Adaptive Impact Factor Research Concerning Effectiveness of the Introduction and use of Digital Twins for Oil and Gas Deposits

V.Ya. Afanasyev[1], V.F. Ukolov[2,*], O.I. Bolshakova[3], O.V. Baykova[3], N.A. Kislenko[4] and A.O. Alekseev[5]

[1]*Department, FSBEI HE State University of Management, Russia*

[2]*Department of Digital Enterprise Management in the Fuel and Energy Complex, FSAEI HE Peoples' Friendship University of Russia, Russia*

[3]*FSBEI HE State University of Management, Russia*

[4]*General Director of NIIGAZEKONOMIKA LLC, Russia*

[5]*Director of the Centre for Corporate Governance Methodology, "NIIGAZEKONOMIKA" LLC, Russia*

Abstract: In recent years, there have been significant changes in the conditions of oil production leading to an increase in its cost and wasteful use of resources. This necessitates the search for a system of adaptive factors that can adapt to environmental changes, affect the cost reduction and increase in the efficiency of oil and gas fields. Studies show that this problem needs to be solved on the basis of the creation of digital oil or gas fields being digital counterparts of existing enterprises, which allow preserving nature and use resources economically due to the existing field development at a new qualitative level. However, the transformation of existing fields through their transformation into digital oil or gas fields requires serious justification, and above all, from a financial and economic points of view. At the same time, one should in no case ignore the natural factor contributing to saving, restoring the used oil and gas resources and preserving the external space being the human environment. The purpose of this study is to develop recommendations for assessing the economic efficiency of the implementation of the project concerning a digital oil or gas field being a digital twin of oil or gas enterprise, and their use in practice. Such an assessment will be carried out based on the analysis of the ratio between capital investments and operating costs necessary to create a digital oil or gas field, as well as by comparing the expected costs and benefits derived from its use.

Keywords: Digitalization, digital oil or gas field, digital twin of a field, adaptive factors, digital technologies, economic efficiency.

INTRODUCTION

In the conditions of depletion of easily recoverable reserves at oil and gas fields, complicating production conditions and an unprecedented drop in oil prices during the global economic crises, an important task is the management of the effectiveness of oil and gas fields based on digital technologies that help reduce costs (Balashova and Bolshakova 2019).

One of the factors for increasing the efficiency of deposits is the transition from conventional to digital oil or gas fields (DOGF), which allow real-time management of business processes on the basis of digital technologies, significantly reducing production costs and increasing the safety of their functioning

LITERATURE REVIEW

In connection with the development of digitalization, the management of production facilities in various segments of the oil and gas industry, concepts such as a "smart" well, a smart field and smart energy have also been used. In our opinion, the digital oil or gas field technology is one of the most promising in terms of its use in the oil and gas business effectiveness management (Berezina 2014; Caraka, Lee, Kurniawan, Herliansyah, Kaban, Nasution and Pardamean 2020). This is evidenced by the concepts, methods and tools which are quite common in foreign literature and applied for assessing the effectiveness of the use of modern digital systems. Some studies are engaged in the analysis of the effectiveness of using digital technologies in the oil industry (Caraka, Bakar, Pardamean and Budiarto 2017). However, the economic analysis of the introduction of digital oil or gas field technologies in the oil and gas industry is not always systemic, multifactorial in nature, and also requires improvement (Balashova and Bolshakova 2019; Caraka, Hafianti, Hidayati, Wilie and Muztahid 2019).

MATERIALS AND METHODS

The methodological and theoretical basis of this paper was the publications of domestic and foreign

*Address correspondence to this author at the Department of Digital Enterprise Management in the Fuel and Energy Complex, FSAEI HE Peoples' Friendship University of Russia; E-mail: vfukolov@yahoo.com

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scientists in the field of information technology and decision theory in the face of constant changes and uncertainty. The research information base was made up of open sources: data from the Ministry of Energy of the Russian Federation, Institute of Energy Strategy, Institute of Energy and Finance, Energy Centre of Skolkovo Business School, Vygon Consulting, such international organizations as IEA, OPEC, SPE, EIA, DOE, USGS, CERA, OIES; materials of oil and gas companies BP, Shell, Exxon, Total, CNPC, Sinopec, PJSC Gazprom Neft, PJSC Lukoil, PJSC NK Rosneft, PJSC Tatneft; publications in domestic and foreign media, materials from industry magazines and methodological documents.

The empirical base of the study was analytical reviews on the use of digital deposits in the oil and gas sector, data from analytical research centers (such as CERA, Accenture, Deloitte, Pwc), materials from thematic conferences, legislative and regulatory acts of the Russian Federation.

In the course of the research, a wide range of general scientific methods was used; it characterizes the problems of collecting, analyzing, interpreting, and evaluating the effectiveness of digital technologies.

RESULTS

The following results were obtained in the course of the study being the foundation of this paper:

Proposals have been developed to optimize the ratio of capital investments and operating costs required for the implementation of the digital twin project at the field. As a result, the additional annual operating costs for the Prirazlomnoye field of Gazprom Neft Shelf LLC related to servicing the digital oil or gas fields system amounted to 146.4 million roubles. This amounts to approximately 15.2% of the total investment costs for the implementation of the digital oil or gas field system, which can be considered a good indicator, while, for example, at the Valhall field (Norway) (Tcharo, Vorobyov and Vorobyov 2018; Balashova and Bolshakova 2019), they are much higher.

Adaptive factors are structured to ensure the effectiveness of the digital twin project at the field, which allows us to determine the significance of each of the groups of factors in improving the efficiency of creating a digital oil or gas field.

It was revealed that the introduction of digital oil or gas fields allows increasing the production level of a field from 2 to 6% due to the optimization of control systems and reduction of losses. It is shown that the introduction of digital oil or gas fields makes it possible to reduce capital and operating costs from 11 to 25%, to increase in the oil recovery coefficient (ORC) and gas recovery coefficient (GRC) and increase in their reserves by 1-2%; It is recommended to use the obtained indicators as arguments for oil and gas companies doubting the feasibility of creating digital oil and gas fields.

DISCUSSION

Digitization of oil production processes is not only profit-making, but also, in most cases, improving the safety of an oil and gas enterprise and improving the environment (Caraka, Chen, Toharudin, Pardamean, Bakar and Yasin 2019).

The concepts of digital oil and gas field and a digital twin of a field are most often understood as equal to each other. In this regard, we will mean by a digital oil or gas field the state of a digital production asset, where management is implemented on the basis of a set of digital integrated models (a digital asset twin), which allow holistic forecasting and optimization of the technological process, work and resources in real time. The digital twin of a production asset acts as a fundamental, one can say the main element of the digital oil or gas field concept.

The main groups of adaptive factors affecting the implementation efficiency of the concept concerning the digital twin of the field characterize the following areas (Chen, Dewi, Huang and Caraka 2020; Sorokin 2019).

We will demonstrate how a process control system for a digital oil or gas field is optimized and the proper productivity of production wells is ensured. It is provided by analysing data on the operation of the equipment, using specially built-in sensors, which allow reading information in real time. It uses the digital technology "Industrial Internet of Things"

A process control optimization system includes:

– Visualization of the current performance indicators for the equipment at the field facilities, including data from the process control system (automated process control system);

– Providing operational access to regulatory and reference information about contractors and equipment;

– The use of an expert decision support system for geologists, developers, technologists and other technical specialists;

– Automated planning of all types of activities in production;

– Integrated modelling of the state of assets with the ability to quickly calculate the impact of operating activities on the production profile.

This set of operations allows them to:

– Optimize the movement of workers employed at various facilities and performing various operations due to standardization of business processes, used tools and management systems

– Save time by automating processes such as data collection, processing and reproduction;

– Reduce the time and improve the quality of management decisions through the timely receipt of reliable information;

– Smooth out the decline in production with optimal planning of work in the wells;

– Detect potentially inefficient wells through the use of more advanced observation methods;

– Translate potential and probable resources into possible and proven reserves by obtaining more reliable information from the digital twin and its correct interpretation;

We show what happens with preventative maintenance and repair at the digital oil or gas field.

As for equipment failure control, the use of Big Data and predictive analytics allows us to achieve several goals:

– Develop optimal condition based maintenance for each class of equipment;

– Increase the availability of equipment and reduce the likelihood and cost of unscheduled repairs;

– Reduce inspection and maintenance costs by focusing on equipment with the highest risk of failure.

– Identify equipment with low productivity, and also to reduce potential product losses.

Practice shows that, in general, modern inventory monitoring systems and mobile equipment diagnostics applications allow optimizing the schedule of preventive maintenance in order to ensure uninterrupted operation of enterprises and minimizing repair costs, and also make it possible to reduce accident rate during work.

Let us pay attention to changes in the business processes of auxiliary divisions of digital oil or gas fields.

Numerous manual operations based on paperwork often lead to errors and additional operating costs of 7 to 15%. Using digital solutions, we can automate processes such as generating applications for employees, creating employee cards when hiring, reconciling bank statements and correcting discrepancies, issuing and paying bills. This in turn leads to a reduction in the complexity of processes, a reduction in the number of errors through control and audit, an increase in added value, and an increase in the speed of task execution.

Real-time analysis of the work of auxiliary units and expenses of the digital oil and gas field allows us to increase the accuracy and efficiency of calculations and, as a result, reveal hidden reserves in the field of minimizing working capital.

We consider the integrated planning and implementation of digital oil and gas field products.

Digital tools, for example, systems for collective development of processes and data analysis, allow us to perform tasks involving various structural divisions of a digital oil or gas field and make operational decisions based on the whole complex of accumulated knowledge.

The transport management system, logistics and warehouse management are changing at a digital oil or gas field. The monitoring of routes and the state of transport, the operability of equipment and stock balances required to service the most important assets, as well as the relationship of these systems with accounting and auxiliary systems are of great importance. The availability of proper control in real time leads to the observance of the delivery time, high load and high quality of the provision of transport and storage services, to reduce unjustified costs. The benefits obtained when using digital technologies in a digital oil or gas field in this direction are proposed to

be grouped in two categories. The first is the benefits that allow us to make quantitative estimates of increased production, reduced costs, and increased ORC and GRC coefficients. The second group of benefits should include benefits of a non-material nature, such as better access to operational data, improving the security of the digital oil or gas field and improving the environment.

An analysis of the expected benefits for various comparable projects of digital oil or gas fields shows that the greatest effect is achieved by increasing oil recovery; meanwhile, the decisive role is being played by the introduction of underwater seismic equipment and sensors, as well as production and automation modelling systems, the costs of which were the highest.

In general, an effectiveness assessment concerning the implementation of a digital twin project at a field can be considered based on the ratio of results to costs for this technology, taking into account the considered features of the use of digital technologies in the oil and gas industry.

CONCLUSION

Given the increasing complexity of production conditions and falling oil prices, companies must solve increasingly complex problems in the field of improving methods and technologies for prospecting, exploration and development of oil and gas fields. Possible progress in this direction is based on the use of digital technologies, a prominent place among which is occupied by technologies of creation and functioning of digital oil or gas fields. However, the transition from conventional to digital oil or gas fields requires taking into account a wide variety of adaptive factors that determine the possibility of obtaining one or another benefit. Their accounting allows us to significantly increase the efficiency of the functioning of digital oil or gas fields in the oil and gas complex.

The practical significance of the study lies in recommendations for assessing the effectiveness of the implementation of digital twin projects based on information on the expected benefits and costs of this technology, taking into account the considered features of the use of digital technologies in the oil and gas industry. This helps to accelerate the implementation of modern digital twin technologies thus increasing the competitiveness of oil and gas companies in the domestic and foreign markets in the near future.

CONFLICT OF INTERESTS

The authors confirm that the materials presented in this paper do not contain a conflict of interest.

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REFERENCES

Balashova, A. D., Bolshakova O. I. 2019. Influence of business digitalization on oil recovery ratio and increasing the efficiency of oil and gas companies // University Bulletin,. No. 5. Pp.73-79. https://doi.org/10.26425/1816-4277-2019-5-73-79

Balashova, A. D., Bolshakova O. I. 2019. Robotisation of processes in the development and operation of oil and gas fields / In the collection: Priority and perspective directions of scientific and technical development of the Russian Federation // Materials of the 2nd All-Russian scientific and practical conference “Priority and promising areas of scientific and technological development of the Russian Federation". Moscow,. Pp. 108-110.

Berezina A.A. 2014. The economic concept of the oil and gas "intellectual" field / A.A. Berezina, A.E. Cherepovitsyn - Publishing House "Oil Industry" (Moscow), - No. 4 –P.14-15.

Caraka, R. E., Bakar, S. A., Pardamean, B., & Budiarto, A. 2017. Hybrid support vector regression in electric load during national holiday season. In 2017 International Conference on Innovative and Creative Information Technology (ICITech) (pp. 1-6). IEEE. https://doi.org/10.1109/INNOCIT.2017.8319127

Caraka, R. E., Chen, R. C., Toharudin, T., Pardamean, B., Bakar, S. A., & Yasin, H. 2019. Ramadhan Short-Term Electric Load: A Hybrid Model of Cycle Spinning Wavelet and Group Method Data Handling (CSW-GMDH). IAENG International Journal of Computer Science, 46(4).

Caraka, R. E., Hafianti, S., Hidayati, S., Wilie, B., & Muztahid, M. R. (2019). Identifying Indicators of Household Indebtedness by Provinces. The Ninth Research Dive for Development on Household Vulnerability, 10.

Caraka, R. E., Lee, Y., Kurniawan, R., Herliansyah, R., Kaban, P. A., Nasution, B. I., ... & Pardamean, B. 2020. Impact of COVID-19 large scale restriction on environment and economy in Indonesia. Global Journal of Environmental Science and Management, 6(Special Issue (Covid-19)), 65-84.

Chen, R. C., Dewi, C., Huang, S. W., & Caraka, R. E.2020. Selecting critical features for data classification based on machine learning methods. Journal of Big Data, 7(1), 1-26. https://doi.org/10.1186/s40537-020-00327-4

Sorokin P.Yu. 2019. Digital transformation of the oil and gas industry: barriers and their solutions // Materials of reports of the Russian Energy Week 2019, October 2-5, - URL: https://rusenergyweek.com/programme/business-programme-2019/

Tcharo H, Vorobyov A.E., Vorobyov K.A. 2018. Digitalization of the oil industry: basic approaches and justification of "smart" technologies // Herald of the Eurasian Science. No. 3. Volume 10.

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