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**Introduction.** The formation and development of the oil and gas industry in any region (country) of the world is primarily related to the volume of forecast hydrocarbon resources, the state of explored hydrocarbon reserves and is determined by a number of technological, economic, organizational, political and other factors. Ukraine is no exception - one of the oldest oil and gas producing countries in the world [1].

Before starting the analysis, we need to define some terms that we will use in this subsection:

- proven hydrocarbon reserves are known volumes of hydrocarbons that can be profitably extracted using existing technology;
- unexplored traditional resources - oil and gas resources that are explored by oil and gas companies with developed technologies and that can be profitably extracted/developed using the existing traditional practice of hydrocarbon development [2];
- unconventional resources - oil and gas resources that exist outside well-defined traps;



- resources obtained due to the growth of deposits - resources that are expected to be added to the explored reserves of the deposit due to: physical expansion of the boundaries of the deposit, development of new horizons, more careful calculation and evaluation of deposit reserves based on mining experience and changes in the relationship between price and costs; application of new technologies and methods of search, development, extraction of hydrocarbons and processing of relevant information [3]. To a large extent, the listed factors depend on innovations, which are difficult to predict. In addition, these factors are complex and interrelated, and therefore difficult to analyze individually. Thus, the assessment of the possible future increase in reserves should be based on the empirical projection of past patterns [4].

Economic analysis estimates the costs of transforming resources into proven reserves that are technologically possible and economically profitable to extract, that is, reflects the price for the search, development and extraction of a certain amount of estimated resources according to current technology and the existing scientific level of understanding. The main final goal of the economic analysis of geological resources is a better understanding of the economic situation by the top management of the industry and the government [5].

Although the available historical data is insufficient to correlate the cost of innovation-driven reserve growth, it is clear that, on average, these costs are lower than the costs of exploration, development and development of new fields, but higher than the costs of production from discovered and proven reserves.

It should be noted that economic analysis estimates in this area are based on geological data, probability analysis and are ranked according to different degrees of confidence. The most important results of such assessments are not in absolute numbers, but in what to do with exploration and production trends and the possible location of unexplored resources. In other words, economic models in oil and gas exploration are used to determine the main trends, not accurate predictions [6].





Perhaps the most important conclusion of the economic analysis is that, taking into account the tendency of deposits to maintain production in countries with well-explored subsoil (Ukraine, USA, etc.), it is necessary to use all possible innovations in the field of exploration and production management, significant improvement of production and exploration technology [7].

When reviewing the results of an economic analysis, or using them for further analytical or planning purposes, the time context must be taken into account, since this analysis does not depend on the function of time. It predicts the costs of converting (with the current level of technology) unexplored resources into proven reserves and production. Of course, drilling wells to prove reserves takes time, but in the meantime, both technology and scientific understanding continue to evolve. For example, during the last 2 decades, many geological, technological and informational breakthroughs have been made in the direction of significantly increasing the efficiency of exploration and development of oil and gas [8].

This probability of improvement shows that the unexplored reserves estimates made are minimal. After all, if significant scientific or technological improvements occur during the exploration of these reserves, a new more effective management technology is introduced, the amount of economically recoverable resources will increase at the same level of energy prices, or the estimated reserves can be mined at lower costs.

The specifics of the oil and gas production industry and modern economic and geological conditions testify to the predominance of the intensive way of increasing the amount of hydrocarbons extracted in Ukraine over the extensive way.

Experience shows that initial estimates of the size of newly discovered oil and gas fields are usually underestimated and increase over the years. The term "reserve growth" refers to the typical increase in the estimate of the maximum possible number of reserves



that can be extracted from these deposits thanks to innovations, in which innovations in the field of IT play a significant role today. In recent years, this increase in reserves in the world, and in particular in Ukraine, is greater than the increase in reserves from newly explored deposits.

The establishment of economic constraints on estimates of technically recoverable oil and gas reserves significantly alters reserve estimates. According to the results, the following corrections in reserve estimates due to the introduction of economic restrictions can be distinguished: a significant decrease in the share and number of unconventional reserves, a decrease in the number of unexplored reserves, and the related increase in the share of explored reserves, growth in the share and number of reserves due to the increase in reserves of existing deposits. these trends indicate the importance of increasing reserves in explored fields as an important factor in the economic stability of the oil and gas industry and the entire economy. It can be concluded that along with the traditional increase in reserves due to the exploration of new deposits (which requires significant and long-term investments), considerable attention should be paid to the increase in reserves of existing deposits due to the introduction of innovations, including and in the field of IT (but this possible increase in hydrocarbon reserves has considerable uncertainty) [9].

Statistics of the development of the industry and analysis of oil and gas companies showed that the introduction of innovations contributes to the growth of production volumes (increase in gas and condensate reserves, the volumes of their extraction, transportation and processing) and the reduction of capital and operating costs per unit of production, which determines the increase in profit and growth in productivity labor Indirectly, this economic analysis shows the importance of all possible factors for reducing the costs of an oil and gas company (in particular, the factor of a more efficient DS) in combination with the introduction of innovations (which, in particular, will reduce the vulnerability of the economic position of the oil and gas industry to fluctuations in oil and gas prices) [10].



Therefore, the growth of reserves of explored deposits due to the introduction of IT achievements into the oil and gas industry is one of the components of the growth of oil and gas resources in Ukraine. And the accumulated historical data and the data of the above economic analysis confirm this thesis.

**Novelty, methodological or general scientific significance, presentation of the basic material.**

Modeling, information systems and technologies are used at all stages of managing the activities of an oil and gas company. The use of modeling, mathematical methods, information systems and technologies in the oil and gas industry is growing, which is explained by the growth in the volume of economic, production and geological information, especially with the increasing complexity and riskiness of management decisions, the increasing complexity of geological conditions. The efficiency of an oil and gas production company's work, in particular the reduction of costs and production cycle time for the search and development of oil and gas deposits, is largely determined by the use of modeling, mathematical methods, information systems and technologies. The following example can be given: in practice, it is possible to explore the place of accumulation of hydrocarbons only once, and if a wrong decision is made, the effectiveness of the geological exploration process will be sharply reduced. However, economic-mathematical modeling allows choosing the optimal option for exploration and development [11]. It should be taken into account that mathematical methods and modeling do not replace the work of an oil and gas company manager, but supplement it.

Thus, the question arises of determining the impact of information support on oil and gas production.

An information product, like any good, has its own consumer value, is a public property and can be suitable for the production of products and services in the process of oil and gas exploration and production.

It is appropriate to reveal the nature of the consumer value of information products, not based on the labor theory of value. The knowledge revealed in the products that the user will receive gives him the opportunity to make decisions at different stages of the work cycle and alternative behaviors and evaluate their consequences [12].

Despite the great interest in the problem in the field of information support in the oil and gas industry, it is possible to recognize the insufficient level of conducting research. Solving questions of a theoretical nature was, and still is, significantly hindered by the undeveloped, vagueness of the terminological apparatus of the entire field of knowledge, lack of understanding of many initial concepts.

If we consider the information potential of oil and gas production enterprises as the achieved level of satisfaction of information needs, which ensures the necessary level of oil and gas production, then the information resource is a part of the information potential used to achieve the set goal of hydrocarbon production and includes all sources of information needs and services needed in the oil and gas industry. At the heart of the creation of information products are processes that provide the user with knowledge, on the basis of which he can get the information he needs, which can reduce labor costs in the following work cycles when searching, exploring or extracting oil and gas.

The influence of information products and services on the intensification of oil and gas production should be studied using the Cobb-Douglas functions, according to which the production function  $Y_t$  in year  $t$  can be constructed, if the amount of oil and gas production in monetary terms is considered as a function of such arguments: objects, means of work and human resources. Then it will look like this:





$$Y_t = K1_t^{B1} K2_t^{B2} L_t^A T_t, \quad (1)$$

where

$K1_t$  — expenses of the main productive funds;

$K2_t$  — costs of working capital;

$L_t A$  — labor costs;

$B1, B2, A$  are the values of coefficients that show how much  $Y_t$  increases by 1% with an increase in the corresponding resource;

$$T_t = D \cdot \exp|z(t - t_0)|, \quad (2)$$

In many economic and mathematical works it is interpreted as the influence of scientific and technical progress on the volume of production. However, taking into account the subject of the study, it is advisable to present:

$$T_t = P_t I_t, \quad (3)$$

where

$P_t$  — the impact of technical progress on the production function  $Y_t$ ;

It is the influence of information provision, that is, the use of information products and services.

The amount of information in year  $(t+1)$  can be determined by the formula:

$$I_{t+1} = k I_t, \quad (4)$$

where

$k$  is the rate of increase in the amount of information in year  $t$ , which can be interpreted as a proportionality coefficient, since the increase in information is proportional; then compared to the base year:





$$I_t = I_0 k^{t-t_0} \quad (5)$$

Let's assume that  $k'$  is the ratio of the amount of necessary information support for the search, exploration and production of hydrocarbons in year  $t$  ( $I'_t$ ) to its total amount accumulated in the oil and gas industry ( $I_t$ ) in the form of:

$$k' = I'_t / I_t, \quad (6)$$

then it can be shown that:

$$I_t = k' I_{t_0} \times \exp|\ln(k)(t - t_0)|, \quad (7)$$

where

$I_{t_0}$  — the total volume of information products and services in the base year  $t_0$ .

It can be seen from formula (7) that the amount of necessary information support for production is determined by the rate of growth of information needs and services in year  $t$  compared to the base year  $t_0$ , and from ratios (1) and (7) it follows that if all production factors at the previous level, there is an increase in the production of hydrocarbons due to the use of information resources. The dependence of the intensification of oil and gas production on information support rapidly increases the role and importance of information modeling in the oil and gas industry.

The development of the structure of the oil and gas industry today has reached such a state that it is necessary to include information in the items of work, and personal computers and, on their basis, appropriate modern information technologies (automated workplaces, databases and data banks, expert systems) in the means of production etc). Information is purposefully obtained with the help of the most modern technical means. The volume of information



processing in the oil and gas industry, necessary for its normal functioning and development, depends on the complexity of the production structure.

The fact that about 6 billion US dollars is spent annually on information technologies in the global oil and gas exploration and production industry confirms the above provisions. Half of this amount is spent on searching, transferring and rewriting data and knowledge. All the more, the question of their effective use, including and by implementing a holistic policy of managing information resources of an oil and gas company.

If the productivity of processing and use of information resources of an oil and gas company does not increase at a faster rate than the growth of the volume of economic, geological information of an oil and gas production company, then the main reason for restraining the development of the company's production structure will be the inability of the management apparatus to fully use the available data and knowledge, which are necessary for ensuring the normal functioning and rational use of resources of the oil and gas company [13].

Therefore, taking into account the above, it is necessary to note the lack of a strategy and a comprehensive approach to intelligent automation, insufficient attention to the use of intelligent technologies, the introduction of modern intelligent analytical technologies, methods and algorithms.

### **Main results and conclusions.**

The main scientific and practical results of this work allow us to draw the following conclusions.

1. Today, the oil and gas industry of Ukraine is in a complex state of crisis caused by a number of military, political and economic factors [14, 15]. All these factors in one way or another are reinforced by the lack or lack of information on the main production and economic processes and its low efficiency, the lack of perfect tools



for comprehensive analysis and forecasting, the insufficient functionality of existing information systems [16]. However, it is necessary to note the lack of a strategy and a comprehensive approach to automation, insufficient attention to the use of network technologies, the introduction of innovative information technologies and algorithms [17].

Therefore, an important reason for a possible drop in the volume of oil and gas production on emerging markets in post-crisis conditions is the insufficient efficiency of managing the cycle of parallel business processes of an oil and gas company: exploration, development and development of deposits, production and sale of oil and gas. Therefore, one of the necessary factors for increasing hydrocarbon production in such conditions is the improvement of the integrated efficiency of the oil and gas company's business process management through the use of effective economic and mathematical modeling at the strategic level of management and the use of knowledge-oriented decision support tools as an integral component of the innovative oil and gas IS companies

2. Economic analysis in the oil and gas industry estimates the costs of transforming resources that can be technologically extracted and economically profitable (at a certain price level) into proven hydrocarbon resources, i.e. reflects the price for the search, development and extraction of a certain amount of estimated resources according to current technology and existing scientific knowledge level of understanding. The main ultimate goal of the economic analysis of geological resources is a better understanding of the economic situation by the top management of the industry and the government. Economic models in oil and gas exploration are used to identify major trends, not precise predictions.

The most important conclusion of the economic analysis is that, taking into account the trend of the growth of deposits, in order to maintain production in countries with well-explored subsoils (Ukraine, the USA, etc.), a significant improvement in the



technology of exploration and production of hydrocarbons and the use of all possible innovations in the field of exploration and production management are necessary. Therefore, the growth of reserves of explored deposits due to the introduction of achievements in the field of information systems and information technologies into the oil and gas industry is one of the basic components of the growth of oil and gas reserves in Ukraine. But this increase in reserves has significant uncertainty.

3. The amount of necessary information support for production is determined by the rate of growth of information needs and services, and if all factors of production remain at the previous level, there is an increase in hydrocarbon production due to the use of information resources. The dependence of the intensification of oil and gas production on information support rapidly increases the role and importance of information modeling in the oil and gas industry [18, 19].

4. Since the information system is an important component of the management system of an oil and gas company, it is important to investigate its specifics and take this into account in further research. Therefore, the management organization of an oil and gas production company is significantly influenced by:

- the specifics of the main production processes: significant territorial dispersion and consolidation of objects; low informativeness of the main production processes; a continuous technological process and an inseparable system of technological objects; great inertia of the processes occurring in the deposit; the uniqueness of the structure and parameters of each deposit and the impossibility of repeating development under identical conditions; change over time in the state and performance of control objects;
- traditional economic specifics of the oil and gas industry: huge investments; slow turnover of resources; great economic risk;
- the transition of the domestic oil and gas complex from a centralized economy to a competitive market caused a number of





additional restrictions in the management of the domestic oil and gas company: the need to take into account the interests of various subjects of the market economy when making strategic decisions; oil and gas companies are ready to invest significant funds at the initial stages in search and reconnaissance work in order to obtain the most reliable and complete information; change in decision-making methodology: from sequential to integrated, synergistic with wide use of advanced technologies and the need to take into account interdisciplinary uncertainty when making group strategic decisions of an oil and gas company;

- the main trends in the management of the global oil and gas industry: consolidation of companies; deepening the specialization of the main and service industries; the growing importance of innovation.

It is possible to distinguish 3 levels of management of an oil and gas production company: technological (operational and accounting); tactical (reporting and planning); strategic. At the tactical and strategic levels of management, the greatest effect can be obtained today from the introduction of information systems and technologies, therefore basic attention should be paid to the use of new methods in management, new economic and mathematical models.

5. The absence of a balanced automation strategy of an oil and gas company has the greatest negative impact on the strategic level of the company's management, where the cost of a manager's mistake is the greatest. Therefore, for the first time in the work, the principles, characteristics, architecture, specific industry problems and the strategy of creating an information system of the Ukrainian oil and gas company are comprehensively defined. In particular, the developed concept of the information system architecture of an oil and gas company provides for the allocation of 3 macro-levels (process management subsystem; tactical management subsystem; analytical subsystem of top management) and 4 macro-functional





blocks (exploration and production management subsystem; transport management subsystem; management subsystem implementation; subsystem of the control apparatus).

Thus, the lack of a balanced and reliable intelligent automation strategy of an oil and gas company has a significant negative impact on the strategic and tactical levels of management of oil and gas companies. We can conclude about the importance of creating an intelligent information system of an oil and gas company, the result of which will be an increase in the total efficiency (improvement of quality and efficiency) of the management of the complex of business processes of an oil and gas production enterprise, and as a result - an increase in its stability and market value of the company.

6. The above-mentioned innovative information system of the oil and gas company should be a complete system that allows managers to get operational access to information at any level, as well as meet the ever-growing needs of management personnel for operational, accurate and convenient information for making management decisions. The construction of IS of an oil and gas company should be based on the principles defined in the work, have qualitative characteristics investigated in this work (and other publications of the authors), and take into account specific industry problems. The IS structure of an oil and gas company is multi-level in accordance with the organizational structure of the company, and each hierarchical level of management is a certain node of analytical processing of information and decision-making.

On the basis of the analysis of existing developments and the Western experience of creating IS of oil and gas production companies, analysis of organizational structures, information flows, the concept of the architecture of the information system of an oil and gas company is proposed, which involves the allocation of 3 macro levels: subsystem of technological process management; tactical control subsystem; analytical subsystem of top management. In addition, variants of the IS functional configuration of an oil and



gas company are given. From a functional point of view, the IS of a vertically integrated oil and gas company is divided into the following main subsystems: exploration and production management subsystem; transport management subsystem; implementation management subsystem; subsystem of the control apparatus. Thus, a Big Data-oriented, broadband IS architecture of an oil and gas company and corresponding to the transformation of its business model is proposed. The development of the global telecommunications industry provides opportunities to replace today's internal IT resources of the oil and gas company with safe, cheap external resources with the help of: Internet service providers; data service providers; application service providers; hardware service providers and knowledge service providers. Thus, the implementation of a new business model provides: economies of scale; effective global collaboration in real time; low IT costs in the industry. Oil and gas companies will be able to operate around their core business - analysis and interpretation of exploration and development data - and outsource all related activities, including data management and storage. So the virtual energy company becomes a reality. Through innovations in knowledge management and the corresponding change in business models, the oil and gas companies of the future will be more profitable.

7. Based on the developed strategy for configuring the information system of the oil and gas company, it can be concluded that: the construction of an effective information system of the oil and gas company is possible through the integration of purchased and self-developed components; specialized software that helps manage an oil and gas company's mission-critical business functions is a potential center of competitive advantage for an oil and gas company (most often a DSS).

8. In the oil and gas industry, DSS built according to a hybrid approach have the greatest application potential - which are a powerful tool for solving complex specific problems of an oil and



gas company. Therefore, the principles of the hybrid application of intelligent technologies and the knowledge-oriented DSS basis of the oil and gas company were further developed in the work. It is necessary to take into account the fact that knowledge-oriented DSS cannot replace an experienced manager and a team of expert professionals in solving the tasks of an oil and gas company, but is only a tool that provides management support to solve problems faster and more efficiently.

Oil and gas companies to maintain their efficiency in the conditions of: liberalization of markets, globalization, increased competition, decrease in consumer loyalty, constant variation in oil and gas prices, development of the Internet and mobile technologies, growing costs for drilling and assembly - must have an open information technology environment, which enables seamless and efficient knowledge sharing across the company and across the value chain. So, the work defines a comprehensive knowledge management policy of an oil and gas company, the key tool for its implementation is knowledge-oriented DSS.

It has also been proven that a critical direction for a modern oil and gas production company is the use of knowledge-oriented technologies in the training of specialists in the exploration and development of oil and gas deposits.

9. Taking into account the developed system concept of the information system of the oil and gas company, the system of economic and mathematical decision-making support at the macro level of the oil and gas production company, the use of knowledge-oriented DSS as a component of the means of implementing the developed knowledge management policy of the oil and gas production company require significant changes in the organizational structure of the oil and gas company, changes in business management decision-making processes, significant investments in Big Data Hardware and Big Data Analytics of the IS being created.



However, according to the testimony of both Western and domestic experts and top managers, if even according to the most pessimistic forecast, the result of implementation will be an increase in the efficiency of management decisions by 5-10%, taking into account the large economic base, the use of knowledge-oriented technology is economically justified.

Therefore, it can be concluded that, subject to further additional research and improvements, the practical use of the theoretical provisions put forward in the work is a necessary factor for ensuring the effective and stable existence of any oil and gas production company on emerging markets, and as a result - an increase in the market value of the company.

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