Scenario Forecasts of Ecosystem Development in the Oil and Gas Industry in the Context of Digitalization

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Abstract. The rapid change in the oil and gas business environment associated with the complication of the oil extraction process has made relevant the search for new ways to interact with partners. The ecosystem in the oil and gas sector is characterized by active interaction with potential partners to find ways to solve non-standard tasks that ensure the best result for all participants. A key factor in ensuring effective interaction is digital technologies that focus on ensuring the interconnection of products, value chains and business models. The article substantiates the need for the introduction and use of digital technologies. Statistical data on smart oil and gas fields in Russia are presented, and strategic guidelines for the development of oil and gas companies in the field of digitalization are defined. A scenario forecast of the impact of digitalization on the oil and gas industry is presented. The conclusion is made about ensuring increased oil production due to digitalization, due to a higher design coefficient of oil recovery and hard-to-recover reserves. The key problems of creating an ecosystem for the use of innovations in the industry are identified. The importance of the introduction of digital technologies for the formation of ecosystems in the oil and gas industry was noted.

1. Introduction

The transformations taking place in the oil and gas industry have allowed for a relatively short period of time to change the corporate culture and form a partner community, called the ecosystem. Reference sources analyzing the innovative component of the oil and gas sector actively use the so-called ecosystem around the well [1]. In this regard, a significant role is assigned to the introduction and use of digital technologies that allow the industry to ensure the transition to a diversified profile. Digital technologies, on the one hand, contribute to the creation of effective tools for assessing the economic impact and stimulating diversification processes. On the other hand, they allow you to free up resources that can be invested in promising areas of energy [2].

The impact of negative factors related to the complexity of the so-called difficult oil production processes, increased competition from shale oil, as well as reducing prices against the background of declining demand for resources, have made relevant the creation of a business ecosystem. The ecosystem in the oil and gas industry is characterized by active interaction with potential partners to find ways to solve non-standard problems that ensure the best result for all participants.

The purpose of this study is to analyze the prospects for using digital solutions in the oil and gas industry that affect the creation of ecosystems under new conditions.
2. Materials and methods
In the course of the research, the author used general scientific methods of cognition, as well as abstract-logical methods and a set of methods of economic and statistical analysis. The sources of information were statistical data on the oil and gas industry in the Russian Federation published in the collections of the State Statistics Committee, as well as reports on the activities of oil and gas companies Rosneft, Gazprom Neft, LUKOIL and Tatneft.

3. Results and discussion
The role of digital technologies in the oil and gas business is to ensure the interconnection of products, value chains and business models, which results in an increase in business profitability. Leading oil and gas companies are creating points of attraction for potential partners, creating partnerships between businesses of different sizes, and creating a complex system of interaction that covers the entire value chain—from exploration to final consumption. For example, DrillingInfo and OAG Analytics, both being analytics startups, offer products that analyze geological data to optimize drilling points and well configurations. Blue Gentoo's Intelligent Hydrate Platform enables intelligent real-time management of gas hydrates and contributes to the digital transformation of oil fields [3].

In Russian oil and gas companies, the introduction of digital technologies began after Shell and BP entered the market. The first project associated with remote monitoring and management smart fields systems was implemented in 2008 at the Salym group of fields. By 2018, the number of such fields has grown to 43, of which 5 are projects in the gas industry (Table 1). Rosneft is the leader in implementing digital technologies. Total production for all fields is 27% of the total oil production in Russia. Smart fields are all offshore projects, the largest new fields (Vankorskoye, Novoportovskoye) and large traditional fields (Romashkinskoye, Samotlorskoye, Priobskoye, etc.).

Table 1. Data on smart deposits in Russia for 2018.

| Company-developer fields | The number of intellectual fields, ed. | Share in production, % | Share in inventory, % |
|--------------------------|----------------------------------------|------------------------|-----------------------|
| Rosneft, PJSC            | 16                                     | 36                     | 33                    |
| Lukoil, PJSC             | 13                                     | 16                     | 10                    |
| Gazprom Neft, PJSC       | 8                                      | 45                     | 32                    |
| Tatneft, PJSC            | 1                                      | 53                     | 28                    |
| Total                    | 43                                     | 27                     | 21                    |

In comparison to the largest international oil and gas companies, digital technologies are used considerably less often in the Russian industry. However, having realized the importance and prospects of their use, companies have been developing and implementing strategic development plans [4]. In the Rosneft 2022 strategy, Rosneft has identified digitalization as one of the key areas of development, which, according to experts, will reduce specific operating costs by 2–3%, reduce well drilling time by 5%, and increase the efficiency of well overhaul by 20%. Gazpromneft, PJSC has added a digital solutions implementation program to its technology strategy, which covers the entire oil sector from exploration to field development [5]. Since 2012, about 30 projects of the program have been implemented, and their effectiveness at the Romashkinskoye field has resulted in an annual increase in production by 0.5–2%, even in severely depleted fields. Since 2015, Tatneft has been operating a business service center that provides support and technical support for production processes. Well modeling allows you to predict production indicators, identify residual oil reserves, and calculate options for optimizing the operating mode of wells. In 2020, the company plans to calculate similar models for all existing wells. The estimated economic impact of digital pilot projects at LUKOIL's fields amounted to more than 3.5 billion rubles over two years. The company's IT strategy Digital LUKOIL 4.0 has been identified as a promising area for development.
Implementation of programs to digitalize oil production in traditional oil production regions’ depleted largest operating fields will allow Russia to maintain its leading position in the global oil market and companies to increase profitability. The use of digital technologies makes it possible to improve the accuracy of forecasting and modeling for the explored fields [6]. For already developed fields, the digitalization effect is manifested by reducing costs and equipment downtime. According to experts, the introduction of digital technologies reduces losses in oil production by 2.5%, and increases the flow rate of wells by 2% [7]. This makes it possible to put into operation some of the deposits of existing fields that are currently recognized as economically impractical. The results of using digital technologies depend on many factors of the external and internal environment, including the availability of financial resources for companies, the development of infrastructure projects, government support, developed regulations, demand from oil-consuming countries, and so on.

A scenario forecast of the impact of digitalization on the oil industry is shown in Figure 1. Maximum production forecast is largely driven by an increase of the design oil recovery coefficient (ORC) and design hard-to-recover reserves coefficient (HRR) that is associated with lower production prices due to digitilization [7, 8].

| Development scenario   | Minimum scenario | Status Quo | Digital transformation | The maximum scenario |
|-----------------------|-----------------|------------|------------------------|----------------------|
| The conditions of implementation | digital technologies in a small number of major projects and maintained unprofitability of undeveloped reserves | maintaining the current level of digital development | the presence of limiting factors for digitalization of the industry | lack of financial and infrastructual restrictions on digitalization of the industry |
| The results of the implementation | Total production, million tons | 483 | 607 | 717 |
| including the expense, million tons | - main production-462 | - main production-440 | - main production-497 | - main production-523 |
| | - involvement of HRR – 16 | - involvement of HRR – 15 | - involvement of HRR – 44 | - involvement of HRR – 78 |
| | - increase in cost-effective ORC-15 | - increase in cost-effective ORC-50 | - increase in cost-effective ORC-32 | - increase in cost-effective ORC-65 |
| | - other factors – (-10) | - other factors – 19 | - other factors – 34 | - other factors – 51 |

**Figure 1.** Scenarios for forecast oil production volumes in Russia until 2035.
The anti-Russian sanctions imposed in 2014 had an extremely negative impact on the introduction of digital technologies in the oil sector. In this regard, one of the key problems of digital transformation is the need for import substitution of foreign technologies. Thus, the most significant problems in the development of the oil and gas sector are caused by the creation of an innovations ecosystem, for example:
- insufficient interest of oil-producing companies in long-term investments in digital technologies and R&D funding, due to weak government incentives;
- lack of specification of measures to support the introduction of digital technologies in industry in the state program for digitalization of the economy [9];
- the inability to attract investment at the riskiest stages of R&D due to gaps in the intellectual property legislation and poor development of the financial market;
- insufficient availability of replacement software made in Russia.

The solution to these problems and the creation of an ecosystem in the oil and gas sector should be based on the principles of equality between customers and contractors, active development and implementation of digital technologies, and better cooperation quality.

4. Conclusion
Thus, despite the opposition between traditional industry and the "new" digital economy, ecosystems are being formed in the oil and gas sector, which are a community of partners that actively interact with each other and effectively solve non-standard tasks. Solving such problems is possible only through creating conditions for the interaction of business partners of different sizes and the creation of a complex structure.

Building an ecosystem of relationships between partners and contractors allows oil and gas companies to carry out joint development and innovation. Digital technologies play a leading role in this interaction, allowing you to create flexible work processes, develop new business lines, and improve the efficiency of field development and operation.

5. References
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