ha); pine of II age class (9.23 m^3/ha). Among the hardwoods with the highest annual growth there are: beech of III age class, and poplar of II age class (9.24, 8.71 m^3/ha, respectively). However, due to the small amount of poplar (only 0.22%) within the stands of Subcarpathian Voivodeship, it has little effect on the average growth of

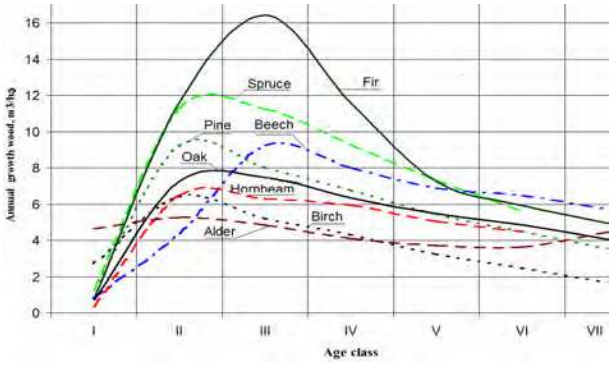

Fig. 15. Dependance of the growth on age classes for the main forest-forming rocks in Subcarpathian Voivodeship

deciduous forest in the province. Pine, beech and fir, which share in the composition of the stands is the largest (35.06, 21.44, 16.43%, respectively) [1, 4-6], have the most significant effect on annual growth.

SPATIAL INVENTORY OF FOREST PHYTOMASS

For the spatial inventory of forest phytomass the territory of voivodeship was divided into square areas 2x2 kilometers in size, and stock phytomass in each such an elementary area has been analised. This task was implemented using GIS technologies. Fig. 16 shows a map of forest of Subcarpathian Voivodeship superimposed on the grid with a size of 2x2 km. Achieved plots with coniferous, deciduous and mixed forests are marked in the same way as at Fig. 2.

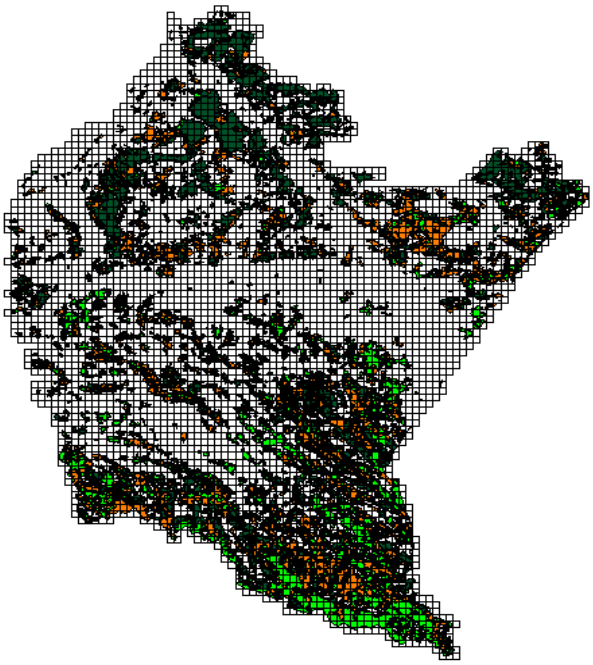

Fig. 16. Forest map of Subcarpathian Voivodeship with superimposed grid

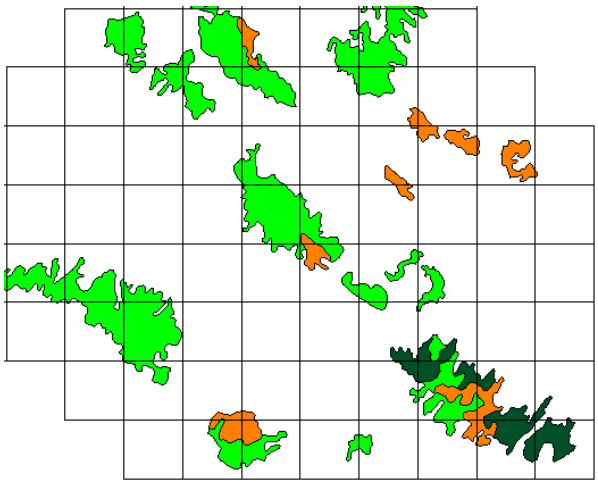

Fig. 17. Fragment of forest map with a net of 2 x 2 km

Table 3 summarizes the data on forests of Subcarpathian Voivodeship. It presents the results of an analysis of the main components of phytomass of forest stands, and evaluation of the deposited carbon.

CONCLUSIONS

Developed geoinformation tool gives a possibility to determine the geodistributed forest phytomass, and to analyse spatially the deposited carbon on the basis of statistical data, species composition, age classes, and other forest valuation indicators. An algorithm for calculation the aboveground and underground phytomass of tree by its stock, taking into account forests of different composition, age, and site conditions, has been created. Improved factors reflecting regional specificity were used for study of phytomass and deposited carbon. Geodistributed database and digital maps of forest vegetation, and map of deposited carbon in Subcarpathian Voivodeship in Poland have been developed.

ANCNOWLEGEMENT

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Factors used for modeling process of forming ecological management instruments of industrial enterprise based on cognitive cards

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Abstract. The article is devoted to the process of forming ecological management instruments of industrial enterprise which belongs to weak-structured problems that are complex in nature and those that are different in qualitative dependencies between structural elements. The essence of cognitive cards is searched as a subjective model of the situation (process), based on the expertise and knowledge. Factors that are used to simulate the process of forming industrial ecological management instruments are marked on the basis of cognitive cards, in terms of achieving the overall socio-ecological-economic efficiency of its operations and its stated requirements. The character, composition and direction of the relationship between indicators within the proposed factors are defined.

Key words: weak-structured problems, ecological management instruments, cognitive cards, factors, socio-ecological-economic efficiency of industrial enterprise activity.

INTRODUCTION

It is necessary to solve weak-structured problems in many areas of human activity. Problems and their solutions are the most common issues in management literature. However, most relevant research has narrowly substantive nature. Problems are discussed in just an economic or in sociological or psychological viewpoints [16]. As a rule researchers do not see the problem as a multi-faceted integrated system. The development of social and economic facilities that may also include industrial enterprises in the environment is a typical situation for weakly structured problems appearance.

The purpose of the article is to determine the indicators of the process of forming ecological management instruments of industrial enterprise as weakly structured problems through the use of cognitive cards.

MATERIALS AND METHODS

The nature of the problems is the basis of systems analysis use as a method of management decisions. Due to its use there are three types of problems:

well structured;
weakly structured;
unstructured.

Restructuring means the opportunity of quantitative expression relationships between elements of the situation. The degree of the problem formalization as a typing feature was first proposed by U.S. cexperts G. Simon and A. Newell [12, 13, 17].

Problems in which the relationship between the elements of the situation can get quantitative estimates are well structured. In solving these problems methods of quantitative analysis are used: linear, nonlinear, dynamic programming, queuing theory, game theory, which methodology is known as "operations research".

Weakly structured (mixed) problems are usually complex, differing primarily in qualitative dependencies between the elements of the situation. Moreover, these elements may be both qualitative and quantitative. This is the area of a systematic analysis. In addressing such problems a combination of quantitative and heuristic methods is used.

Unstructured (or expressed qualitatively) problems have only descriptions of the most important resources, features and characteristics, quantitative relationships between them are completely unknown. Solution of unstructured problems is made using heuristic methods based on intuition, logic, theoretical reasoning,

experience, professionalism individual or collective body regulator [20].

In the process of structuring the problem it is necessary to minimize the number of informal elements in such a way that the problem has more definite character. In management practice often instead of tasks and problems they prefer to talk about problem situations in which the problem exists, but is not clearly separated. Decisions are often based on an incorrect understanding of the causes and consequences of the problem, because the problem is not analyzed in the complex. The issue of identification problems, formation of goals and a set of alternatives to achieve them are often left behind. In real management situations often arise tasks that are not so much to make a choice between alternative solutions, as is to analyze the situation to identify the real problems and causes of their occurrence. Understanding the problem is mandatory precondition of finding an acceptable solution. This typical problems that are difficult isolation in the study of managerial situation limits the use of traditional methods of finding optimal (or satisfactory) solutions in problems of managing such systems [1, 4].

There is a need of development and research of formal methods, which are based on mathematical apparatus, based on the expert knowledge representation, together with comprehensive (qualitative and quantitative) information in the form of cognitive cards. Cognitive cards and models based on them are used for structuring expert knowledge, build consensus view of the panel or the analysis of differences in such opinions, analysis of weakly structured (problem) situations in the development of enterprise-based simulation, training management decisions (as policies) based on solving inverse problems and structural analysis of the target and so on [19].

When making decisions under uncertainty experts and analysts rely on their own experience and intuition, creating a subjective model of this situation, based on the expertise and knowledge. In this case analysis and decision support modeling methodology based on cognitive cards [5, 8, 15]. Within the modeling methodology cognitive cards solved the problem of structuring ill-defined domain, constructing models of subjective situation obtaining forecasts of the situation, make recommendations to manage the situation.

To estimate the effect of individual factors on the formation of ecological management instruments of industrial enterprises is difficult, but visualize a system of interrelated factors and their impact on the aforementioned process by using cognitive cards. Cognitive approach to modeling economic processes focused on how to strengthen intellectual processes of the subject and help him fix his understanding of the problem situation in a formal model.

Cognitive card contains a hypothesis about the system (the development process). In terms of the formal description of cognitive cards is often represented as balanced directed graph.

Technology of cognitive modeling problem situation or a process is a sequence of stages, namely:

selection of a set of the most important factors that describe the problem situation;

selection of target-driven factors;

establishment of causal relations between the factors;

construction of cognitive process cads;

construction of matrix interference factors;

assignment of initial conditions and impulse actions;

calculation of predictive values of target factors according to the rule given impulse distribution process.

The problems of the study of complex economic systems are caused by the number of features. First, the interconnectedness of the processes occurring in them and their multidimensional nature, because it is impossible to isolate and detailed study particular phenomena (e.g. only economic or social) – all phenomena occurring within the economic system should be considered and explored together. Secondly, the lack of sufficient quantitative information about the dynamics of the processes in a system that is modeled, which makes use along with a quantitative and qualitative information in describing such processes. Thirdly, most processes are not stationary, and the change in certain characteristics of processes is often unknown, making it difficult to build their quantitative models. Such systems are called weakly structured (weakly formalized). They cannot be the traditional mathematical (economic, sociometric, etc.) approach to the analysis of processes for the production of complex (i.e. those that deal with various aspects of the system) solutions. For the modeling of complex systems using poorly formalized cognitive approach based on cognitive aspects. These aspects include the processes of perception, thinking, learning, explanation and understanding.

The term cognitive card as a model of knowledge experts on poorly defined dynamic situations was proposed in work [3]. As a model of knowledge cognitive card is a homogeneous semantic network in which many factors related causal relationships of two types: positive and negative. Structure of the situation can be represented in the form of oriented immersed graph G (F; W), if F – set of factors, W $W \subseteq F \times F$ – oriented arcs of the graph loaded with impact of $w_i \in W$.

Cognitive card is based expert way. Expert highlights the many factors of the situation, the causal relationships between them, because of the influence

factors and their scale. Usually cognitive card is represented as a directed graph.

As for the simulation of forming ecological management instruments of industrial enterprises by constructing cognitive cards, it starts with the selection of a set of the most important factors that describe the problem situation. The purpose of the formation of corporate of ecological management instruments is to achieve a high overall efficiency of industrial enterprises through management of ecological aspects on the basis of information contained in such instruments. That is the main factor in the formation of targeted instruments of ecological management is the overall efficiency of the industrial enterprise, ensuring its sustainability.

From the organizational point of view the state of sustainable enterprise development through achieving the overall efficiency of its operations must meet three key criteria. This means that the enterprise as a system should be:

1) viable – may pay for their operation (costs covered by income);

2) sustainable – may support long-term viability (long-term viability) of their ecosystems;

3) desirable – equally satisfy cultural, material and spiritual needs of staff and the public area business location [11].

Sustainable industrial enterprise is possible only when a complex socio-ecological-economic efficiency of its operations.

General socio-ecological-economic efficiency of industrial enterprises depends on three components: social, economic and ecological efficiency, which in turn consist of a number of indicators (fig. 1).

Factors used to construct cognitive cards of the formation of ecological management instruments of industrial enterprises must meet the list of requirements, among which are the following:

relevance, i.e. corresponding to the task that has to be solved with a particular factor;

accessible to perception – factor must be understood by all members of the target group (managers, experts and other users);

validity and ease of interpretation;

flexibility to adapt to new situations;

adapted to describe the interconnections of phenomena – factors should show the link between economic, social and ecological aspects of the company;

scale and dynamism – factors should have sufficient measurement range of parameters and trends of their changes over time;

reliability – factors should be based on actual data (which does not always mean a high degree of accuracy);

efficiency – the ratio of costs and benefits of data access must be reasonable, the data should be standardized, quality and renewable, they carry timely information to help in time to prevent or solve problems;

comparability – factors should allow to make comparisons. This should be taken comparable intervals or units;

continuity – the factors to be measured continuously or frequently to ensure timely response to changes.

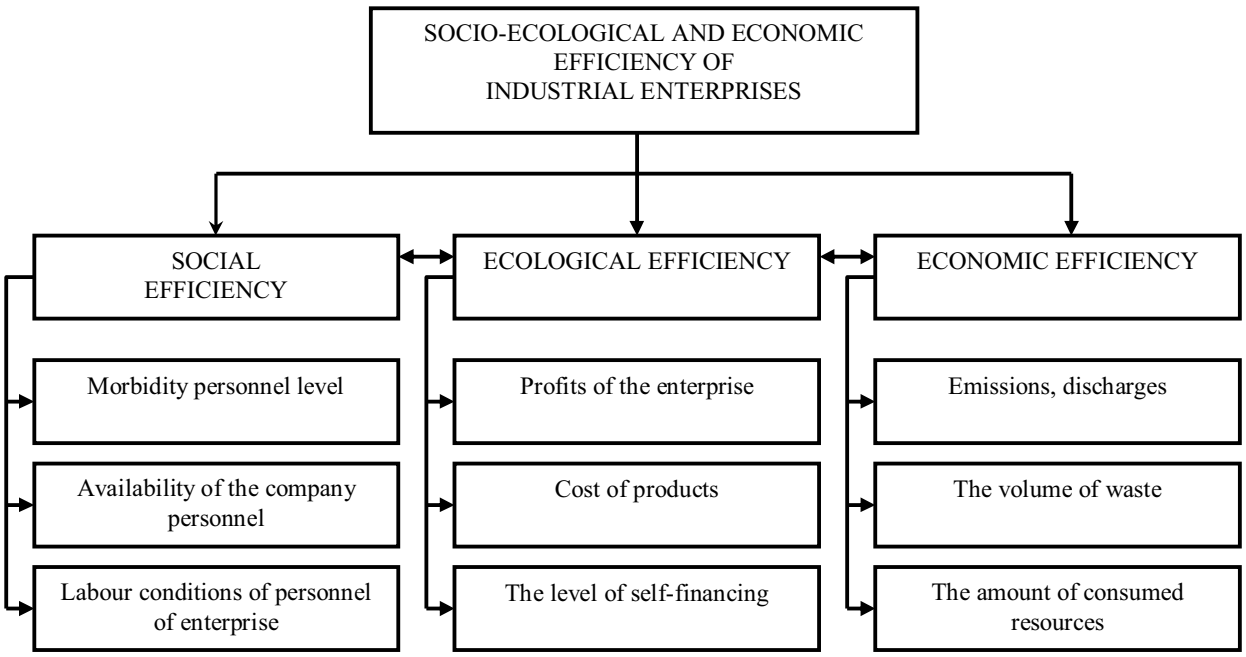

Fig. 1. Indicators of general socio-ecological-economic efficiency of industrial enterprises
Source: Author's own research results

Table 1. Factors influencing the formation of ecological management instruments of industrial enterprises

№	Name of factor	The nature of the factor	The factor's structure
External Factors			
I. Political and legal			
1.1	Ecological product certification	simple / qualitative	-
1.2	Environmental legislation	simple / qualitative	-
1.3	Sanitary-hygienic norms	complex / quantitative	Maximum allowable concentration (MAC); Maximum permissible emission (MPE); Maximum permissible discharge (MPD); noise level; level of electromagnetic radiation, etc.
II. Economic			
2.1	Ecological contributions	complex / quantitative	limits on environmental pollution and use of natural resources; payment standards for environmental pollution and use of natural resources; fines for above-limit environmental pollution and use of natural resources; adjustment factors
2.2	Prices of resources	simple / quantitative	-
2.3	Benefits for environmental-oriented enterprises	complex / quantitative	exemptions from income tax, including a so-called "tax holidays" for a certain period; benefits for VAT payments; exemption from customs duty on import of environmental equipment not produced in Ukraine; preferential lending; government subsidies and subventions; accelerated depreciation of fixed production assets
III. Social			
3.1	Quality of life	complex / quantitative	household incomes; costs of living; household consumption; basic integral indicators of living; providing and scope of population by the infrastructure objects and the technical equipments of branch social sphere; demographic parameters; security
3.2	Morbidity of population	simple / quantitative	level of morbidity
3.3	Social and ecological associations activity	simple / qualitative	activity level of social and environmental associations
IV. Ecological			

4.1	Environmental pollution in the region	complex / quantitative	level of atmosphere pollution; level of hydrosphere pollution; level of land pollution; volumes of waste disposal, etc..
4.2	Provision of regional natural resources	complex / quantitative	level of provision of energy resources (combustible minerals, hydropower, biofuels, etc.); level of provision of non-energy resources (minerals, water, land)
4.3	Number of polluting enterprises in the region	simple / quantitative	-
		V. Scientific and technical	
5.1	Development of clean and resource-saving technologies	simple / qualitative	-
5.2	The development of alternative energy	simple / qualitative	-
		Internal	
6.1	The used technology	simple / qualitative	-
6.2	Machinery and used equipment	simple / qualitative	-
6.3	Corporate culture	simple / qualitative	-
6.4	Style guide	simple / qualitative	-

Source: Author's own research results

Cognitive approach to study the formation of ecological management instruments of industrial enterprise as socio-ecological-economic system to describe its structure and various processes within it, their interaction with the environment, to detect the influence of the environment at management of the current situation in the system and is on this basis justify the necessary management decisions to solve problems that arise in such weakly structured systems. The cognitive card depicts the main groups of factors and relationships arising from the sustainable economic development of the system. Factors describing the situation may be complicated structure. In particular, they may consist of a set of parameters that affect the value factor. For example, the factor "environmental charge" reflects the amount of environmental charges businesses that it pays for environmental pollution and use of natural resources as within its limits, and above-limit environmental pollution and use of natural resources. It includes such factors as limits on environmental pollution and use of natural resources, environmental pollution norms paying and use of natural resources; fines for above-limit environmental pollution and use of natural resources; adjustment factors. For such complex factors it is necessary to find their meaning on the basis of available estimates of indicators that make up this factor.

Description of factors influencing the formation of ecological management instruments of industrial enterprises is presented in Table 1.

Table 1 shows, that the factors are both quantitative and qualitative. Quantitative factors are based on a numerical representation of quantitative information, or are the result of some calculations. To describe the quality factor values a set of relevant linguistic variables is selected. Selecting shades from the values of linguistic variables allows to give the required level of detail – "weak-medium-strong" or more detailed "very weak-weak-medium-strong-very strong" and so on. Each linguistic variable corresponds to a number on the scale [0, 1], which is the numerical equivalent of this variable [9, 10]. These numerical equivalents are called qualitative variables. For example, the factor of "the development of alternative energy" describes the linguistic variable "level of development of alternative energy" with linguistic values α1 = "low", α2 = "middle", α3 = "high", each of which is a fuzzy set with domain T_{F_i} = [-1, 1] and membership function μ_α: $T_{F_i} \rightarrow$ [0, 1]. It should be noted that the nature of qualitative indicators is different. Each indicator X (F_i)= 1, …, k_i, may be characterized by:

1) linguistic meaning (e.g. very low, low, medium, high, very high);

2) unclear value (e.g. low – 0,3, mean – 0,8);

3) quantitative values defined by ordinal or nominal scale;

4) binary attributes, positive and negative, each of which is characterized by its frequency display [6, 7].

As already mentioned, the result is a formalization of ideas as causal networks, called cognitive cards and has the form (1):

$$G = \langle E, W \rangle, \quad (1)$$

where: $E = \{e1, e2, ..., e_n\}$ – set of factors (which are also called concepts); W – binary relation on the set E, which defines a set of relationships between its elements.

Items e_i and e_j are associated by the ratio W (denoted $(e_i, e_j) \in W$ or $e_i W e_j$), If the change the value of the concept e_i (cause) changes the meaning of the concept e_j (consequences). According to the terminology of cognitive modelling in this case we say that the concept e_i affects the concept e_j. If you increase the value of the concept causes increases the importance of the concept-effect, the effect is positive ("gain") if the value decreases – negative ("inhibition"). Thus, the ratio of W can be represented as the union of two disjoint subsets: $W = W^+ \cup W^-$, де W^+ – many positive and W– many negative connections [2, 6]. Most concepts thus can set as relative (qualitative) indicators (management style, organizational culture), and absolute, measurable terms – for example, the level of morbidity, cost, profit and so on. This model allows us to consider the dynamic system consisting of a set of factors that influence each other. Some components of this system can be introduced perturbation, and the behaviour of the system in this case can be directed to settle the disturbance (negative feedback) or increased disturbance (positive feedback).

CONCLUSIONS

1. The formation of ecological management instruments of industrial enterprises are weakly structured problem due to its complexity, which in turn is characterized by qualitative dependencies between its structural elements.

2. These items can be both qualitative and quantitative, and the internal structure be simple or complex. Therefore, for the simulation of forming of ecological management instruments of industrial enterprise should apply a systematic analysis based on a combination of quantitative and heuristic methods.

3. With a high degree of uncertainty can create subjective model this situation on the basis of expert opinions and knowledge. In this case, analysis and decision support modeling methodology based on cognitive cards.

4. Cognitive cards modeling methodology enables structuring ill-defined domain, constructing models of subjective situation obtaining forecasts of the situation, make recommendations to manage the situation. Cognitive cards can visualize a system of interrelated

factors and their influence on the formation of ecological management instruments industrial enterprise.

5. Factors suggested in the article, and the relationship between them will be further used to model the formation of industrial ecological management instruments on the basis of cognitive cards.

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Information technology for studying carbon sink in stemwood of forest ecosystems

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Abstract: An information technology for calculation of carbon sink in stemwood of forest ecosystems on a territorial basis is developed. This information technology involves interpretation of input data of statistical inventory of forest stands using electronic maps of forestry, formation of databases and processing the data by applying a special algorithm for calculating the carbon sink in stemwood and presenting the results in a form of thematic maps. The estimation of the carbon sink in stemwood is done by using a "bottom-up" (wood – sample plots (SP) - forestry) approach applying mathematical models of distributed inventory of the carbon sink that take into account regional specificities of species in the study area and average annual growth of biomass. We estimated carbon sink in stemwood using data from experimental studies conducted on 54 sample plots of forestry "Spaske" of forest enterprise "Broshnivske FE" of Ivano- Frankivsk region. The largest carbon sink occurs in mixed forest ecosystems - 1829 tons/year, the average carbon sink (per ha) is 951 kg/year. The information technology can be applied for estimation of the carbon sink in forest stemwood in any part of Ukraine or another country where necessary input data are available.
Key words: forest ecosystems, mathematical models of carbon sink in forest ecosystems, spatial inventory.

INTRODUCTION

Nowadays, climate change is one of the most important global problems, which is a significant threat to the Earth's environment as well as political and economic development of mankind [4]. One way of coping with the climate change is a system of measures for effective forest management that will reduce the human impact on Earth's atmosphere. Enhanced reproduction of forests and increasing forest productivity will help to increase the absorption of carbon dioxide.

Forests play an important role in the global carbon cycle, removing about a third part of the carbon released from burning fossil fuels. Understanding the role of forests in the carbon cycle is increasingly important today, and countries are encouraged to monitor forests in order to effectively manage forests and report their state to respective international organizations.

Ukraine, as a member of the United Nations Framework Convention on Climate Change and the Kyoto Protocol, has certain obligations on greenhouse gas (GHG) emissions. First of all, Ukraine has to establish a national system for inventory of emissions and removals of GHGs [5, 9, 25]. Successful participation of Ukraine in international processes on climate change and GHG emissions trading depends on availability of accurate control, completeness and accuracy of data reporting [1, 3, 14, 18]. The assessment of carbon dynamics in forest ecosystems is an important part of functioning of the national inventory. Therefore, the investigation of the carbon balance in forest ecosystems is particularly relevant today.

ANALYSIS OF RECENT PUBLICATIONS AND RESEARCH

Today, a lot of attention is paid to research questions on the carbon balance of forest ecosystems.

While investigating the dynamics of carbon in forests, it is necessary to study the size of carbon reservoirs, stocks of carbon, and the impact of environmental factors [26] on the carbon cycle processes.

Many recently published books and journal articles are devoted to temperate and boreal forests [15, 22], the forests of Canada [8], Finland [16], Ukraine [10, 11, 19, 20], and others. To estimate carbon stocks and changes in stocks, a growing number of countries use carbon budget model developed by the Ministry of Natural Resources of Canada [8], known as the carbon budget model of the Canadian forest sector (Carbon Budget Model of the Canadian Forest Sector), or CBM-CFS3. This model simulates the dynamics of all forest carbon stocks as required under the Kyoto Protocol (aboveground biomass, underground biomass, litter, dead wood and soil organic carbon); it allows monitoring carbon stocks in forests and predicting future changes. CBM-CFS3 is being tested by scientists from Australia, China, Korea, Germany, Italy and the United States. Model meets integrating carbon forests. Results of CBM-CFS3 can be used to support ongoing monitoring of carbon stocks in forests. This model can also be used to produce forecasts of future flows of carbon based on forest management, natural disturbances and changes in land use. These predictions can be used to develop forest management strategies that are aimed at mitigating the effects of climate change.

Carbon balance of forests of Ukraine has been studied by P. Lakyda [13], V. Pasternak [19, 20], I. Buksha [19, 20], R. Bun [2], S. Myklush [17]. The approach in [13] is based on the results of forest inventory and regression models of phytomass components of main tree species of Ukraine. It does not take into account changes in soil carbon. The technique of carbon dynamics in forest ecosystems, described in [19], includes all components of the system and is based on the transfer of forestry statistics into carbon units using conversion factors. Another approach to assess carbon dynamics in forest ecosystems [16] is based on the existing forest inventory data as input for statistical models and simulation of the dynamics of biomass litter and soil. This model of terrestrial vegetation needs to be improved: consider different types of forests and assess the carbon in litter and soil carbon by integrating Yasso dynamic model, which simulates the carbon cycle in forest soils. The approach presented in [2] estimates carbon stocks in ecosystems of broadleaf and coniferous forests for individual region and for the whole Ukraine; it involves data of forest inventory using regression and correlation, linking the supply of wood with a mass of absolutely dry matter ground and underground parts of the stand, litter vegetation, and corresponding conversion factors.

Therefore, it is a relevant and not fully researched problem of estimating carbon balance of forest ecosystems, which would take into account the characteristics of different types of carbon reservoirs, national inventory data, conversion factors, environmental factors.

AIM OF THE STUDY

The aim of the study is to create a database of parameters of forest ecosystems and mathematical models to study the carbon balance in forests. To achieve this aim, the following tasks have to be solved: to develop algorithms to determine the biomass accumulation in plants; to develop mathematical models to estimate emissions and carbon sink of forest ecosystems; based on these models and GIS technology to build a software package for spatial inventory of carbon in forests.

METHODOLOGY

The processes of absorption, emission and carbon sequestration in forest ecosystems depend on many factors (e.g. age of plantations, tree species, productivity, natural and anthropogenic disturbances, etc.). Therefore, to assess carbon dynamics in forest ecosystems we need a detailed information on the status of forests, forest parameters, and mathematical models and geoinformation approach that will help to carry out a spatial inventory of absorption and emission of carbon in forests, carbon stocks, and to determine and to display the results on the map.

As a basic methodology for creation of a database "Forest Ecosystems" we took a technique which was used for inventory of Uholsko- Shyrokoluzhanskyi primeval beech forest of the Carpathian Biosphere Reserve [23]; this technique was designed to store, edit and display forest information and to assess dynamics of structure of forest stands of dead wood, natural regeneration, distribution stands for diameter and height, with margin and more. By building queries it is easy to get all necessary information on forest ecosystem (time of measurement, all characteristics of wood, etc.). Mathematical modules were designed for statistical analysis of data, e.g. a choice of models of growth stands and determination of parameters of these models.

The developed database "Forest Ecosystems" is based on the relational data model. This model was selected because of easy data presentation (in tables), a powerful theoretical framework for it and thus tools to create a relational database management systems. The database was created using Microsoft Access (format .mdb), which is a software package of Microsoft Office. Nowadays, Microsoft Access is a well-developed package and can be used for support and maintenance of databases, including forest inventory.

When designing the database structure (a few tables with fields and their interconnections), the method described in [23] was used. All forest inventory, service and reference information contained in the tables are

logically linked. Total number of tables is over 60. All tables can be divided into three groups: tables of forest inventory measurements, service tables, and tables of references.

The table named "Trees" contains records of measured diameters of all standing live trees (at a height of 1.3 m), their height and specified azimuth and distance from the centre of the plots, the average age of plantation. The dependence of the height on the diameter is approximated by the expression described in [21].

Based on the calculated height and diameter for each level of thickness of specie, form factor is estimated using formula [7]:

$$f = \frac{1}{1 + e^{(b_1 + b_2 / \ln(d) + b_3 / \ln(h) + b_4 * (h/d)}}, \quad (1)$$

where: d is a diameter of a tree at the high of 1,3 m, cm; h is a tree high, m; $b_1,\ldots,b_4$ are the coefficients of equation.

Based on values of d, h, f, by using main forest inventory formula below, we determine the volume of each tree:

$$V = g \cdot h \cdot f, \quad (2)$$

where: g is a cross sectional area of a tree, m2; f is the form factor.

Growing stock of specie on SP is determined as the sum of volumes of all trees:

$$M_i = \sum_{i=1}^{n} V_i, \quad (3)$$

where: M_i is a growing stock of tree specie on a SP, m3; V_i is a volume of a tree, m3.

The total growing stock on a SP is calculated as a sum of growing stock of all trees:

$$M_{total} = \sum_{i=1}^{n} M_i. \quad (4)$$

The growing stock per ha is calculated by dividing total growing stock on a sample plot by the plot's area (S):

$$M_{1ha} = \frac{M_{total}}{S}. \quad (5)$$

Mean annual increment of stemwood for species is determined by the following formula:

$$\Delta_{M_i}^{average} = \frac{M_i}{A}, \quad (6)$$

where: $\Delta_{M_i}^{average}$ is a mean annual increment of stemwood of tree species, m3 per year; M_i is a growing stock of a specie at a sample plot, m3; A is an average age of a tree specie on a SP.

Accordingly, the total increment of stemwood per ha for all species is equal to:

$$Z_{M1ha}^{average} = \frac{\sum_{i}^{n} \Delta_{M_i}^{average}}{S}, \quad (7)$$

where: $\Delta_{M_i}^{average}$ is mean annual increment of stemwood of a tree specie, m3 per year; S is an area of a sample plot, m2.

Based on the measurements of azimuth and distances from the plot center to the trees we calculated conditional coordinates x and y:

$$x = \sin\left(radian(\lambda)\right) \cdot L,$$
$$y = \cos\left(radian(\lambda)\right) \cdot L, \quad (8)$$

where: λ is an azimuth from centre of a SP to a tree, degrees; L is a distance from center of a SP to a tree in meters.

These coordinates were transferred to conventional coordinate system UTM WGS-84, and then by means of ArcGIS and attribute information of tables, thematic maps were created to visualize the data (Fig. 1).

Additionally, these tables are filled with information for every tree: category of technical suitability, class of Kraft, defoliation, category of sanitary conditions, availability of folked tree, level of tree, trunk form, which are grouped and graphically presented in relative terms (Fig. 1 - 4).

Further results are used to analyze the plantation, its spatial structure, trade and sanitary condition, its vitality and resistance to adverse factors.

To evaluate the flow of carbon into the test plot we used the technique [6] (the Gain-Loss method) and mathematical models of distributed inventory of carbon sink [2, 24], where we took into account regional specificities of the study area [12]. Average annual biomass per ha was calculated based on forest inventory.

Below, an example of the technology for estimating carbon sink in stemwood of forest ecosystems at 54 sample plots of Savior Forestry of "Broshniv LH" with total area of 4143.9 hectares is presented. The whole area was divided into 1km x 1km grid. The results can be obtained in the form of reports on carbon sink in stemwood by species in the Savior Forestry of "Broshivske LH" (Fig. 5) or by the sample plots (Fig. 6), report on overall distribution of carbon sink in stemwood in the investigated area, and digital maps (Fig. 7, 8).

Carbon sink in stemwood varies depending on the category of land, age and breed structure. For the study area the calculated carbon sink in stemwood is presented in Table 1.

The largest amount of carbon sink in stemwood of mixed forest is 1829 t per year, the average sink per ha is 951 kg/year. The largest sinks are observed for the beech forests of age 50, where carbon sink is approximately 2187 kg/ha per year. Average sink of forest is 376 m3/ha, the relative completeness is of 0,87 and the average increase of carbon sink in stemwood accordingly is 7,7 m3/ha per year.

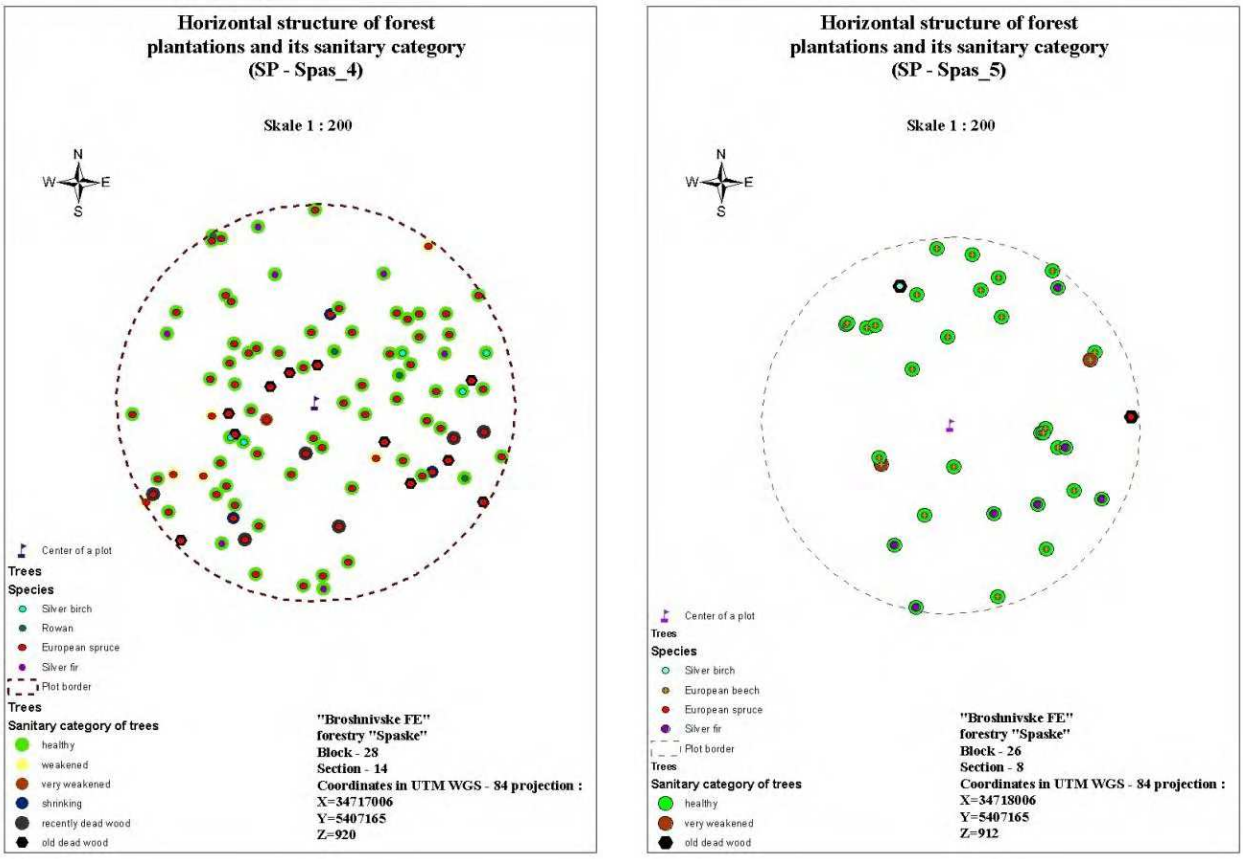

Fig. 1. The horizontal wood structure and sanitary category of planted trees

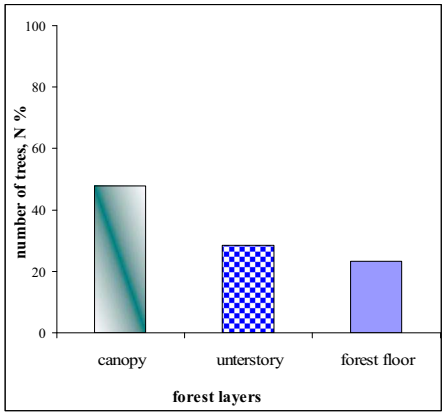

Fig. 2. Distribution of trees by levels

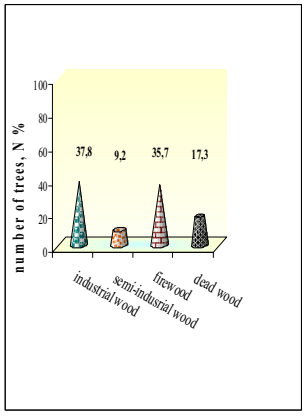

Fig. 3. Distribution of trees by category of technical suitability

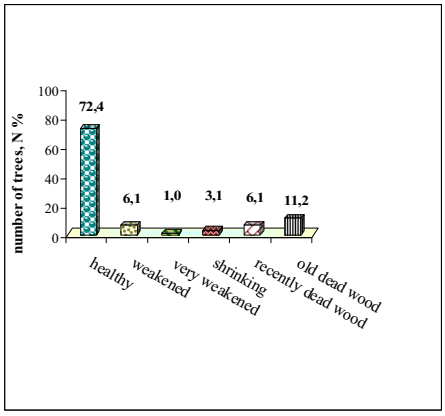

Fig. 4. Distribution of trees by category of sanitary condition

tree species	No.	number of trees	area, ha	growing stock, m3	mean annual increment, m3/year	mean annual increment, m3/ha per year	area covered by tree species, ha	carbon sink, t/year
European beech		427	,4687	321,7977	4,5675	4,9862	1204,67	1676,94
	5	26	,0371	27,1472	,2951	5,9016		
	6	33	,0330	41,7462	,5091	10,1820		
	11	11	,0081	23,5390	,2308	4,6155		
	12	24	,0255	19,5973	,4170	8,3393		
	13	7	,0130	5,6861	,0693	1,3868		
	17	31	,0352	17,9884	,3271	6,5412		
	18	11	,0204	12,3993	,1216	2,4312		
	19	5	,0048	,9467	,1183	2,3666		
	20	5	,0063	3,2041	,0605	1,2091		
	22	39	,0300	18,1459	,3558	7,1161		
	23	1	,0013	,1299	,0027	,0541		
	24	8	,0111	3,2437	,0601	1,2014		
	25	13	,0155	2,9801	,0621	1,2417		
	26	12	,0146	17,5522	,1439	2,8774		

Fig. 5. Total carbon sink in stemwood in the forestry “Spaske” of forest enterprise "Broshnivske FE"

No.	tree species	number of trees	area, ha	growing stock, m3	mean annual increment, m3/year	mean annual increment, m3/ha per year	carbon sink, t/year
4		98	,0500	16,9939	,3332	4,5124	,0382
	Rowan	4	,0020	,4421	,0087	,1734	
	Silver birch	5	,0026	1,9679	,0386	,7717	
	Silver fir	7	,0036	1,0646	,0209	,4175	
	European spruc	82	,0418	13,5193	,2651	5,3017	
5		35	,0500	28,7773	,3217	4,4049	,0614
	European beech	26	,0371	27,1472	,2951	5,9016	
	European spruc	1	,0014	,8460	,0092	,1839	
	Silver birch	1	,0014	,6332	,0158	,3166	
	Silver fir	7	,0100	,1508	,0016	,0328	
6		50	,0500	42,2640	,5154	6,7399	,0940
	European beech	33	,0330	41,7462	,5091	10,1820	
	European spruc	1	,0010	,2816	,0034	,0687	
	Silver fir	16	,0160	,2363	,0029	,0576	
7		60	,0500	13,9102	,2440	3,9083	,0330
	European spruc	56	,0467	11,7822	,2067	4,1341	
	Silver fir	4	,0033	2,1280	,0373	,7467	

Fig. 6. Carbon sink in stemwood on the sample plots of the forestry “Spaske” of forest enterprise "Broshnivske FE"

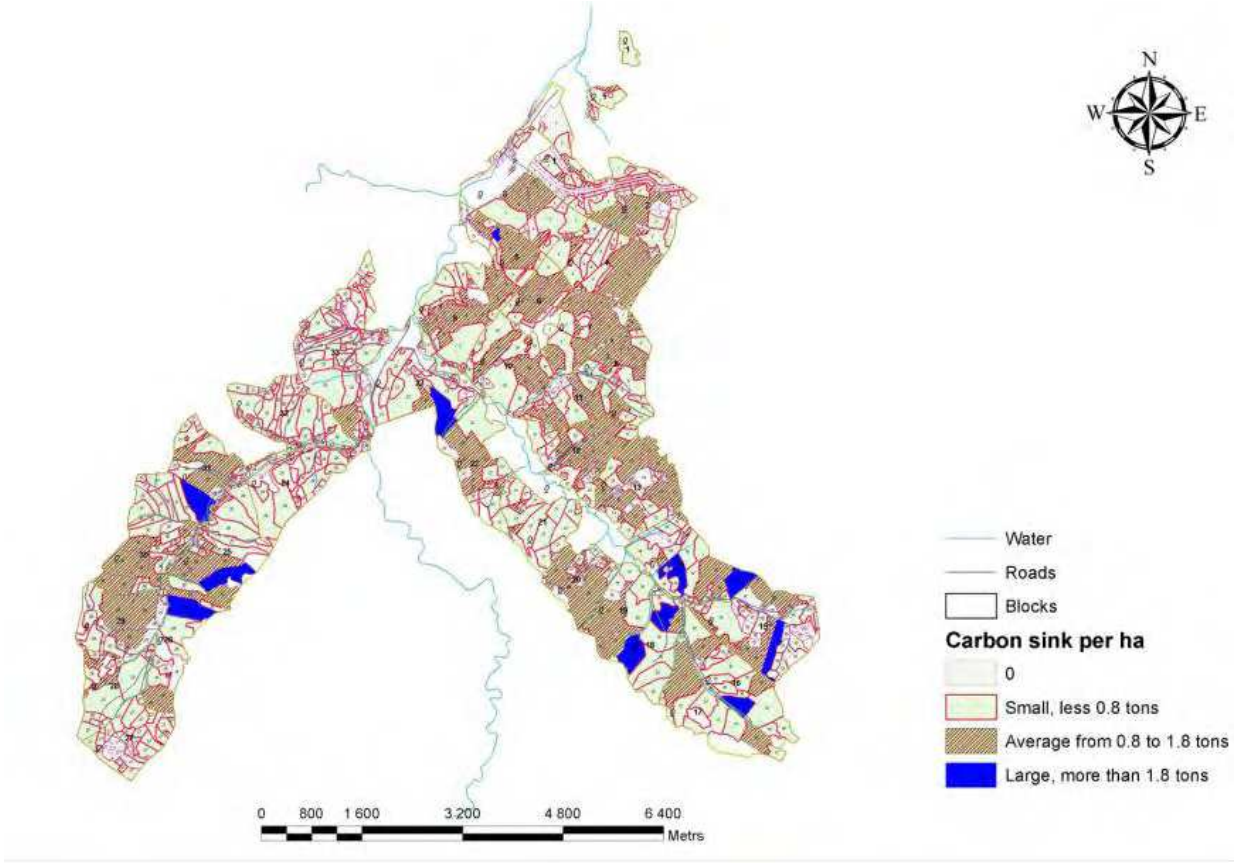

Fig. 7. Distribution of the carbon sink in stemwood for the study area (t ha-1)

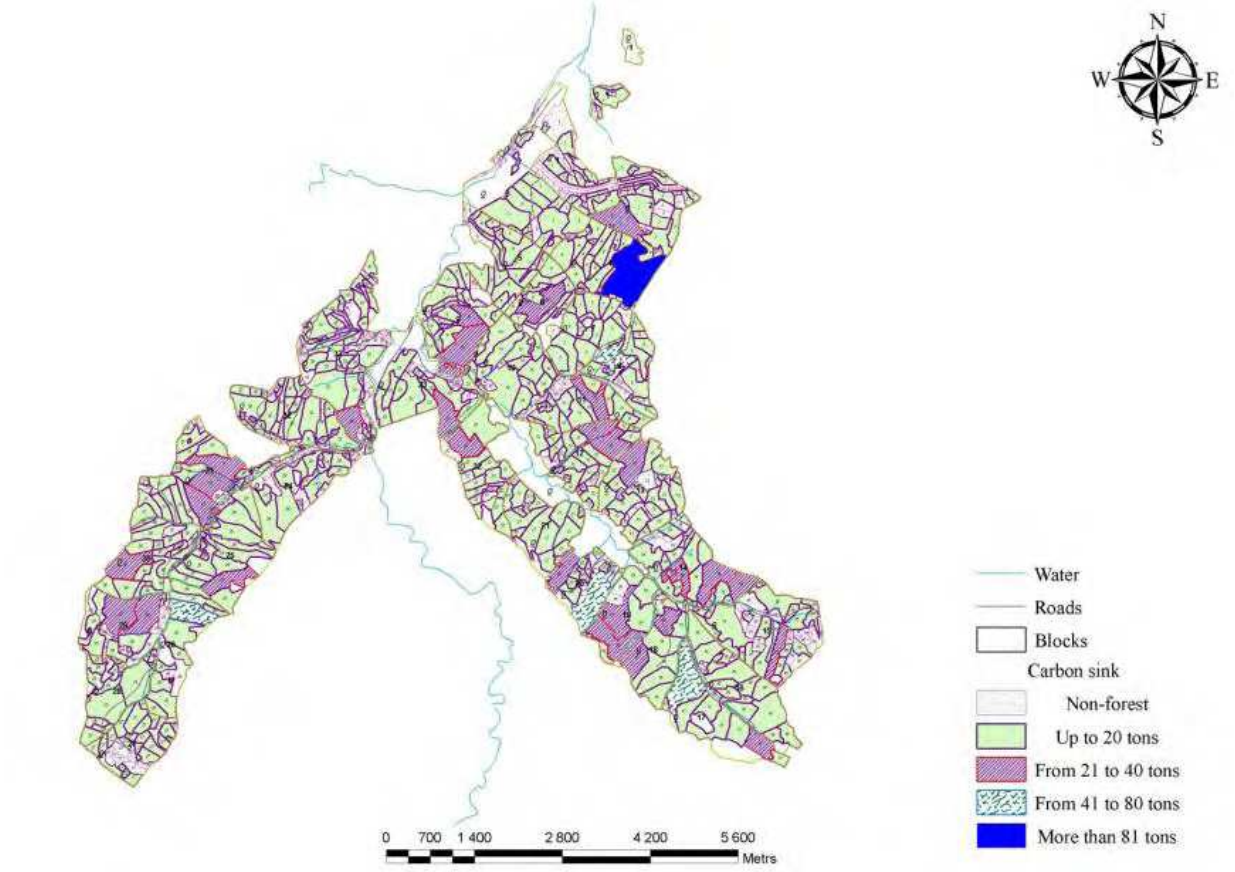

Fig. 8. Overall distribution of carbon sink in stemwood in the investigated area (t)

Table 1. The distribution of carbon sink in stemwood for different categories of the study area

Land category	Area, S, ha	Overall carbon sink, C, t/year	Average carbon sink per ha, C, t/year
Non-forest areas	95,1	0,000	0,000
Open trees	193,2	3,774	0,020
Coniferous forest	1222,8	876,202	0,717
Mixed forest	1922,1	1828,793	0,951
Broadleaf forest	710,7	809,792	1,139
Total	**4143,9**	**3518,6**	**0,849**

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CONCLUSIONS

The paper presents the mathematical model of spatial inventory of carbon sink of individual trees and describes the characteristics of their practical implementation. We developed a database on forest inventory characteristics of trees with visualization of the results on a map. The sample plots in the forestry "Spaske" of forest enterprise "Broshnivske FE" demonstrates the usefulness of spatial inventory of carbon sink by "bottom-up" method (from one tree to a forest area). We calculated carbon sink in stemwood by species in the investigated area. The largest carbon sink occurs in mixed forests and is 1829 tons/year, the average per hectare is 951 kg / year. In our calculations we did not consider underground part of wood, as well as all the above-ground phytomass (only stem phytomass). In the future, we will complement this model in order to assess full wood phytomass for any forest and to estimate carbon sink that will be useful for decision-making on forest management.

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Assessment of personnel risks at adoption of administrative decisions

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Abstract. In article the technique of an assessment of personnel risks is developed at a choice of optimum version of the administrative decision. The analysis of alternatives in the course of decision-making assumes serial consideration of all candidates solution with determination of advantages and shortcomings of each option by all possible criteria, including on a factor of personnel risks. Following the results of an assessment the card of risks is formed, and the assessment of an acceptability of alternative is defined as average weighed by each stage of realization of alternative where as weight information evaluation test is accepted.

Key words: personnel risks, alternatives of the decision, risks map, rating scale.

INTRODUCTION

Effectiveness of functioning of the economic organization in the conditions of the composite, dynamic and uncertain environment in many respects depends on comprehension of the reasons and mechanisms of action of personnel risks and their account at a decision making. Quality of human resource management of the organization defines effectiveness of activity of the organization and success of achievement of the purpose.

At the same moment, in practice of functioning of the Ukrainian organizations not only methods of identification of personnel risks are not developed, but often there is no comprehension of need of their account in organization activity. Also in science this problem yet did not receive complete conceptual judgment and the methodical decision that considerably slows down development of the theory and practice of management by personnel risks.

The purpose of article is development of a technique of estimation of personnel risks at an alternative choice at adoption of administrative decisions.

Many leading domestic and foreign scientists in the field of production management paid attention to studying of decision-making process and the factors influencing their quality. It is necessary to distinguish such experts as G. Ford, F. Teylor, A. Fayol, G. Emerson, P. Draker, S. Yaung, M. Meskon, F. Hedouri, H. Saymon, A. Nevil, T. Rassell, R. Teylor, V. L. Makarov, V. M. Polterovich, B. G. Kleyner, H. N. Gizatullin, A. I. Tatarkin, O. C. Vikhansky, R. A. Korenchenko, A. I. Naumov, R. A. Fatkhutdinov [1-13]. The result of researches of these authors is development of efficient methods and decision making procedures in various administrative situations at any emergence of problems.

Risk problems in a decision making consider in the researches of J. Von Neyman, D. Allen, M. Meskon, I. Kh. Ansoff, S. Bir, V. Rove, U. Nayms, P. Slovik, K. Frost and also Russian and Ukrainian scientific A.G. Badalova [1, 2], E.N. Bulanova [3], A. E. Voronkova [4], O.A. Dedov [6], N. Kalyuzhnaya [10], I.V. Pronina [18], A.L. Slobodskiyu [19]. In their works the analysis of the reasons and sources of emergence of economic risks of the enterprise is carried out, techniques of the quantitative and quality standard of risks are offered.

As for such problem as the accounting of personnel risks at an alternative choice at adoption of administrative decisions, to this aspect of attention practically it was not given.

In practice of management most often use the following methods of an assessment and a choice of alternatives:

1) In the conditions of a determinacy:
- creation of hierarchical semantic structure;
- bootstrapping (analogies or reproduction);

- preferences method;
- lexicographic method;
- "a displaced ideal" method;

2) In the conditions of indeterminacy:

- probability statement of adoption of preferred solutions;
- theory of statistical decisions;
- method of a consequence of events;
- game theory method;
- creation of trees of decisions method;
- the analysis of hierarchies method [1].

Thus any of above-mentioned methods does not consider influence of personnel risks on possible development of a situation.

As for methods of an assessment of personnel risks, they can be grouped as follows:

The first group — calculated and analytical methods of an assessment (conditions of complete certainty). Indexes of personnel risk in this case are determined generally by data of personnel audit [2, 3].

The second group — probability and statistical methods of an assessment. Are used at partial indeterminacy when information on a risk situation exists in the form of probability of emergence of risk events and the risk is respectively considered as probability category. Are thus applied probability and statistics of an assessment of risk [4].

The third group — expert methods of an assessment. These methods can be used in the conditions of the complete indeterminacy when information on a risk situation is absent completely. With their help it is possible to receive information necessary for decrease in degree of indeterminacy and adoption of the reasonable personnel decision [5].

These methods are focused on an assessment of personnel risks as a self-contained task and directed on a decision making about management of mainly personnel risks and increase of personnel safety.

Thus, need of more detailed analysis of influence of personnel risks on results of the decision defined a choice of the direction of research.

STATEMENT OF THE MAIN MATERIAL

For upgrading of the decisions made at the enterprise, the factor of personnel risks has to be one of criteria of a choice of optimum alternative.

Personnel risks are a deviation from the planned purposes or decrease in expected effect from planned which results from any action or an inaction of a term of group of employees of the enterprise united in a process of manufacture.

The technique offered by the author can be used for an assessment of personnel risks as a self-contained task, or for the analysis of alternatives and a choice of optimum version of the administrative decision. In the second case she assumes comparison of characteristics and risk degree on each alternative and a choice of a candidate solution, in which risk minimum. Thus available alternatives are ranged on the basis of personnel risk on accepted completely, accepted conditionally and unacceptable in general. Results of ranging are considered at a choice of an optimum candidate solution. The assessment of personnel risks at a stage of a decision making can bring the greatest benefit and increase effectiveness of adoption of administrative decisions. The developed technique includes sequence of decision-making on the basis of an assessment of personnel risks (fig. 1).

The analysis of alternatives in the course of decision-making provides serial consideration of all candidates solution with determination of advantages and shortcomings of each option by all possible criteria, including on a factor of personnel risks.

When developing a technique of an assessment of alternatives on a factor of personnel risks it is expedient to follow the principle of reasonable sufficiency, i.e. to consider only those risks which most significantly influence results of the decision. Therefore in this technique all possible personnel risks are grouped in particular categories. Further we will consider indexes and methods of an assessment of personnel risks on each

Individual personnel risks

1) Biological personnel risks:

- psychophysiological features – quality standard (0 – 1);
- risks of discrepancy of age structure of the personnel – the quantitative assessment (coefficient of age structure of the personnel: relation of unit to coefficient of pair correlation).

2) Socially - psychological personnel risks:

- discipline level – quality standard (0 – 1);
- risks associated with conflict – the quantitative assessment (a ratio of quantity of the conflicts at the worker and total of the conflicts, expressed as a percentage).

3) Spiritually – intellectual personnel risks:

- education level and cultures – quality standard (0 – 1);
- creative potential – quality standard (0 – 1).

4) Economic risks:

- level of abuses – quality standard (0 – 1).

Organizational personnel risks

1) Personnel risks on an entrance:

- quality of system of personnel selection – quality standard (0 – 1);
- index of realization of functions – the quantitative assessment (a ratio of number of qualitatively executed functions upon and number of the planned functions).

2) Personnel risks in the course of functioning:

- the risks bound to advance on a career ladder – quality standard (0 – 1);
- risks of an assessment and certification - quality standard (0 – 1);
- risks of safety – quality standard (0 – 1);

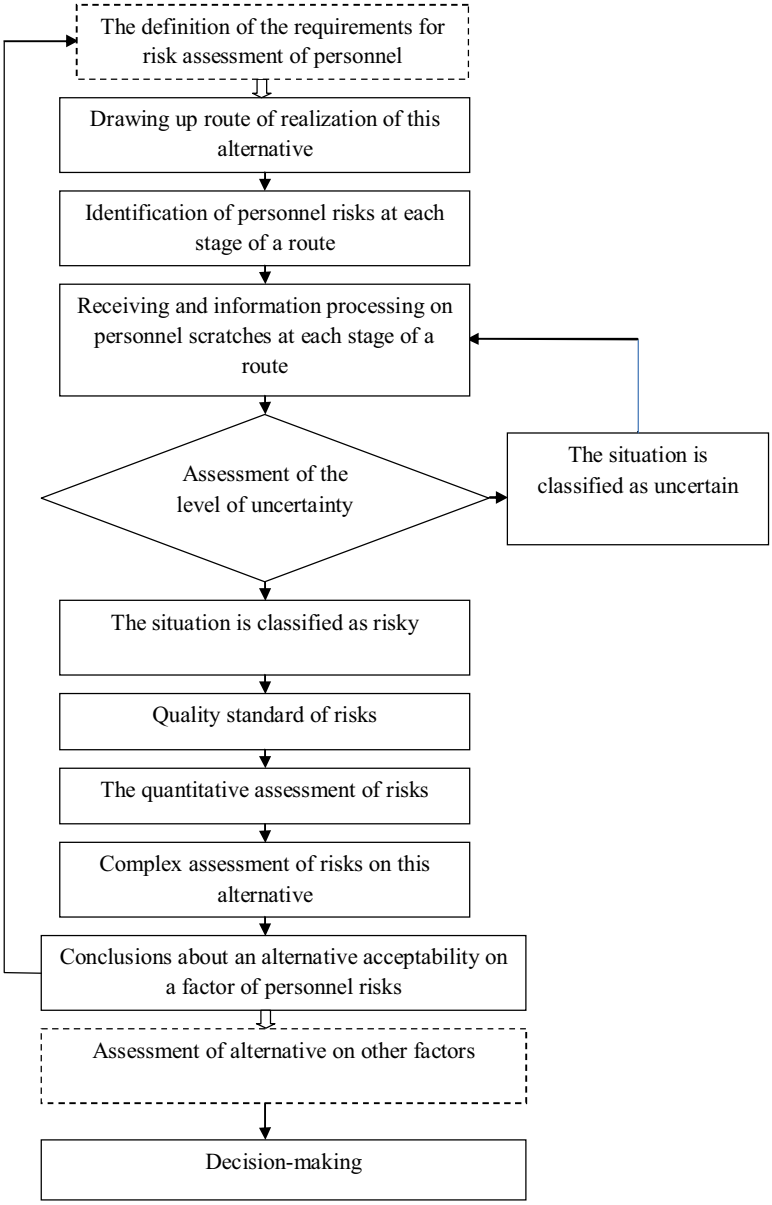

Fig. 1. Sequence of decision-making according with an assessment of personnel risks

- risks of rationing – quality standard (0 – 1);
- the risks bound to tutoring – the quantitative assessment (a ratio of expenses for tutoring and economic efficiency of tutoring);
- the risks bound to career guidance of the worker – the quantitative assessment (a ratio of correctly carried out professional tasks and the total number of tasks);
- the risks connected with management career – the quantitative assessment (a ratio of number of the workers accepted to key positions from the outside and number of workers, "grown" to a higher position in the organization);
- risks of discrepancy of qualification of workers to level of complexity of works – the quantitative assessment (a ratio of the average tariff category of workers and the average tariff category of works);
- the risks bound to adaptation of the personnel – the quantitative assessment (the sum of indexes taking into account weight of each of them: coefficient of productivity of methods of adaptation, the sum of the used resources on one worker in the course of adaptation, percent of the trained instructors, percent of extension of a trial period, level of skills of the instructor, ease of development of the methods used at adaptation);
- risks of motivation – the quantitative assessment (a ratio of number of the workers who have left at own will and for violation of labor discipline and average number of workers);
- risks of the organization of work – the quantitative assessment (a ratio of number of failures in work and in time the blurted-out operations);

- risks of scheduling of the quantitative and qualitative requirement for the personnel – the quantitative assessment (a ratio of number of the personnel in a section of positions upon and number of the personnel necessary on standards);

- risks of discrepancy of number of the production personnel – the quantitative assessment (a ratio of the actual number of the production personnel and the number corresponding to the expected perspective power of the enterprise);

- risks of discrepancy of number of the administrative and non-productive personnel – the quantitative assessment (a ratio of the actual charges of the administrative and non-productive personnel and economically necessary them I will drop, calculated proceeding from planned profitability and the actual volume of realization);

- risks of possible loss of qualified personnel – the quantitative assessment (the relation of work of an average monthly salary and coefficient of a regularity of payment of a salary competitors to work of an average monthly salary and coefficient of a regularity of payment of a salary at the analyzed enterprise).

3) Personnel risks at the exit:

- risks of untimely reduction and replacement of workers – quality standard (0 – 1).

Thus, the offered system of indexes of an assessment of personnel risks is enough the complete as considers practically all types of personnel risks. Nevertheless, the offered indexes are not unique and can change; on their choice affect both external, and internal factors: objectives, level of the made decision, possibility of obtaining necessary information, financial condition, etc.

For an assessment of degree of risk at each stage of implementation of the decision information characterizing conditions by the form of personnel risks has to be collected. Received information will allow to establish indeterminacy level in the sphere of personnel risks. As for each source of information degree of expressiveness of each characteristic differs, offered a five-point rating scale of quality of information.

As sources of information are used:

- organizational documents;
- polls of employees;
- expert estimates.

At identification of risks by a defining factor quality of used information is. Quality of information is defined by the following key parameters:

reliability;
objectivity;
timeliness;
reliability;
completeness of coverage.

As absolute completeness, reliability, reliability and objectivity of information on personnel scratches cannot be reached, the situation of lack of indeterminacy cannot be considered even at the maximal estimates.

On the basis of the offered scales the generalizing assessment of the informative conditions bound to personnel risks on considered alternative of the decision is defined. The generalizing assessment pays off as prime average arithmetic of estimates on each stage of implementation of the decision.

At a high level of indeterminacy of the conditions bound to personnel risks, they or are not considered at all at an assessment of alternatives, or the stage of collecting and information processing repeats until then when it will be possible to speak about increase of level of a determinacy of information till accepted.

At acceptable level of indeterminacy procedure of an assessment of personnel risks on each alternative is started. It includes:

1) Quality standard.
2) The quantitative assessment.
3) Complex assessment.

Quality standard of personnel risks provides:

- definition of conditions of emergence of risk;
- determination of risk factors; -
- definition of indexes of risk.

The quantitative assessment of personnel risks provides:

- determination of weight coefficients;
- definition of criteria of an assessment;
- development of rating scales;
- drawing up the summary table of the quantitative assessment;
- calculation of a generalizing index of personnel risk.

Weight coefficients are defined for an assessment of influence of each type of risk on generalizing assessment. For the accounting of a share of influence of each view of a risk level the specific weight coefficients expressed in shares of unit are used.

The quantitative assessment is carried out on the basis of the data received at quality standard, that is only those scratches which are present at this stage of implementation of the decision will be estimated. Can be estimated both simple types of risks, and groups. Join of types of risk in groups is carried out for more complete accounting of their influence on a common risk level.

The rating scale of risk constructed by means of statistical methods, is presented in table 1 [6].

This estimating scale is used at determination of admissible values of risk at each stage of implementation of the decision.

For each type of risk or group the individual scale is formed. By drawing up estimating scales each numerical value in points is interpreted by the detailed description of the corresponding risk conditions. The advantage of this approach is that the experts involved in the assessment are formed unified criteria of assessment.

Table 1. Rating scale of personnel risks

Risk level	Risk characteristic
Till 0,2	The minimum The probability of approach of the negative results is extremely small; personnel scratches which negatively influence results of the decision, practically are absent.
0,2 - 0,4	Small The probability of approach of the negative results of the decision is insignificant; personnel scratches which negatively influence results of the decision, are not essential.
0,4 - 0,6	Average The probability of approach of the negative results is essential, level of personnel risks can complicate implementation of the decision.
0,6 - 0,8	High The probability of approach of the negative results the considerable, level of personnel risks can interfere with implementation of the decision.
0,8 - 1,0	Critical The probability of approach of the negative results maximal, level of personnel risks threatens implementation of the decision

Table 2. The card of an assessment of personnel risks on alternative No. 1

Types of personnel risks	Stages of implementation of the decision				
	1	2	3	4	…
1.Biological	0,59 (2,25)				
2. The social and psychological	0,2 (2,5)	0,3 (2,6)			
3. Spiritually - intellectual	0,2 (3,0)				
4. Economical	0,2 (2,5)				
5. Personnel risks bound to entrance on enterprise		0,26 (3,0)	0,35 (3,0)		
6. Personnel risks bound to process of work at enterprise	0,2 (2,25)	0,3 (2,25)	0,34 (2,0)	0,35 (2,1)	
7. Personnel risks bound to exit from enterprise		0,2 (3,0)	0,25 (3,0)		
Complex assessment of risk	0,28	0,26	0,31	0,35	
Complex assessment of information	2,5	2,7	2,61	2,1	
Assessment of an acceptability of alternative			0,3		
Conclusion about an alternative acceptability from the point of view of personnel risks			0,1 - 0,4 it's acceptable 0,4 - 0,7 it's acceptable conditionally 0,7 - 1,0 it's not acceptable		

For an assessment of a type of risk on group the summary table in which the assessment of risk by each look is corrected taking into account weight coefficient is used. The generalizing assessment by this type of risk is determined as average weighed of estimates by all types.The trust to an assessment of risk depends on quality of information according to which it was received. Therefore the summary table joins also information evaluation test. The rating scale of quality of information is for this purpose used.

The assessment of risk on group taking into account weight coefficient and quality of information is made by all types of risk revealed at this stage of implementation of the decision and on all stages, falling into to this alternative [7].

The result of an assessment of personnel risks on considered alternative is provided in the summary table of the quantitative and qualitative estimates, namely in the card to an assessment of risks. The assessment of an acceptability of alternative is determined as average weighed according to risks by each stage where as weight information evaluation test is accepted. The example of the card of an assessment of personnel risks on one of alternatives is presented in tab. 2.

The offered technique of an assessment of personnel risks is based on the following principles:

1) Objectivity – consists in the adequate description of initial parameters of an assessment with use of the scientific methods which are most reducing subjectivity of an assessment.

2) Efficiency – assumes timeliness and fastest estimates.

3) Productivity – obligatory and expeditious acceptance of effective measures by results of an assessment.

4) Complexity – allows to consider the greatest possible quantity of indexes.

5) Substantial uniqueness – relatives according to the contents factors owe baht are excluded from an assessment.

6) Balance – selection of such quantity of indexes which, on the one hand, would be enough for a complex assessment of personnel risks, and, on the other hand, which will not overload and complicate assessment procedure.

CONCLUSIONS

Thus, the offered technique of an assessment of alternatives assumes application of a complex assessment of personnel risks, Results of an assessment

of personnel risks can be used not only for upgrading of the made administrative decision, but also for definition of the directions of development of the personnel and perfecting of all organization.

The card of an assessment of the personnel risks, made at the final stage of an assessment, can be used for identification of the most problem from the point of view of the personnel of sites of division or the enterprise.

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Optimization of the structural components of gearwheels of cylindrical reducing gears

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Abstract. For the first time the design equations for determining the structural components of cylindrical tooth gears of reduction units are improved allowing for the use of informational technologies (IT).

On the basis of the equations obtained the optimizing mathematical model of the optimal synthesis of structural components of tooth gearwheels has been developed. For solving the optimizing model the Monte-Carlo method is applied. The structural parameters (quantities), obtained by the developed optimizing mathematical model, have optimal values with probability up to 0.95 under the conditions of necessary strength and production safety.

The implementation of the optimization process is recommended at the design institutions for the design of the cylindrical reduction drives for different objects of mechanical engineering and into the educational process of higher technical educational institutions while studying theoretical matters, accompanied by the use of IT.

Key words: optimization, structural components of a tooth gearwheel, optimizing model, tooth gearwheel strength, gearwheel reliability.

SETTING THE PROBLEM

Providing the substantiated choice of the optimal parameters of a designed construction is the main problem of modern mechanical engineering.

It especially concerns constructions working under the conditions of possible high overload. Some well-known scientists were concerned with the problems of structure synthesis and parameter optimization of different constructions, namely: I.I. Artobolevski, V.L. Genkin, E.M. Gerasimov, A.F. Kirichenko, P.L. Nosko, B.I. Kindratskij, and many others. K.I. Zablonskij, A.F. Kirichenko, V.P. Shishov and others dealt with the optimizing of the tooth gears of reduction units. But the methods they developed are applied only to certain tooth gear elements and gear shafts without using IT. So, the task is to develop a methodology allowing the synthesis of main optimal structural components of the tooth gears of reduction units according to their intended purpose with the use of IT. This task is urgent and necessary to be solved at the current stage of technology development.

ANALYSIS OF RECENT ACHIEVEMENTS AND PUBLICATIONS

Many researchers at research and design institutions, as well as at higher educational institutions in Ukraine and in the world were engaged in the development of different technical objects including tooth gears for technological objects with the use of IT.

Their efforts resulted in the development and implementation to the design practice such software as **ARM WinMachine, MDesign, Kompas, T-Flex,** special software (**Deshyfr, DMCost, DMNS, Pryvod**) and other [1].

Analyzing the software mentioned above and the techniques of their applying for the computation and development of different technical constructions, it could be noticed that using them produces certain results, but they cannot determine the optimal parameters of the object being designed. This drawback is caused

by their using only well-known design equations without taking into account optimizing criteria necessary for a certain construction [5]. For example, the **T-Flex** system provides the multiple-choice geometrical calculation of tooth gear construction and strength in accordance with standard techniques.

In works [2-3] the prospects of improving the tooth gearwheels by means of the synthesis of the output circuit of the gear teeth are considered. In addition, on the base of the differential equations of operating profile only the profile of gear teeth with Novikov's toothing was synthesized [4]. Examining the tooth gearwheel, one can easily notice that besides the tooth operating profile there are many other construction elements which are not considered in the optimization process.

So the task set is to eliminate this deficiency to some degree, while determining the dimensions of the structural components of the tooth gearwheels of cylindrical reduction units, which should have high maintenance reliability. Using IT, it is necessary to take into consideration the current experience of higher educational institutions from abroad, concerned with this field: Politehnica University of Bucharest (Romania), Technical Military Academy of Bucharest, Silesian Polytechnic (Poland), Technical University Magdeburg (now The Otto von Guericke University of Magdeburg, Germany), Moscow State Technical University n.a. N.E. Bauman (Russia), National Technical University of Ukraine "KPI", Donetsk National University, Donbas National Academy of Civil Engineering and Architecture, National Technical University "Kharkiv Polytechnic Institute", Donbass State Engineering Academy, Donbas State Technical University and others.

The purpose of the work is to develop the optimizing mathematical model of the synthesis of structural components of tooth gearwheels in cylindrical reduction units based on the results of the theoretical and experimental investigations with the use of IT.

SOLVING THE SET TASK

Choosing the optimization criteria. One of the main factors characterizing the quality of a certain product is its reliability. In turn, one of the main reliability indicators is the life span of every structural component and the product in general. According to State Standard of Ukraine 2860-94, one of the reliability indicators of the structural component of the product is an average life cycle $T_{cл}$. However, it should be added that increasing the product life cycle without considering its economical reliability indicators may not be reasonable.

Following the state for optimizing and synthesizing the construction parameters of the shaft tooth gears mentioned above, let's establish following criteria:

1. The economical indicator of reliability of the tooth gearwheel Q_e in UAH, which is equal to [6]:

$$Q_e = K_e \cdot T_{cл},$$
$$K_e = (Q_B + Q_E)/T_E, \quad (1)$$
$$T_{cл} = \frac{N_0}{60 n_u \left(\frac{\sigma_E}{\sigma_r}\right)^k}, \quad (2)$$

where: K_e are expenses according to the equation (1), relating to the production and operation of the tooth gearwheel, UAH per hour; $T_{cл}$ is the average life span of the gear according to the relation (2), concerned with the maximum possible basic number of loading periods and projecting stress cycles effecting on the gear teeth, h; Q_B are production costs of the tooth gearwheel, UAH; Q_E – total operational costs, UAH; T_E is a set life span, h; N_0 is the basic number of stress cycles (for contact stresses $N_0 = N_{H\lim b} = 30\text{HB}^{2,4}$; for bend tensions $N_0 = N_{F\lim b} = 4 \cdot 10^6$; (when the hardness of tooth gearwheel is given in HRC, it is necessary to multiply hardness in HRC by 10); n_u is the frequency of stress cycles, min^{-1}; σ_E is equivalent tension (σ_H and the major of two values σ_{F1} and σ_{F2}, correspondingly), MPa; σ_r is limit endurance ($\sigma_{H\lim b} = 2\text{HB} + 70$ and $\sigma_{F\lim b} = 1{,}8\text{HB}$ correspondingly), MPa; k is the index of bend tension hardness rate ($k = 6$ for wheels with homogeneous material structure and a ground fillet surface regardless of the hardness and thermal treatment of the teeth; $k = 9$ for nitrated tooth gearwheels, as well as for gears after carburizing and carbonitriding treatment).

2. Reliability costs Q_H, UAH:

$$Q_H = Q_H (T_E / T_{cл})^{\alpha}, \quad (3)$$

where: Q_H – reliability costs of the tooth gearwheel prototype, UAH; a – number exponent characterizing the level of production progressiveness in terms of increasing the product reliability; $\alpha = 1{,}3...1{,}5$.

The choice of these criteria can be explained in such a way. $T_{cл}$ being increased, the stated criterion Q_e is gradually increasing up to the limit, when $T_{cл} = T_E$. In this case it becomes equal to $Q_B + Q_E$, determining the normal operating mode (Fig.1).

On the contrary, according to (3) the second criterion Q_H is gradually decreasing, while $T_{cл}$ being increased, at the expense of the reduction of operating costs, that is, the number of breakdowns is reduced (Fig.1).

Applying set criteria for the optimization and synthesis the constructive parameters of the tooth gearwheels of cylindrical reducers, let's present them as a two-criterion optimization surface (Fig. 2).

Along the axe X (Fig. 2) the operating span of the tooth gear is shown, which is proportional to the economical reliability indicator of the tooth gearwheel Q_e, and the axe Y represents the operating span of the tooth gearwheel, proportional to the reliability cost $-Q_H$. Then the general optimization criterion can be shown as:

$$\left| Q_e - Q_H \right| \Rightarrow \min .$$

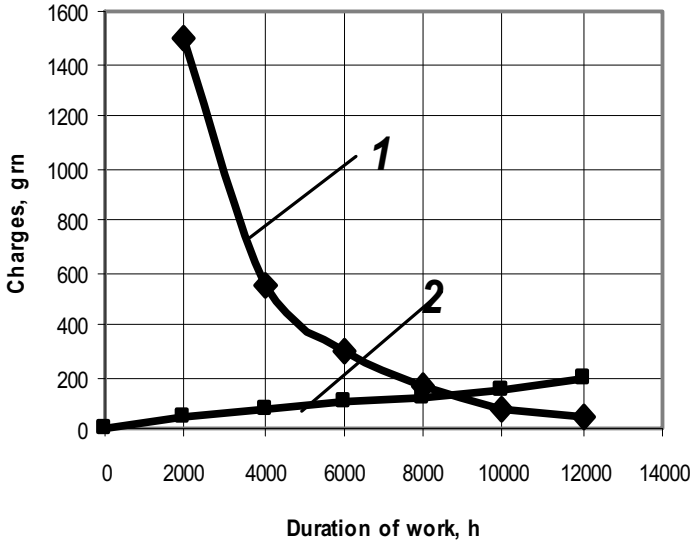

Fig. 1. Criterion relations: *1* – Q_H; *2* – Q_e

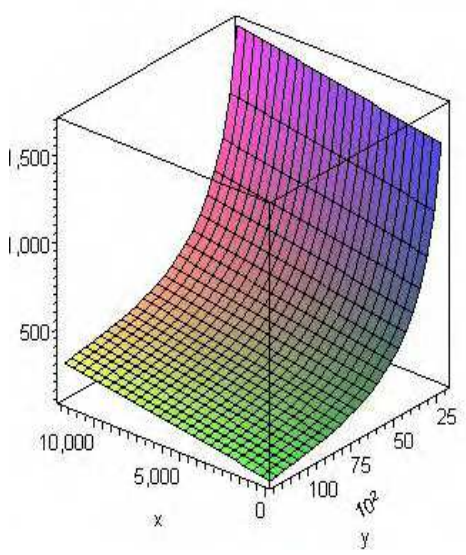

Fig. 2. Two-criterion optimization surface

The constructions of the tooth gears of cylindrical reducers. For the cylindrical reducers, three construction types of tooth gearwheels are mainly used: 1) single-crown gearwheels with sufficient length l and diameter d_o of a datum bore (a hub), so that $l/d_o > 1$; 2) single-crown gearwheels of disc type with $l/d_o \leq 1$; 3) tooth wheel-shafts, made as a whole, where the shaft is significantly long comparing the length of a toothed ring.

Determining the dimensions of structural components of the tooth gearwheels according to their mode of deformation. While operating under the load the deformation mode of the every tooth gearwheel appears, which is affected by the *thrust force* F_t, *axial force* F_a and *radial force* F_r. The values of these forces are determined by the equations:

$$F_t = \frac{2T_1 \cdot 10^3}{d_1},\ F_a = F_t tg\beta,\ F_r = \frac{F_t tg\alpha_n}{\cos\beta},$$

where: T_1 is a torque, Н·м; d_1 is the diameter of the index gear of a driving tooth gearwheel, mm; β denotes the gradient angle of a gearwheel; α_n is a pressure angle in the normal section of the gearwheel tooth.

The main structural components of the cylindrical tooth gearwheel are: the top of tooth diameter (the outer diameter of the tooth gear) d_a; face width b; the datum bore of the hub d_o; a key groove in the datum bore of the hub $l_ш$ long, $b_ш$ wide, t_2 deep, and with the depth in the shaft t_1; the length of the hub l; plate thickness between the hub and the toothed ring δ_o; the internal diameter of the toothed ring $d_в$.

For the determining the optimal dimensions of structural components of the tooth gearwheels depending to their deformation mode it is necessary to obtain the dependencies allowing the use of relevant IT methods. In this case the list of input data which are useful for obtaining design equations should be compiled.

The input data for obtaining design equations and the optimization of structural components of the tooth gearwheel are as foolows:

- material of the tooth gearwheel, with the hardness of HB or HRC in accordance with the grade of material and the kind of thermal treatment applied;
- liquid limit of the material of the tooth gearwheel $\sigma_т$, MPa;
- reduction ratio of the tooth gearwheel u_{12};
- given life span of the tooth gearwheel is considered to be up to 30000 hours (according to routine repair tips the average duration of a repair cycle from the first putting into operation equals to 30000 hours[8]);
- trouble-free life T_B, hours;
- circular velocity of the driving gearwheel V_1, m/s;
- driving torque on the driving gearwheel T_1, N·m;
- possible short-time overloads k_n, times;
- face width index $\psi_{ba} = 0{,}2\ldots0{,}5$;
- allowable contact stress $[\sigma]_H$, MPa;
- allowable bend tension of the driving gearwheel tooth $[\sigma]_{F1}$, MPa;
- allowable bend tension of the driven gearwheel $[\sigma]_{F2}$, MPa;
- safety margin index S_F;
- index taking into account the transmission parameters K_a, $MPa^{1/3}$;
- accuracy grade of gearwheels n_{cm};
- acceptable sound volume L, dBA;
- reliability cost of the tooth gearwheel prototype $Q_П$, UAH;
- production cost of the tooth gearwheel Q_B, UAH;
- total operational costs Q_E, UAH;
- index of the degree of a stability curve k;
- number exponent characterizing the level of production progressiveness in terms of increasing the product reliability α;
- allowable bearing stress for a key joint $[\sigma]_{зм}$, MPa;
- allowable tensile stress for steel $[\sigma]_p$, MPa;

- the diameters of a driveshaft $d_{в1}$ and a driven shaft $d_{в2}$, on which tooth gearwheels are located.

Design equations.

1. Determining the number of the teeth of the driving gearwheel z_1 and the driven gearwheel z_2 according to the given circular velocity V_1:

$$z_1 = -0,0004V_1^2 + 0,1477V_1 + 17,728, \qquad (6)$$

$$z_2 = u_{12} z_1 .$$

The obtained numbers of the teeth are rounded off to the nearest integer.

2. The minimum distance between axes for the externally toothed tooth gearwheel, mm [5]:

$$a_{w\min} = K_a (u_{12} + 1)\sqrt[3]{\frac{T_1 K_{H\beta}}{u_{12}\psi_{ba}[\sigma]_H^2}},$$

where: $K_{H\beta}$ is a tentative rough value of the index which takes into account the irregularity of load distribution along the width of toothed ring:

when HB≤350

$$K_{H\beta} = 0,994\exp[0,0486\psi_{ba}(u_{12} + 1)],$$

when HB>350,

$$K_{H\beta} = 0,984\exp[0,1057\psi_{ba}(u_{12} + 1)].$$

The determined value $a_{w\min}$ is rounded off to the nearest integer a_w.

3. Tooth gradient angle β, degr:

$$\beta = 0,0183L^2 - 3,0583L + 127,38,$$

where: L is the acceptable sound volume, dBA (according to the Ukrainian sanitary code CH 2.2.4/2.1.8.562-96 L = 50…85 dBA).

4. The module of the tooth gearwheel m_n, mm, is obtained as follows:

$$m_n = \frac{2a_w \cos\beta}{z_1 + z_2}.$$

The determined module value is agreed with a standard value and the real value of the distance between axes a_w of the tooth gearwheel is calculated.

5. Reference diameters of the driving gearwheel d_1 and the driven gearwheel d_2, as well as gear faces b_1 and b_2, mm, are calculated according to:

$$d_1 = \frac{m_n z_1}{\cos\beta},\ d_2 = \frac{m_n z_2}{\cos\beta},$$

$$b_2 = \psi_{ba} a_w;\ b_1 = b_2 + 2.$$

6. The adjustment of the diameter of the wheel slot d_{f1} for the tooth wheel-shafts with the shaft external diameter $d_в$, bearing the driving gearwheel:

$$d_{f1} = d_1 - 2,5m_n \ge d_{в1}. \qquad (4)$$

In the case, when according to the dependence (4) $d_{f1} < d_{в1}$, it is necessary to perform a recomputation, increasing module m_n or the number of teeth z_1.

7. Circular velocity in gears mesh, N:

$$F_t = \frac{2T_1 10^3}{d_1}.$$

8. Indexes taken into account during the calculations of contact hardiness and bend hardiness of gear teeth respectively: load distribution between the teeth $K_{H\alpha}$, $K_{F\alpha}$; adjusted load distribution along the face width $K_{H\beta}$, $K_{F\beta}$; tooth dynamic load K_{Hv}, K_{Fv}:

$$K_{H\alpha} = 0,53n_{cm}^{0,33}V_1^{0,04},$$

$$K_{F\alpha} = \frac{4 + \left(\left[1,88 - 3,2\left(\frac{1}{z_1} + \frac{1}{z_2}\right)\right]\cos\beta - 1\right)(n_{cm} - 5)}{4\left[1,88 - 3,2\left(\frac{1}{z_1} + \frac{1}{z_2}\right)\right]\cos\beta},$$

where: n_{cm} is the accuracy grade of the tooth gearwheel (n_{cm} = 5…9); V_1 is the circular velocity of the driving tooth gearwheel between 2,5…25 m/s:

$$K_{H\beta} = 1 + \frac{7\cdot 10^{-8} HB^{2,432} b_2}{d_1},$$

$$K_{F\beta} = 1 + \frac{7,5\cdot 10^{-8} HB^{2,432} b_2}{d_1},$$

$$K_{Hv} = 1,56n_{cm}^{0,064}V_1^{0,029}HB^{-0,1},$$

$$K_{Fv} = 5,26n_{cm}^{0,12}V_1^{0,11}HB^{-0,35}.$$

9. Specific design thrust forces, while the contact hardiness and strength of the tooth surface w_{Ht} and bend hardiness and strength w_{Ft} are calculated in accordance with the equation:

$$w_{Ht} = \frac{F_t}{b_2} K_{H\alpha} K_{H\beta} K_{Hv},$$

$$w_{Ft} = \frac{F_t}{b_2} K_{F\alpha} K_{F\beta} K_{Fv}.$$

10. Contact hardiness and strength of the teeth of the steel tooth gearwheels externally toothed at α_n = 20° is obtained as follows:

$$\sigma_H = 487\cos\beta\sqrt{\frac{w_{Ht}(u_{12} + 1)}{d_2\left[1,88 - 3,2\left(\frac{1}{z_1} + \frac{1}{z_2}\right)\right]\cos\beta}} \le [\sigma]_H.$$

Designed contact hardiness is allowed in the range:

$$1,05\,[\sigma]_H \ge \sigma_H \ge 0,9\,[\sigma]_H.$$

In the case of the failure to meet this requirement, it is necessary to change the face width b_2 or the distance between axes a_w etc.

Maximum contact stresses are calculated as shown:

$$\sigma_{H\max} = \sigma_H\sqrt{k_n} \le [\sigma]_{H\max} = 2,8\sigma_T.$$

11. Bend hardness and strength of the teeth of the steel tooth gearwheels is obtained as follows:

- for the driving gearwheel:

$$\sigma_{F1} = \frac{5,32\left(1 - \frac{\beta}{140^0}\right)w_{Ft}}{m_n\left(\frac{z_1}{\cos^3\beta}\right)^{0,092}} \le [\sigma]_{F1},$$

- for the driven gearwheel σ_{F2} is determined under the condition of z_2 in comparison with $[\sigma]_{F2}$.

Maximum bend tensions are calculated by the major value σ_{F1} or σ_{F2}:

$$\sigma_{F\max} = \sigma_{Fi} k_n \le [\sigma]_{F\max} = \frac{4,8HB}{S_F},$$

where: S_F is a safety margin (S_F = 1,4…1,7).

12. The dimentions of the key joint of gearwheels with shafts $d_{в1}$ and $d_{в2}$, mm are calculated in accordance with the formula:

$$l_i \ge \frac{2 \cdot 10^3 T_1}{(0,042 d_{вi}^2 + 1,574 d_{вi})[\sigma]_{зм}} + 0,271 d_{вi} + 0,93.$$

Determined dowel lengths l_1 and l_2 are agreed with standard boundary lengths according to the shaft diameter $d_{вi}$.

Groove depth in the datum bore in the hub t_{2i} is determined by the equation:

$$t_{2i} = 0,044 d_{вi} + 1,822.$$

Dowel width $b_{шi}$ is calculated by:

$$b_{шi} = 0,271 d_{вi} + 0,9301.$$

The value $b_{шi}$ is to be rounded up to the integer.

13. Gearwheel hub lengths $l_{м1}$ and $l_{м2}$ depend on the dowel lengths:

$$l_{м1} = l_1;\ l_{м2} = l_2.$$

14. Hub external diameter $d_{мi}$ is:

$$d_{мi} = \frac{4 \cdot 10^3 T_1}{d_{вi} l_{мi} [\sigma]_p} + d_{вi} + 2(0,044 d_{вi} + 1,822).$$

The value $d_{мi}$ is to be rounded up to the integer.

15. The internal diameter of the toothed ring $d_{з.в.i}$ is determined as:

$$d_{з.в.i} = 0,8 d_{fi}.$$

16. Plate thickness $b_{∂}$ between the hub and the toothed ring is found as:

$$b_{∂i} \ge \frac{10^3 T_1}{6\pi d_{мi}^2}.$$

The value $b_{∂i}$ is to be rounded up to the integer.

17. The weight of the steel tooth gearwheel M, kg is calculated as:

$$M_i = \frac{7,8 \cdot 10^{-6} \pi}{4} \left(\begin{array}{l} b_i [0,5(d_{ai}^2 - d_{fi}^2) + (d_{fi}^2 - d_{з.в.i}^2)] + \\ +(d_{з.в.i}^2 - d_{мi}^2) b_{∂i} + (d_{мi}^2 - d_{вi}^2) l_{мi} \end{array} \right),$$

$$d_{ai} = d_i + 2m_n;\ d_{fi} = d_i - 2,5m_n.$$

In the case when $0,5(d_{з.в.i} - d_{вi}) \le 20$, it is necessary to accept the condition $b_{∂i} = b_i$.

18. Reliability costs of the gearwheel prototype $Q_П$ in UAH are determined according the equation:

$$Q_П = 1,97 \cdot 10^{-4} M_i^{1,11} n_{cm}^{-1,,05} d_i^{1,01} \lambda^{-0,9}, \quad (5)$$

where: λ is the failure rate, h^{-1}:

$$\lambda = \frac{1}{T_B}.$$

T_B is the trouble-free life, h (for the tooth gear of the seventh accuracy grade T_B = 3600 hours [7]).

19. Production costs for the tooth gearwheel Q_B, UAH. The value Q_B is determined by the equation (5), when the values obtained after the calculations of the structural components of the tooth gearwheel, namely, the reference diameter, weight, set accuracy degree and failure rates are substituted in it.

20. Total operational costs Q_E in UAH are determined according to the equation:

$$Q_E = 6 \cdot 10^{-7} T_E^2 + 0,01 T_E - 2,381,$$

where: T_E – set life span of the tooth gearwheel, h.

21. Cycle friquency $n_ц$, min^{-1}:

$$n_{цi} = \frac{6 \cdot 10^4 V_1}{\pi d_i}.$$

Optimization mathematical model of the determining the structural components of the tooth gearwheel. The task set for developing the optimization mathematical model refers to the discrete programming. The Monte-Carlo method is suitable for its solving. Constraint region, defined with the variable factors and optimization criteria, is enclosed into the n-dimentional parallelepiped, where the investigations are carried out.

The optimization mathematical model can be represented as follows:

aim function:

$$Q_{Bi} \Rightarrow \min, \quad (6)$$

by the criterion:

$$|Q_{ei} - Q_{Hi}| \Rightarrow \min, \quad (7)$$

limited by:

$$\left. \begin{array}{l} a_1 \le \psi_{ba} \le b_1; \\ a_2 \le L \le b_2; \\ a_3 \le T_B \le b_3; \\ a_4 \le T_E \le b_4; \\ a_5 \le V_1 \le b_5; \end{array} \right\}, \quad (8)$$

$$p \ge [p]. \quad (9)$$

where: a_1, a_2, …, a_5 are minimal values of operational and structural factors, which are determined at the stage of developing the technical development task; b_1, b_2, …, b_5 are the maximum values of the operational and structural factors; p is the probability of hitting the investigation point into the range of the feasible solutions, surrounded by the n-dimentional parallelepiped determined by the limitations (8) and the criterion (7); [p] is the allowable value of the probability of hitting the investigation point into the range of the feasible solutions.

While using the Monte-Carlo method for solving the task, it is necessary to create the sequence of pseudorandom numbers μ_i in the range from 0 to 1,0 using special software. Pseudorandom numbers should be transformed into the factor values (8) according to the equation:

$$x_i = a_j + \mu_i (b_j - a_j),$$

where: x_i is the factor value at the i-stage of the task solving process; μ_i is the pseudorandom number at this stage; a_j, b_j are correspondingly minimum and maximum values of j- limitation according to the equations (8).

For solving this optimization task an algorithm has been developed including all necessary calculations for

the tooth gear and the simultaneous definition of the optimization criteria: 1) design algorithm determining the distance between axes a_w, module value m_n and design parameters of the toothed ring; 2) testing active tooth surfaces for their contact hardiness; 3) testing active tooth surfaces for their contact strength; 4) testing teeth for the bend hardiness; 5) testing teeth for the bend strength; 6) structural dimensions of the key joint, the hub, the internal diameter of the toothed ring and plate thickness; 7) weight of the tooth gearwheel.

It is necessary to include into the algorithm the determinations:

$$T_{сл1} = f(\sigma_H),\ T_{сл2} = f(\sigma_{F1})\ \text{і}\ T_{сл3} = f(\sigma_{F2}),$$

taking the least of values obtained and taking it into account during the calculations of optimization criteria.

On the basis of the algorithm an application package has been developed which has contributed to the solving the task set in the range of the feasible solutions, limited by the aim function (6), the criterion (7) and the limitations (8). During running the program the probability p of hitting the investigation point into the range of the feasible solutions is determined as:

$$p = \frac{w}{N},$$

where: w is the general number of computer operational cycles, having hit into the range of the feasible solutions; N is the general number of computer operational cycles.

CONCLUSIONS

1. The method of multiparametric synthesis of the basic structural components of the cylindrical tooth gear using the optimization multicriterion mathematical model, which makes it possible to reduce many times the period of designing the production stage. With the use of the computer the duration of the synthesis of the parameters of the structural components of the tooth gearwheel does not exceed 20…40 s.

2. For the realization of the method of multiparametric synthesis of the structural components the Monte-Carlo method has been used, which considerably simplifies the optimization process due to the use of the pseudorandom numbers.

3. Using the set criteria allows ensuring the given life span duration of the designed cylindrical tooth gear.

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Factors influencing the enterprise innovation

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Abstract. The factors that influenced the enterprise innovation are investigated and summarized in the article. Key factors of impact on the enterprise innovation are grouped. Their relationship and mutual influence are proved. Graphic reflect on the impact of external and internal environment factors of the innovative enterprise characteristics are constructed.
Key words: innovativeness of enterprise, environmental factors, factors of direct influence, sustainability, factors of indirect influence.

INTRODUCTION

At present results of innovative activity initiated by the acceleration of scientific and technical progress, substantially affect all aspects of human society development, change the environment of life and human activity, ways to ensure its existence and development. The modern economy is characterized by increased competition. In these terms innovations become the mandatory member of economic activity of enterprises and are basic motive force and pre-condition of their development. That is why innovative activity is one of the main activities of any company that uses knowledge and interact with the field of technology, economy and ecology, social psychology and sociology, basic and applied sciences, theory and practice of production and management, strategy and tactics. The growing role of innovations and innovative activity in development of enterprise requires a broader study of the impact of factors on innovation, innovative activity and, in particular, on the level of innovativeness of its activities.

Among the scholars who have researched the factors influencing the level of innovativeness of the enterprise are B.D. Babaev [2], A. Chernykh [4], V.M. Suyazov [2], B. Shlyusarchyk [16], G. I. Zhits [20], N. V. Sobchenko [17], E. V. Opekun [13], A. I. Nikolaev [12], O. V Myasnikova [10, 11], I. V. Usacheva, V.A. Kuklinov [18], M.A. Ryazanov [15], S.R. Yaholkovskyy [19] and others. But each of these researchers has its own vision to this question, that is why there is a necessity of specifying the factors influencing the level of innovativeness of the company in the context of our study.

The research aim is to systematize the factors affecting the level of innovativeness of the enterprise and to identify the relationship between innovation and the characteristics of its activities.

CLASSIFICATIONS OF FACTORS INFLUENCING THE INNOVATIVE ACTIVITY OF ENTERPRISES

The main prerequisite for competitiveness in the conditions of innovative scientific and technological development is a high level of innovativeness of its activities.

Innovative business is a complex characteristic, which reflects its ability to update through the development and implementation of new ideas as well as transfer of ideas from the outside. Thus, the concept of innovativeness of the enterprise is innovation potential, which is broadly defined as a combination of scientific, technical, technological, infrastructural, financial, legal, cultural and other opportunities to provide perception and realization of innovations, i.e. introduction of innovations. Actualization of innovative potential, in turn, is a prerequisite for innovation company, which is characterized by the intensity of innovation processes and expressed in terms of innovative activity and performance results, expressed in terms of the effectiveness of innovation.

Thus, any research of the essence of innovative capacity, innovative activity, its forms, intensity and results within the research enterprise inevitably implies the need to identify and study the factors that actually determine the parameters of the investigated phenomena.

Obviously, the study of innovation of the company should be given a more detailed classification of factors - their selections in separate groups of more than one criterion to identify the location of each factor in their overall population. Such classification, at first, will describe the effects of changing factor on the business, using multiple classifications. Secondly, it will provide an opportunity to highlight the permanent factors that could increase the level of innovativeness of the enterprise.

In our research while analysing the factors affecting the level of innovativeness of the company, we adhere to the traditional approach, which allows factors in accordance with the environment of their origin, the degree of impact on the company and the possibility of control of the company divided by the factors: macro- (external factors mediated (indirect) impact), microenvironment (external factors directly (direct) effect) and internal factors. And their impact on innovation of the company for the specific conditions of space and time can have both positive and negative direction, i.e. uniquely determine the direction of their influence on the investigated characteristics is impossible, because of its dual nature.

Environmental factors that influence the innovativeness of the company, divided into factors of macro and micro.

It should be noted that an external environment is characterized by several basic properties:

- interconnectedness of environmental factors;
- complexity, large amount and level of variability factors that affect the company as a whole and for its innovation in particular;
- dynamism, due to the dominant economic development of the state;
- probabilistic nature of the changes occurring in the environment [1, 3, 5, 6].

In addition, a detailed study of various aspects of the external environment on the innovation of the company seems relevant since it is a provider of economic resources to support domestic innovation processes on a desired level.

The company is in a constant exchange with the environment, thus providing the opportunity for its effective functioning and development. The successful operation of the company needs to have a thorough understanding of the situation, trends change various components of the environment in order to develop innovative policy that requires behavioral strategies and tactical actions for its implementation.

The state of external environment is key to the development of innovative enterprises, as an external environment in relation to epy enterprise is the objective and determining condition of its existence. In scientific literature there is a classification of environmental factors: factors of direct influence (factors of microenvironment), factors of indirect influence (factors of macroenvironment) [7, 8, 9].

The factors of indirect influence (macrosurroundings) create general conditions for the existence of enterprises in the environment. In macro factors affecting the innovation of the company, we have included the legal, political, social, technological, economic, sustainable and climatic factors.

FACTORS OF INDIRECT INFLUENCE

Political factors. Stability of the political situation in the country determines the efficiency of innovation, and thus increases the investment attractiveness of the domestic industry, including foreign partners.

Legal factors. Legislated legal status of the company determines the sequence well-organized driving innovation and cooperation with central and local authorities exercising control and supervision of the innovation enterprise, guided by a system of legislation.

Economic factors reflect the general economic situation in the country or region where the company operates. These factors are most significant, as current and projected state of the economy affect the achievement of business objectives, including the implementation of innovations.

The scientific and technical factors of macroenvironment characterized by an indirect effect on innovation of enterprises are crucial for the emergence of technological innovations in production processes. The high level of innovative activity of industrial enterprises is possible in the case when it is fully using all scientific and technological progress does the state support.

Social factors. The social environmental factors include the indirect impact of organizational culture and consumer population, its moral code of conduct, professional and personal qualities of employees, health care and so on. Social environment largely determines the range, volume of production, pushing the requirements for an innovative product, and indirectly affects its quality, subject to the availability of effective demand on this or any other food item. Social factors have a substantial influence on innovative activity of industrial enterprises and, as a consequence on the results of their innovative activity.

Sustainable factors. The importance and significance of the impact of sustainable factors determined their consequences increase the risks in the current difficult conditions and technological production. The main problem of Ukrainian economy is low productivity at a high level of wear of equipment in the leading industries, leading to disasters and improving environmental risks.

Natural and climatic factors - a collection of the natural environment in which the company operates and

it is also the level of sustainability for innovation. The value of these factors in the current situation of limited natural resources due to the fact that they motivate companies to improve their innovation activities in the field of development and innovation related to improving the use of natural resources and their replacement alternatives , including artificially created.

MICROENVIRONMENT FACTORS

Factors of direct influence (microenvironment) are an aggregate of factors that directly affect the activities of the company and feel the feedback i.e. direct impact of the company on them. These factors directly affect the pace and scale of the enterprise, its effectiveness as a full range of these factors is the kind of system constraints. In particular, the micro factors that influence the innovativeness of the company, we have included suppliers, competitors, customers and contacts audience.

Suppliers. Such factors as suppliers take notable place among micro factors affecting the innovativeness of the enterprise. The influence of this factor on the innovativeness of the company can be detected because of the level of prices, quality, volume, delivery time necessary raw materials, components and more. In the market there are alternative proposals from businesses, suppliers, because the effectiveness of supplier selection is a prerequisite for effective innovation.

Consumers. The level of innovation of the enterprise and, in particular, the implementation of its innovation strategy largely depends on such factors directly influence as consumers. In a market environment characterized by active competition among manufacturers for the consumer market saturation is a variety of goods and services. Manufacturers have to meet the needs of customers, constantly improving existing products and developing new headings, i.e. actively implementing various innovations.

Competitors. Competition, as part of a market economy, in modern terms is considered as a continuous (permanent) process, the formation of competitive advantage through innovation. To compete in the market enterprises are the additional costs of research and experimental development for innovation which provide to the enterprise their difference from other.

Pin audiences. The pin audiences include: government agencies that act as regulators, coordinators, controlling, monitoring bodies, etc. of the enterprise, financial and credit institutions that are sources of funds for businesses, social organizations such as performing supervisory and regulatory functions, some speakers claims against the company.

Internal factors impact on the innovativeness of the company, in our opinion, should be considered at the level of its functional subsystems, namely financial, production, personnel, marketing and management. Within the limits of every subsystem it is possible to distinguish many factors that have an impact on the noted description. Their final list will be determined separately for the particular company.

Graphically, the factors affecting the innovation of the company may be represented as a cone, where each of its bases corresponds to a specific group of factors (Fig. 1).

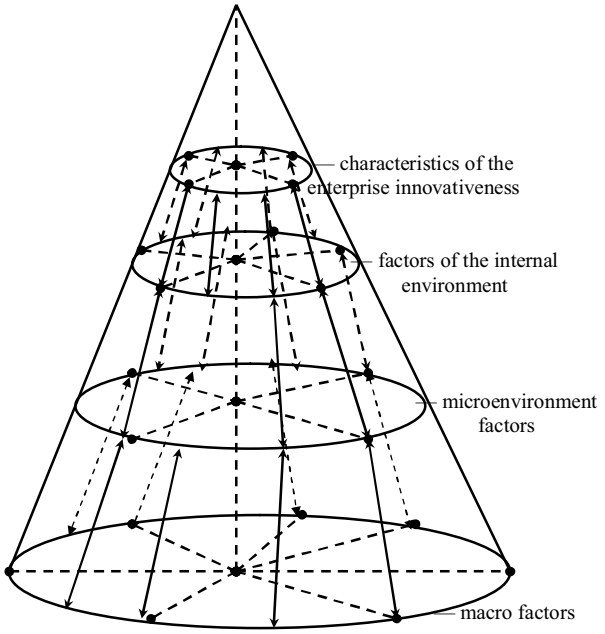

Fig. 1. Factors influencing innovativeness in the enterprise
Source: the results of author's research

Each group of factors influencing the innovativeness of the company meets certain base of the cone, the plane is determined by the degree of exposure to the specified characteristics and the possibility of control of the company: the biggest plane is the basis of the cone that defines leakage as they describe macro that determines the general conditions operation of the business within the state at a particular time and is not subject to review by the company. It should be noted that the base of the cone area decreases with increasing degree of influence factors which they correspond, the innovation of the company and the growth opportunities of the enterprise to their control. The smaller the footprint, the denser the impact of factors on each other and on the characteristics of the innovation enterprise.

Each environment has its own plane, which is limited to a truncated cone, excluding the upper base, and bottom base is divided into sectors which number corresponds to the number of impact factors on the innovativeness of the company. It should be noted that the factors are not isolated from each other, and have poured upwards and vice versa according to the constructed cone, thus increasing or decreasing the mutual influence and impact on the innovativeness of the company.

As already noted, the restrictions created in the bottom level of a truncated cone are determined a set of relevant environmental factors regarding a particular company. Thus, the environment has two levels - macro

and micro, which are described by the following factors namely: macro factors (political, legal, economic, social, technological, environmental, climatic), reflecting the peculiarities of national economic policy state regulatory framework, adequacy of resources, etc.; microenvironment factors (suppliers, customers, competitors, pin audience) , reflecting the immediate environment of market economy, which creates demand and supply in the market and determines the infrastructure components of this market.

Internal environment factors that influence the innovativeness of the company are defined within its functional subsystems (production, finance, personnel, marketing and maagement) and determine the excess or lack of resources, interest in enterprise innovation and institutional capacity to implement innovations.

INTERCOMMUNICATION BETWEEN COMPANY CHARACTERISTICS AND FACTORS OF INNOVATIVENESS

Innovation enterprise is part of its internal environment and the result of many sub-systems company, which is difficult to distinguish clearly in the overall subsystem, as it is essentially a form of innovation potential, that generally determines the innovativeness of the company. Innovation is the manifestation of the company through characteristics such as activity, reliability, market value, sociality and environmental described by a number of indicators. These properties and parameters allow us to isolate those factors of internal and external environment that directly or indirectly affect them (Table 1).

Table 1. Determination of intercommunication between descriptions of enterprises innovativeness and factors, that influence on it

Classification sign	Intercommunication within the limits of classification sign	Factors of influence the innovative activity of enterprise
Market value	Direct	Economic, financial, ecological, political, legal, marketing, competitors, administrative
	Mediated	Social, natural and climatic, personnel
Sustainability	Direct	Natural and climatic, ecological, political, legal, productive
	Mediated	Financial, scientific and technical, economic
Reliability	Direct	Scientific and technical, financial, productive, economic, political, legal, administrative, consumers, suppliers
	Mediated	Competitors, ecological, to the shot
Activity	Direct	Marketing, productive, administrative, political, legal, personnel
	Mediated	Financial, economic, scientific and technical
Sociality	Direct	Social, skilled, financial, economic, political, legal
	Mediated	Ecological, natural and climatic, scientific and technical, competitors

Source: the results of author's research

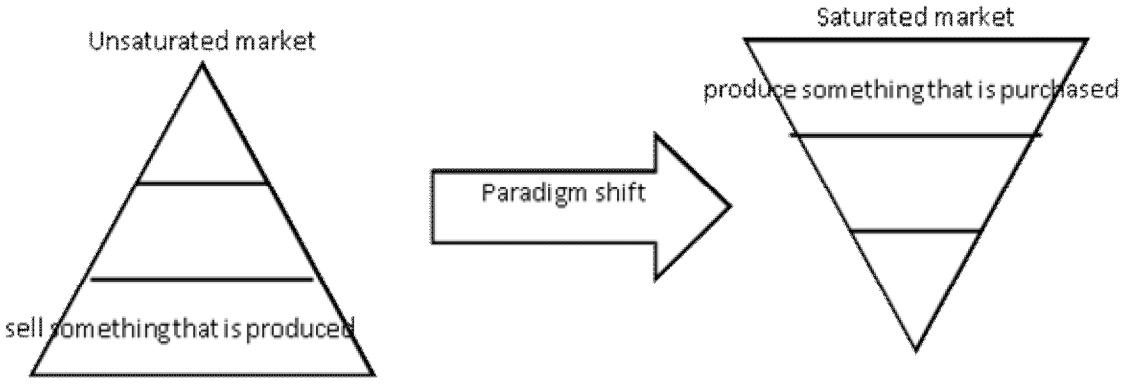

Fig. 2. A paradigm shift in the transition from unsaturated to saturated market

Market value that affects the level of innovation of the enterprise is ambiguous characteristic with certain factors both directly and indirectly. The factors include the direct effects of factors both external and internal environment, namely economic, financial, sustainable, political, legal, marketing, management factors, competitors, as for the indirect effects of factors, they are social, climatic, personnel.

Sustainability that affects the level of innovation of the enterprise is specific and determines the accordance of enterprise activity to the existent norms in relation to ecological safety, so-called "ecological friendliness" of enterprise resulting efficient use of natural resources and the amounts of emissions of pollutants and waste. Natural and climatic, ecological, political, legal, productive factors directly influence this characteristic innovation of enterprises, indirectly - financial, technological and economic factors.

Reliability and activity, these characteristics are influenced by society and are the result of imagination or vision of society that makes demands on product innovation and on the innovation of the company in general. Therefore, we took to the factors that have direct impact on reliability the scientific, technical, financial, industrial, economic, political, legal, administrative factors, customers and suppliers, to the indirect effects of factors - competition, sustainability and personnel. Such factors directly influence activity: marketing, manufacturing, administrative, political, legal, human factors; mediated are financial, economic, scientific and technical factors.

Sociality is ambiguous and the specific characteristic of this innovation of enterprise. Its duality is evident, as with the development of society demands on living conditions increase: the environment, infrastructure, requiring quality improvements that are the basis of innovation. Innovation and innovativeness of a particular company change the paradigm of society (the transition from unsaturated to saturated market) (Fig. 2).

Social, skilled, financial, economic, political, legal factors have a direct influence on the noted description, and mediated are ecological, natural and climatic, scientific and technical factors and competitors.

CONCLUSIONS

Thus, we introduced the system of external and internal environment factors affecting the innovation of the enterprise, and determined their impact on the main characteristics of innovation. Such grouping of factors will affect the management of enterprise to influence internal factors and factors of microenvironment, and also to take into account the factors of macroenvironment, thus reducing the uncertainty of the environment in order to maintain or improve the existing level of innovativeness of the company.

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