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MODELLING OF MANAGEMENT ACTIVITY OF THE ORGANIZATION CONSIDERING THE IMPACT OF IMPLICIT FACTORS IN BUSINESS PROCESSES

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Наведено результати теоретичних досліджень управлінської діяльності організації з урахуванням неявних факторів впливу. Запропонована економіко-математична модель оцінки впливу неявних факторів на основі побудови функцій приналежності. Для отримання відповідних залежностей використано методику експертної оцінки, яка базується на положеннях теорії нечітких множин. Застосування моделі дозволяє оптимізувати управлінські рішення у бізнес-процесах та забезпечує можливість побудови адаптивної системи управління сучасною організацією

Ключові слова: неявні фактори, теорія нечітких множин, бізнес-процеси, управлінська діяльність, інвестиційний потенціал

Представлены результаты теоретических исследований управленческой деятельности организации с учетом неявных факторов влияния. Предложена экономико-математическая модель оценки влияния неявных факторов на основе построения функций принадлежности. Для получения соответствующих зависимостей использована методика экспертной оценки, которая базируется на положения теории нечетких множеств. Использование модели позволяет оптимизировать управленческие решения в бизнес-процессах и обеспечивает возможность построения адаптивной системы управления современной организацией

Ключевые слова: неявные факторы, теория нечетких множеств, бизнес-процессы, управленческая деятельность, инвестиционный потенциал

1. Introduction

The growth of the intensity of technical and technological changes in the world economy occurs on the basis of intellectualization of socio-economic processes, the introduction of unconventional energy sources, the development of biotechnology and nanotechnology. It requires from business entities an orientation towards innovation, which is not possible to provide only at the expense of extensive use of material and financial resources.

Therefore, special importance for the participants in modern economic relations is given to the use of non-material resources in the business processes used in theoretical studies as implicit assets. In particular, they include human and information capital, intellectual management systems, corporate culture and more.

In practice of management of developed countries with leading economies, the understanding has already consolidated that the system of effective management of the organization and its individual business processes must be built

taking into account the formal impact of implicit factors. Their timely economic assessment becomes an important tool that ensures the formation of competitive advantages of the organization for its further successful operation and, accordingly, strengthening the positions on the domestic and foreign markets [1].

In the institutional aspect, further enhancement of the influence of implicit factors has not been fully explored and requires refinement research considering the transition to a new technological process that is developing in the framework of the information economy.

The traditional methods of managing the firm are based on the economic standard that is general for the modern economic conditions: the equilibrium of processes, the functional-structural approach in management, the use of corporate information systems with a traditional set of functions. However, this approach does not fully correspond to important economic processes, since it does not take into account the potential impact of implicit factors, in particular, the exponential growth of the weight of the information component, requirements for the intellectualization of business processes.

As a result, the development of tools for managing the organization's economic processes, based on the traditional analysis of explicit data technologies, is a necessary, but insufficient condition for improving control systems. This allows you to integrate the organization into the information economy, as it provides automation of sustainable management methods of the organization. For the purpose of effective further development, as recent studies of domestic and foreign scientists show, it is necessary to search and introduce new economic and mathematical models that change and improve traditional methods and technologies of organization management, and also form new formal institutes.

One of the topical problems facing society in this context is the complex problem of assessment of implicit factors and their impact on the performance of the organization or the performance of business processes. Most of the models existing at the present stage are qualitative, which when assessing such influence answer the questions uniquely, positively or negatively, and not sufficiently adapted for a more in-depth analysis.

This is particularly evident in the directions of economic activity associated with the influence of a significant number of factors. At the same time, a significant part of them will have an implicit character, which is due not only to the lack of a part of the important information for making a management decision, but also with its considerable volume, which is difficult to process. An example of such activity can be the operations of exporters in the Foreign Exchange Market, where a significant number of direct and indirect factors of influence on the system is in a covert, implicit form.

The absence of such models does not allow adapting the use of scientific achievements in the real sector of the economy and developing tools for assessing and managing the implicit factors. Therefore, the development of new mathematical models, instrumental and software tools, within the framework of intellectualization of economic processes, has a significant practical significance. In turn, it is capable of ensuring the sustainable development of economic entities, including the proper management of implicit factors in conditions of economic instability and uncertainty.

On the other hand, formalization and assessment of implicit factors of influence will allow organizations to assess their unused resource possibilities, that is, existing elements of economic development potential, first of all, investment potential in quantitative form.

Thus, the development of tools for the assessment and management of implicit factors based on predictive indicators of economic and mathematical modeling is a topical question nowadays. This is explained by complication of assessment of the influence of the set of implicit factors on the indicators of performance of business processes and the absence of systematized approaches to quantifying this impact for Ukrainian enterprises.

2. Literature review and problem statement

At the present stage of society development, the problem of the influence of implicit factors on the main economic indicators of management activity must be investigated on a fundamentally new level – in the context of the transition to an innovative economy [2].

In the capacity of subjects of the practical component of the study, one can name firms of any organizational and legal forms and their business processes, whose management system requires taking into account the growing influence of implicit factors of economic activity.

Global trends in the use of models for assessing the effectiveness of modern business usually ensure the alignment of the business strategy of a separate organization with key indicators of its effectiveness. It is based on the determined dependencies between them and the system of internal and external factors of influence [3]. "Road maps" of implementation of business models with the possibility of assessment of key indicators of the system of efficiency of the management process gained their further development [4].

These models are trying to provide a coherent picture of the management process. At the same time, the analysis of literature sources has shown that they practically don`t take into account a thorough assessment of implicit factors [3–6]. There is also no unified methodological approach to the practical study of the structure, properties and quantitative characteristics of the factors of implicit influence.

Evolution of theories of implicit components of the efficiency of economic activity has a gradual nature. It starts with the period of identification of scientific approaches to management work as a valuable tool for the formation of an additional product [7]. In turn, it ends with the period of formation of the notion of information economy, which is associated with a constant increase in the weight of implicit assets in the activities of business organizations [8].

This trend will lead to an increase in the number of resources involved in creating added value. Thus, the development of production, management and information technology will lead to the emergence of new factors that will have an economic essence different from the traditional triad of "land – labor – capital". An overwhelming majority of these factors will be implicit, or, in a broader sense, intangible.

During current development of economic theory, one starts to understand implicit factors as factors that have a significant influence (direct or indirect) on the organization's activities. They are based on hidden information, practically useful and available for generating knowledge in the transition from informal to formal institutes and making economically sound decisions [9]. At the same time, the objective consideration of implicit factors in economic activity

contributes to improving the effectiveness of the management system of the organization.

In terms of institutional theory, implicit factors are a component of the organization's management mechanism. In addition, they are one of the structural components of the management activity [10–14]. It follows that the decision-making process is based on a deep intellectual analysis of all possible data in order to obtain the complete information by the decision-maker [15].

In this context, one can mention the methodology for assessing the error of the determination of the volume of work performed to improve the quality of raw materials, the efficiency of managing the deposits of kaolin of the Veliko-Gadominetsky deposit, taking into account the varietal differentiation. This is an example of the successful application of grounded technological solutions in the manufacturing business [16]. The disadvantage of the proposed methodology is the narrow scope of application. This can be explained by the use of a limited number of factors of influence – indicators of the quality of deposits of kaolin.

Determination of the impact of factors on the effectiveness of business processes using the intelligent dependency analysis is a more versatile approach [17]. It allows determining the change of indicators of business performance because of the change of technical and economic indicators of a lower level of the hierarchy. Unfortunately, this methodology can't be fully used for the purpose of investigation of implicit factors of influence as it is based on continuous monitoring of events for their identification. The last one is a rather difficult issue in frames of the process of assessment of hidden factors.

In order to avoid the creation of a business process management support system, one can use the modular structure of monitoring of economic activity [18]. This approach allows obtaining positive results in the organization of small and medium-sized enterprises. However, the risk of distorting the objective assessment of the overall situation at the enterprise remains.

Thus, the nature of implicit factors is in the presence of hidden (implicit) information. This information occurs at the first stage of the implementation of the system "data – information – knowledge" in the organization's business processes that help to create the new knowledge. The presented theoretical aspects of implicit influences form a theoretical basis for the development of technologies for the assessment of implicit factors in the organization's activities. The goal of these technologies is to model the structure of organization`s management potential in difficult economic conditions. This causes the objective need to supplement the previous research [19].

Hence, the relevance of this study is determined by the lack of research devoted to issues of the development of the problem of creation of assessment models of the implicit factors and their impact on the management process and the potential of modern organization as a whole.

Considering mentioned ways of management and monitoring of business processes, it is reasonable to propose a new approach to improving the quantification of implicit factors of influence on the management activity of the organization and individual business processes. This approach must be based on a hierarchical model. The usage of this model will significantly simplify the process of formalization of management parameters at each level of the hierarchy, including indicators that were optimized at previous levels.

The results of optimization of the model allow obtaining quantitative characteristics of the influence of an array of implicit factors. This allows conducting a comparative analysis and a comprehensive assessment of the whole set of factors.

In addition, there is a possibility to use the results of an expert assessment of the influence of implicit factors in the form of mathematical and logical dependencies between them and key indicators of the efficiency of business processes in the model. This makes the proposed methodology rather versatile in conditions of economic instability and uncertainty.

Thus, the proposed approach allows assessing the potential of the organization based on the creation of the adequate model, which takes into account implicit impacts on the appropriateness of making reasonable management decisions and their results.

3. The aim and objectives of the study

The aim of the study is to find tools for taking into account factors of implicit influence on the efficiency of business processes and to develop a mathematical model of assessment of such influence in the process of management activity of manufacturing organizations.

To achieve the assigned goal, the following tasks were set:

– to determine the sequence of management actions in business processes with a large number of uncertain factors of influence, which were formalized as a set of implicit factors that influence the key indicators of business processes through indirect ones;

– to determine the system of mathematical dependencies between key and indirect indicators of business processes, as well as between indirect indicators and implicit factors of influence. The last ones are the basis of a structural model for assessment of the influence of implicit factors on the resulting indicators of management activity of the manufacturing organization.

4. Assessment of factors of implicit influence on making management decisions

In general, an econometric and mathematical description of a model that takes into account implicit impacts in the management of a particular business process will have the following form.

Let the state of any business process, as an active process, be described by a set of variables $y=\{y_1, y_2, ..., y_n\}\in Y$, which belongs to the admissible set Y – the set of factors of management of the business process, formed by the mechanisms of integrated assessment. The state of the system (business process) at a certain time depends on the managerial actions, $x\in X$: $y=F(x)$. Assume that the set $X\times Y$ specifies the functional $F(x, y)$, which defines the efficiency of the business process.

All the constituent factors of the specified functionality will be divided into three interrelated components: key business process factors, mediated business process factors, implicit factors in the business process. The assessment of these factors will take place in the form of an acyclic graph using integrated assessment methods and active expert assessments. The specified functional will be a graph with

nodes $Qi(t)$ (i=1, 2,..., n), where all nodes $Qi(t)$ represent a set of values.

Thus, the level l of the decomposition of the output functional will have the following mathematical form:

$$Q_l = \sum_{j=1}^{j=sl} Q_{lj}, \quad (1)$$

where Q_{lj} – constituents of the graph of the level Q_l low hierarchy; sl – the number of elements of the graph of the level Q_l of the lower hierarchy.

In turn, each element Q_{lj} consists of n_{lj} components.

At the next stage of constructing the model, we will form a matrix of the relation of factors in the form of binary correspondences. Then M_1 and M_2, respectively, are the binary relations of the set X, and λM_1 (x, z) and λM_2 (z, y) of their membership functions, which set the quantitative characteristics of the influence of implicit and mediated factors on the key.

To assess the efficiency of management of a particular business process, we use the procedure for assessing the factors before and after the control influence. This will allow determining the upper limit of the cost of management actions in accordance with the change in the influence of implicit factors on the basis of the correlation of the assessment of key factors before and after management actions. The mathematical form of the business process management function, which maximizes the value of its efficiency, provided that the reaction of the system $F(x)$ is known for action under the corresponding system of constraints:

$$P(x) \rightarrow \max F(x, F(x))$$

$$\left\{ \begin{array}{c} \lambda M_1 M_2(x) \le d, \\ \lambda M_1 M_2(\Phi(x)) \le b, \\ \lambda M_1 M_2(x) - \lambda M_1 M_2(F(x)) \le h, \end{array} \right\} \quad (2)$$

where $P(x)$ – assessment of the effectiveness of business process management; M_1, M_2 – binary relations of the set X; λM_1, λM_2 – functions of the membership of the binary relations of the set X; d – vector of restrictions imposed on the management process; b – vector of restrictions imposed on the reaction of the system; h – vector of constraints imposed on the choice of control influence.

In this form, we have a mechanism for managing the business process within the system of balanced indicators taking into account the influence of implicit factors in the form of a set of rules of decision-making and interaction procedures. An analysis of the results of the application of the proposed model in the search for an optimal structure of performance indicators for managing business processes of the organization showed that they organically combine the ideas of balance and systemicity. This allows including indicators of different types in one model: traditional, defined in a standard and implicit way, which are difficult to formalize.

On the other hand, implicit factors always introduce uncertainty into the management system of the organization, which can only be taken into account partly. This requires the development of more adaptive economic and mathematical methods that allow reflecting not only quantitative but also qualitative characteristics of the process or phenomenon. As a result, the application of the proposed model may identify new significant causal relationships that form the logic of achieving a strategic goal, taking into account the influence of implicit factors.

Thus, it is possible to formulate the composition and sequence of managerial actions in business processes with a large number of uncertain factors of influence, assessing them as implicit.

As a practical application of the proposed model, we proposed to consider the situation that has developed for domestic exporting companies. Significant devaluation of the national currency of Ukraine over the past two years has had a significant impact on the conditions of foreign economic activity of domestic firms. During this period, the instability of the financial market was non-systemic: the sharp drop in the hryvnia exchange rate varied over its long-term retention.

As a result, market operators, on the one hand, had plenty of time to integrate existing changes and apply measures to minimize their own losses, and on the other hand, they were subjected to panic at the rapid correction of the national currency. The latter testifies to the presence of problems in the anti-crisis management of foreign economic activity of domestic organizations. Also, this causes the urgency of implementation of tools for minimizing costs in conditions of instability and uncertainty of prospects for the development of the financial market.

For domestic exporting companies, the devaluation of the hryvnia in the short term had some positive aspects. Selling of products in foreign markets allowed receiving the so-called "export premium" in the exchange of foreign currency at cheaper national cost. At the same time, there is a significant excess of the level of convertible in hryvnia world prices in comparison with the cost of production of export-oriented products. This situation facilitates entry into the market with dumping prices in order to increase sales volumes and share in a certain segment of the market [1]. However, limited production capacity and shortage of working capital, together with separate export restrictions, do not allow domestic firms to pursue a policy of price expansion fully.

At the same time, the instability of international monetary and financial relations in the long run for exporting firms is associated with negative economic consequences. Significant fluctuations in the foreign exchange market, the complexity of determining the volume of expected revenues in the national currency, high level of speculation and accelerating domestic inflation are associated with a significant risk of financial losses for exporting firms. Hryvnia devaluation significantly impedes the acquisition of necessary imported fixed assets, materials, intangible assets, and increases the credit burden of business entities in foreign currency liabilities.

Under such conditions, it is expedient to use in a comprehensive way modern tools for minimizing the possible losses of exporting companies against fluctuations in the exchange rate of hryvnia. In particular, it is proposed to form a system of currency risk hedging using the opportunities of the Foreign Exchange Market (FOREX). We also propose to include the conclusion of forward contracts and currency options in this system, introduce netting payments, enter into contracts with the possibility of delaying or accelerating payments with counterparties, etc.

On the other hand, the functioning of business processes is associated with a significant number of implicit factors. That is, those ones that have a significant impact, but which

are based on hidden or unknown information. Indeed, such information may be known to the organization. However, its receipt, processing and analysis are of a certain cost and time-consuming. It is in this situation that the application of the model taking into account implicit factors will minimize potential losses in the course of changing the exchange rate of the national currency. This can be achieved by means of having the opportunity to ensure the stability of cash revenues from foreign economic activity by reducing currency risks in the long run. In such a situation, there is a significant but indirect influence of implicit factors on the organization's potential, especially financial and investment.

In order to solve such problems, in accordance with the above mentioned methodology, a structural model of the behavior of exporting firms in the form of a causal field is formed, which contains three groups of factors: the group A will characterize the set of key indicators of the organization, the group B is a set of mediated indicators, and the group C – implicit factors in the form of a system of indicators.

Indicators of the implicit factors (the group of factors C) influence the key indicators of the organization's activity (the group of factors A) indirectly, through the system of measurable indicators of the group of factors B, which, on the one hand, are related to the key, and on the other hand – implicit factors (Fig. 1).

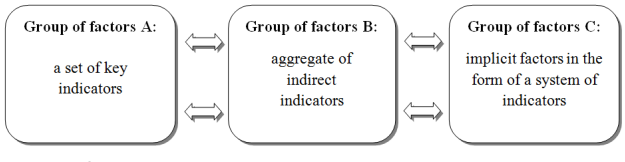

Fig. 1. Components of the hierarchical model of behavior of exporting firms on the market

Directly the economic and mathematical model of constructing the function of effective management decisions, taking into account implicit factors, can be represented as an acyclic graph which parameters are obtained by processing expert estimates. An intermediate result will be the aggregation of expert assessments l level to ratings l–1 level.

Each expert assessment is a definite integer in the range of 1 to p. The matrix of responses consists of m expert assessments of n experts.

$$A = \begin{pmatrix} a_{11} & a_{12} \dots & a_{1m} \\ a_{21} & a_{22} \dots & a_{2m} \\ \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nm} \end{pmatrix}, \quad (3)$$

where $1 \le a_{nm} \le p$.

Let us transform the matrix of expert assessments A into the matrix H – the consistency of these assessments:

$$H = \begin{pmatrix} h_{11} & h_{12} \dots & h_{1j} \\ h_{21} & h_{22} \dots & h_{2j} \\ \dots & \dots & \dots \\ h_{p1} & h_{p2} & \dots & h_{pj} \end{pmatrix}, \quad (4)$$

where h_{pj} is the number of experts who have assessed p when responding to the j-th question.

The membership functions of each of the sets m are determined by the formula:

$$\lambda Q_{lj} = \frac{h_{pj}}{\max\left(h_{pj}\right)}. \quad (5)$$

We record all membership functions in the form of a matrix M:

$$M = \begin{pmatrix} \lambda_{11}(R) & \lambda_{12}(R) \dots & \lambda_{1j}(R) \\ \lambda_{21}(R) & \lambda_{22}(R) \dots & \lambda_{2j}(R) \\ \dots & \dots & \dots & \dots \\ \lambda_{p1}(R) & \lambda_{p2}(R) & \dots & \lambda_{pj}(R) \end{pmatrix}, \quad (6)$$

where R – the same carrier R={1, 2, ..., p}.

As a result, each column of the matrix M is a fuzzy set, indicating the degree of expert consent. These sets are used as the basis for aggregation of thoughts in the form of a sequence of values of the membership function of the set. On the basis of the received membership function, with the help of the known algorithms, for example, Mamdani, one can obtain a value expressing the aggregate opinion of the experts. Thus, a single aggregated expert assessment of the level l-1is formed. If necessary, with increasing degrees of hierarchical structure, the calculation procedure is repeated. Such formalization will further help to assess the impact of one factor on the other, considering them as a binary pair, and apply sound management technologies based on methods of research of fuzzy sets.

Implementation of the proposed model by means of computer technologies will allow to quickly obtain a plurality of estimation of the influence of implicit factors. This, together with traditional technical analysis tools, will allow organizations to adopt effective solutions in the relevant business processes. In addition, this will give the possibility of constructing adaptive management system on the scientific basis.

5. Results of the research of influence of implicit factors on the investment potential of the exporting company

Consider the proposed methodology on the example of the mining industry in Ukraine. Limited Liability Company "Hlukhiv quartzite quarry" produces quartz sandstones of the Banichi deposit. Conditioning products are high-purity quartzite lenses of fraction 20–90 mm. With unique features, they are used for the production of silicon, which is used in electronics. The majority of "HQQ", LLC products are sold for export.

Devaluation of the hryvnia in 2014–2015 in relation to the world's reserve currencies provided the company with significant profit by converting currency earnings into the national currency. Additional revenues allowed accumulating funds in the short run, further aimed at expanding the technical base of "HQQ", LLC. At the same time, the growth of operating costs and the need to purchase imported equipment significantly increased the current and capital costs of the Hlukhiv quarry. As a result, the instability of the monetary, financial and political situation in 2016 predicted a negative economic impact while maintaining similar trends in 2017.

The process of managing the investment potential for the sustainable development of "HQQ", LLC was chosen as

a modeling object in order to reduce the dependence of its technical and economic and financial indicators on external and internal factors of influence. In accordance with the proposed methodology, a structural model was created in the form of a causal field. It can be built, as it was mentioned previously, based on three groups of factors. The first group is the set of key indicators of the enterprise (the group A). The second group is the set of indirect indicators of the enterprise (the group B). The last group is the set of implicit factors in the form of a system of indicators (the group C).

In the capacity of key performance indicators of formation of the investment potential of the sustainable development of "HQQ", LLC we singled out: operational costs, available stocks of conditioned products, the content of high-purity quartzite lenses of the corresponding fraction in the raw material, the energy intensity of extraction of 1 ton of minerals, labor productivity, litter or loss of minerals, as well as the price for finished products of enterprises.

The set of indirect indicators includes the texture and structural characteristic of the quarry horizons, the geological conditions of extraction, the coefficient of equipment operation, the price of the imported component of materials, components and equipment, the use of innovative mining technologies. Implicit factors of the model were identified as state policy in the field of regulation of subsoil use, state tax policy, fluctuations in demand and supply of high-purity quartz sandstones in world markets, fluctuations of foreign exchange rates, economic situation in the country and the world, competition.

The set of available factors of the proposed technical and economic model was formalized by an expert method. Twelve executives and leading specialists of "HQQ", LLC were involved in the expert work. They were asked to assess the influence of implicit factors on the final indicator directly and, in the second stage of the study, on the basis of the methodology proposed by the authors of the assessment.

The group of experts of twelve executives and leading specialists of the enterprise assessed the influence of the group of factors of indirect influence (the group C) directly on the investigated indicator. That is, the investment potential of the sustainable development of "HQQ", LLC according to the 10-point scale. The expert assessments provided were formalized in the form of averaged value for each factor (Table 1).

Table 1

Averaged direct expert assessment of the influence of implicit factors on the investment potential of the sustainable development of "HQQ", LLC

Symbols	Implicit model factors	An average expert assessment
Factor I	State policy in the field of regulation of subsoil use	0.15
Factor II	Tax policy of the state	0.05
Factor III	Fluctuations in demand and supply of high-purity quartz sandstones in world markets	0.25
Factor IV	Fluctuation of foreign exchange rates (hryvnia – US dollar "currency pair")	0.35
Factor V	Economic situation in the country	0.1
Factor VI	Economic situation in the world	0.05
Factor VII	Competition in the market of high-purity quartz sandstones	0.15

To simplify the analysis and obtain comparability with the results of further research, the quantitative characteristics of expert assessments are given in relative units (Fig. 2).

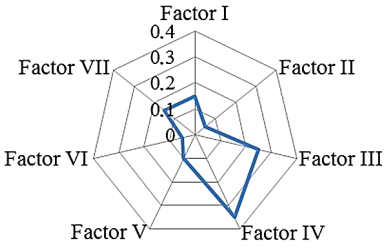

Fig. 2. Expert assessment of the influence of implicit factors on the investment potential of the sustainable development of the organization

From the data provided, we can conclude that the experts generally do not consider the implicit factors of influence to be decisive for the formation of the investment potential of the sustainable development of "HQQ", LLC. The maximum averaged assessment does not exceed the value of 0.35 (Factor IV) across the aggregate of factors in the group C. The quantitative characteristic of Factor II, Factor V and Factor VI, that is, the tax policy of the state and the economic situation in the country and the world, is determined by the experts as an extremely insignificant influence on the investment potential of the sustainable development for the given company. At the next stage of the study, the expert group of twelve executives and leading experts of "HQQ", LLC, which was mentioned above, has assessed a set of available factors using the proposed model. The experts were asked about 10 questions that characterize each of the following implicit factors of influence (the group C) in the form of a causal field of interconnections with a number of key performance indicators of the enterprise (the group A) and a set of indirect indicators (the group B). The qualitative characteristics of the rating were fixed by an integer on the 10-point scale (Fig. 3).

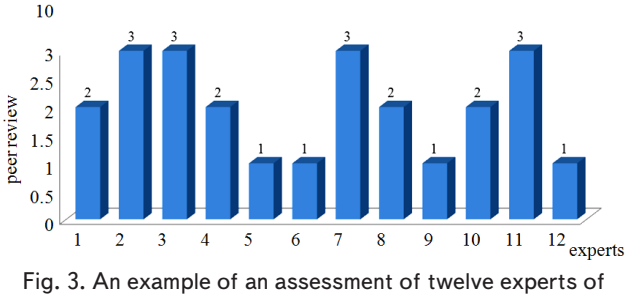

Fig. 3. An example of an assessment of twelve experts of one of the issues on the 10-point scale ("the possibility of changing the regulatory indicators of the geological and economic assessment of the GCR in the short term"), which characterizes the implicit model factor (Factor I – "state policy in the field of regulation of subsoil use")

At the next stage of the study, the problem of assessing the degree of consistency of expert opinions is solved quantitatively.

The results of the questionnaire are processed, considering the obtained data array as the fuzzy set A with the membership function λ_A. The analysis of the fuzzy set A was carried out by calculating the indexes of fuzzy sets of expert

assessments that characterize the unity and distribution of assessments concerning each question [20].

We presented the set A in the form of the matrix X, which contains an array of marks according to the 10-point scale on 10 questions (columns) by experts (lines). For this array, we determined the frequency of assessments that differs for each question.

Calculation of the percentage of deviations in order to determine the degree of affiliation of each assessment to the set of assessments for each issue is the next step. The obtained results are normalized by means of division of the value of each element of the matrix of the fuzzy set by the maximum value of each column according to the formula (5). At the same time, the maximum value of the degree of affiliation of each assessment to the fuzzy set of assessments of the answers of experts will be equal to unity. And we will get the value of the function of the assessments' membership (Table 2).

Table 2

Normalized fuzzy set of expert assessments

k/j	1	2	3	4	5	6	7	8	9	10
1	0.25	0	0	0	0.25	0.25	0	0	0.25	0.25
2	0	0	0	0	0.25	0	0	0.5	0.5	0.25
3	0	0	0	0.25	0	0	0	0	0	0
4	0	0.25	0.5	0	0.25	0	0.5	0	0	0
5	1	0.25	0.25	0.5	0.25	0.5	0.75	0.25	0.25	0.5
6	0.5	0.25	0.25	0	0.5	0.25	0.5	0.5	0.25	0.25
7	0.75	0.75	1	0.75	0.25	0.5	0.75	1	0.75	0.75
8	0.5	0.5	0.75	0.75	0.5	0.25	0.25	0	0.25	0
9	0	0.25	0	0	0.5	0.5	0	0.25	0.25	0.25
10	0	0.25	0	0	0.25	0	0	0	0	0.25

That is, we obtained the fuzzy set of expert assessments for each issue $M=\lambda_A$, which characterizes the membership function. We constructed a clear set $\lambda_{Ao}=M_0$, which is as close as possible to the considered fuzzy set. In order to do this, we use the conditional function:

$$M_{0k,j}=\text{if}(M_{k,j}>0.5; 1; 0). \quad (7)$$

Determination of indices of fuzziness by means of the usage of linear metric (Hamming distance) is the next step. At the same time, the indices of fuzziness allow quantifying two interrelated indicators: the degree of coherence of expert responses and the degree of discrepancy of expert opinions concerning each issue. For the example considered, the divergence of assessments is close for all issues of questionnaires and is quantified as acceptable.

At the second stage of the research, we obtain an aggregated assessment. It shows the rating of the certain object in the system, based on the rules of fuzzy inference. It uses one of the commonly used algorithms – the Mamdani algorithm [21]. On the basis of the obtained membership functions, according to the formula of the center of mass method, one can obtain a value expressing the aggregate opinion of the experts. It takes the form of the aggregated assessment for each of the influencing factors of the C group (implicit). Also, it takes into account the interactions with the factors of the group A (direct effect) and the group B (mediated influence), directly to the final indicator of the model (Table 3).

Table 3

Aggregated expert assessment for Factor I ("state policy in the sphere of regulation of subsoil use")

Experts	1	2	3	4	5	6	7	8	9	10	11	12
Mark	0.241	0.311	0.152	0.201	0.264	0.201	0.090	0.286	0.162	0.241	0.152	0.242

Thus, an aggregate expert level assessment is formed l–1 for each implicit factor used in the model (Table 4). If necessary, with increasing degrees of hierarchical structure, the calculation procedure is repeated. In comparison with the direct assessment of the influence of implicit factors on the formation of the investment potential of the organization's sustainable development, the maximum value of the assessment decreased – from 0.350 for Factor IV (fluctuation of foreign exchange rates) to 0.295 for the same factor.

Table 4

Joint aggregated expert assessments of implicit factors of the hierarchical model of the investment potential of the sustainable development of "HQQ", LLC

Symbols	Implicit model factors	A combined aggregated expert assessment
Factor I	State policy in the field of regulation of subsoil use	0.215
Factor II	Tax policy of the state	0.185
Factor III	Fluctuations in demand and supply of high-purity quartz sandstones in world markets	0.150
Factor IV	Fluctuation of foreign exchange rates (hryvnia – US dollar "currency pair")	0.295
Factor V	Economic situation in the country	0.095
Factor VI	Economic situation in the world	0.080
Factor VII	Competition in the market of high-purity quartz sandstones	0.075

On the other hand, the quantitative characteristics of the influence of practically all indirect factors have changed significantly (Fig. 4).

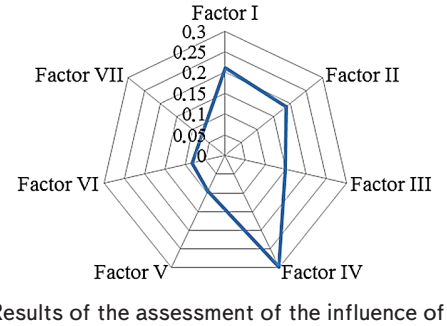

Fig. 4. Results of the assessment of the influence of indirect factors on the investment potential of the sustainable development of the organization after the application of the proposed model

Thus, the adjusted assessment of the influence of indirect factors on the investment potential of the sustainable devel-

opment of "HQQ", LLC was gained. The implementation of the model has confirmed the existence of connection concerning the dependency between key, indirect and implicit factors. At the same time, the quantitative characteristics of factors of implicit influence, in some cases, differ significantly from the previous expert assessment. It must be taken into account in further scientific research on this problem.

6. Discussion of the results of the quantitative assessment of implicit influences on the parameters of the hierarchical model

Among the factors that were identified as factors of minimal impact, only the assessment of the impact of the economic situation in the country (Factor V) was reliable, as the world economic situation (Factor VI) and, in particular, the state tax policy (Factor II), in practice, have a significantly greater influence on the formation of the investment potential of the sustainable development of "HQQ", LLC.

This is primarily due to the orientation of the company towards the export of products and the corresponding policy of Ukraine in the customs regulation of export and import operations. The significance of the state policy in the field of regulating the use of subsoil (Factor I) for the investment potential of a sustainable functioning of the organization was also found to be significantly higher. On the other hand, the preliminary assessment was significantly overestimated by the volatility of demand and supply of high-purity quartz sandstones in the world market (Factor II) and competition in this market (Factor VII). Further analysis showed that this is due to the shortage of high-purity quartzite lenses in the world market against the background of high rates of expansion of their application. The result of the calculations was the determination of the significant impact of implicit factors on the resulting indicator, as well as the close link between explicit, implicit and mediated factors of the system's impact. By the method of ranking of quantitative indicators, it is possible to divide the implicit factors into three groups, respectively, significant, substantial and non-significant effects, while excluding the last group to facilitate further analysis. Thus, it is possible to detect the presence of implicit impacts on the parameters of the model being investigated in the system of assessment.

Qualified experts can clearly determine the degree of direct influence of a plurality of factors, but identifying an implicit influence through the mediated factors is a rather complicated task. During analyzing the investment potential of the sustainable development of the organization, there is a situation in which two factors of the set practically do not affect the resulting indicator. However, there are elements of this set, due to the implicit influence of which their relationship becomes significant. Such an indirect effect, although implicit, should be taken into account in the final model of the formation of the investment potential of the sustainable development of the organization. Proposed general approaches to taking into account implicit influences on management activity of the organization and the developed economic and mathematical model are universal. They can function as an additional toolkit for substantiation of management decisions, especially in conditions of economic instability and uncertainty. At the same time, it is important to notice that the usage of the proposed model needs considerable preliminary preparation at the stage of formation and work of expert groups.

The developed toolkit of the assessment of implicit influences on key indicators of business processes must be used in the economic practice of Ukrainian enterprises. It allows assessing the set of available factors for individual business processes and determining their quantitative characteristics in an objective and systematic way.

The conducted research is the continuation and deepening of the scientific achievements of the team of the authors in the field of studying theoretical and practical aspects of assessing the economic potential of manufacturing organizations and optimizing their management processes in economic activity.

7. Conclusions

1. The approaches to formalization of the influence of the set of implicit factors were formed. This was done by means of the development of the hierarchical system of interconnections between main indicators of business processes and implicit factors of influence. These approaches were used as the basis for the development of the economic and mathematical hierarchical model of the assessment of the influence of implicit factors on the management process of organization's business processes.

2. By means of the expert data, the system of mathematic dependencies between key and indirect indicators of the model and also between indirect indicators and implicit factors of influence was determined. It allows using the proposed method for the predictive assessment of the investment potential of sustainable development of "HQQ", LLC (the mining exporting company). The comparison of quantitative assessment of the influence of implicit factors on the investment potential before and after the usage of the proposed model has shown more accurate results. It directly influenced the determination of their position in ranking according to the weight of influence. The information was taken into consideration during the process of preparation of a long-term plan of the development of "HQQ", LLC for 2017. This plan forecasted 11.7 % income increase from the level of 2016 at the expense of measures of hedging of currency risks and optimization of the tax policy of the company. In particular, the geological and economic assessment of the Banychskyi deposit of high-purity quartzites was ordered. Its approval allows optimizing the fee for the use of the subsoil during periods of decline in the price of quartzite lenses. In the future, the results will contribute to the development of a complex adaptive management system of this company. This will help to maintain its production capacity at the level of 80–100 thousand tons per year for quartzite lump fraction 20–900 mm.

References

1. Business process measurement model based on the fuzzy multi agent systems / Pakseresht M., Seyyedi M. A., Zade M. M., Gardesh H. // AIKED Proceedings of WSEAS. 2009. P. 501–506.

2. How business process reengineering affects information technology investment and employee performance under different performance measurement / Huang S. Y., Lee C.-H., Chiu A.-A., Yen D. C. // Information Systems Frontiers. 2014. Vol. 17, Issue 15. P. 1133–1144. doi: 10.1007/s10796-014-9487-4
3. Van Looy A., Shafagatova A. Business process performance measurement: a structured literature review of indicators, measures and metrics // SpringerPlus. 2016. Vol. 5, Issue 1. doi: 10.1186/s40064-016-3498-1
4. Batocchio A., Ghezzi A., Rangone A. A method for evaluating business models implementation process // Business Process Management Journal. 2016. Vol. 22, Issue 4. P. 712–735. doi: 10.1108/bpmj-08-2015-0117
5. Pádua S. I. D., Jabbour C. J. C. Promotion and evolution of sustainability performance measurement systems from a perspective of business process management // Business Process Management Journal. 2015. Vol. 21, Issue 2. P. 403–418. doi: 10.1108/bpmj-10-2013-0139
6. Camara M. S., Ducq Y., Dupas R. A methodology for the evaluation of interoperability improvements in inter-enterprises collaboration based on causal performance measurement models // International Journal of Computer Integrated Manufacturing. 2013. Vol. 27, Issue 2. P. 103–109. doi: 10.1080/0951192x.2013.800235
7. Shumpeter Y. Teoriya ekonomicheskogo razvitiya. Kapitalizm, sotsializm i demokratiya. Moscow: Eksmo, 2007. 864 p.
8. Mainzer K. Interdisciplinarity and innovation dynamics. On convergence of research, technology, economy, and society // Poiesis & Praxis. 2011. Vol. 7, Issue 4. P. 275–289. doi: 10.1007/s10202-011-0088-8
9. Kouz R. Firma, rynok i pravo. Moscow: Novoe izd-vo, 2007. 224 p.
10. Defining process performance indicators by using templates and patterns / del-Río-Ortega A., Resinas Arias de Reyna M., Durán Toro A., Ruiz-Cortés A. // Business process management. 2012. Vol. 7481. P. 223–228. doi: 10.1007/978-3-642-32885-5_18
11. Kravchenko V. M. Hibrydnyi metod pidtrymky ta pryiniattia upravlinskykh rishen na osnovi obrobky ekspertnykh sudzhen i nechitkoi lohiky // Formuvannia rynkovoi ekonomiky v Ukraini. 2012. Issue 27. P. 165–168.
12. Vasylkovskyi D. M. Metodolohiya modeliuvannia protsesu ukhvalennia upravlinskykh rishen pry rozrobtsi i realizatsiyi stratehichnykh napriamiv pidvyshchennia ekonomichnoho potentsialu pidpryiemstva // Ekonomichnyi analiz. 2013. Issue 12. P. 71–75.
13. Vasylkovskyi D. M. Rozrobka stratehiyi rozvytku ekonomichnoho potentsialu pidpryiemstva na osnovi metodu nechitkoho modeliuvannia // Visnyk Khmelnytskoho natsionalnoho universytetu. Ekonomichni nauky. 2015. Vol. 2, Issue 4. P. 36–42.
14. Tsiutsiura S. V., Kryvoruchko O. V., Tsiutsiura M. I. Teoretychni osnovy ta sutnist upravlinskykh rishen. Modeli pryiniattia upravlinskykh rishen // Upravlinnia rozvytkom skladnykh system. 2012. Issue 9. P. 50–58.
15. Lipych L. H. Biznes-protsesy ta yikh informatsiyne zabezpechennia // Aktualni problemy ekonomiky. 2010. Issue 10. P. 202–206.
16. A procedure for modeling the deposits of kaolin raw materials based on the comprehensive analysis of quality indicators / Sobolevskyi R., Vaschuk A., Tolkach O., Korobiichuk V., Levytskyi V. // Eastern-European Journal of Enterprise Technologies. 2017. Vol. 3, Issue 3 (87). P. 54–66. doi: 10.15587/1729-4061.2017.103289
17. Identifying influential factors of business process performance using dependency analysis / Wetzstein B., Leitner P., Rosenberg F., Dustdar S., Leymann F. // Enterprise Information Systems. 2011. Vol. 5, Issue 1. P. 79–98. doi: 10.1080/17517575.2010.493956
18. Koetter F., Kochanowski M. A model-driven approach for event-based business process monitoring // Information Systems and e-Business Management. 2017. Vol. 13, Issue 1. P. 5–36. doi: 10.1007/s10257-014-0233-8
19. Novakivskyi I. I., Prokopyshyn-Rashkevych L. M. Ekonomiko-matematychni modeli optymalnoho rozvytku struktury upravlinskoho potentsialu pidpryiemstva // Investytsiyi: praktyka ta dosvid. 2011. Issue 6. P. 33–37.
20. Zadeh L. A. Generalized theory of uncertainty (GTU) – principal concepts and ideas // Computational Statistics & Data Analysis. 2006. Vol. 51, Issue 1. P. 15–46. doi: 10.1016/j.csda.2006.04.029
21. Jantzen J. Foundations of Fuzzy Control: monograph. John Wiley & Sons, Ltd, 2007. 209 p. doi: 10.1002/9780470061176