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Методологические основы анализа портфеля шельфовых нефтегазовых проектов

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Аннотация: В России сегодня отсутствуют как общепризнанные теоретико-методологические подходы к формированию программы освоения нефтегазовых ресурсов шельфа, так и единое мнение в отношении целесообразности их освоения. Разработка российского шельфа способна не только подготовить новую ресурсную базу углеводородов, но и, как показывает мировой опыт (Норвегия, Бразилия), стать локомотивом национальной экономики, обеспечив рост целой цепочке смежных отраслей за счет высокого мультипликативного эффекта. Выбор стратегии разработки нефтегазовых ресурсов российского шельфа, нацеленной на ускорение экономического роста в стране, требует глубокого анализа государственной политики и практического опыта стран, достигших значительных успехов в области освоения энергетических ресурсов и сумевших использовать их в качестве фундамента благосостояния населения и катализатора инновационного развития. В статье представлена авторская методика комплексной оценки портфеля нефтегазовых проектов шельфа, применение которой за счет многокритериального анализа проектов дает возможность сформировать программу освоения шельфа, ориентированную на получение максимального эффекта для национальной экономики.

Ключевые слова: нефтегазовый комплекс, многокритериальный анализ, программа освоения российского шельфа, стратегия развития нефтегазовой отрасли

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METHODOLOGICAL BASIS FOR ANALYZING SHELF OIL AND GAS PROJECTS PORTFOLIO

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Abstract: Today, in Russia there is no agreement on recognized theoretical and methodological approaches concerning the formation of shelf oil and gas resources development programs and the desirability of their development. The development of the Russian shelf can prepare a new hydrocarbon resource base, and also, according to the international experience (Norway, Brazil), become the driving force of the whole national economy, in other words, to ensure the growth of an entire chain of related industries due to the high multiplier effect. The choice of the strategy for developing oil and gas resources of the Russian shelf, which is necessary to accelerate economic growth, requires an in-depth analysis of government policy and practical experience of countries that have achieved significant success in the development of energy resources and have been able to use them as a foundation to increase the population's prosperity and catalyst for innovative development. The article presents the author's technique of a complex estimation of a portfolio of shelf oil and gas projects, the use of which by multi-criteria projects analysis provides an opportunity to form the shelf development program that focuses on obtaining the maximum effect on the national economy.

Keywords: oil and gas industry, multi-criteria analysis, the Russian shelf development program, development strategy for the oil and gas industry

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Introduction

On the one hand, Russia's oil and gas complex in recent years has generated a significant amount of federal budget revenues and industrial production, and on the other, it determines the raw material orientation of the Russian economy. According to such a structure, economic growth is achieved due to a simultaneous increase in hydrocarbon production and export, as well as beneficial market conjuncture (high oil prices worldwide).

In the post-Soviet era, the oil and gas industry in Russia mainly developed within the framework of the resource-inertial model (in the Soviet years, five production oil or gas wells accounted for one exploratory well, whereas in modern Russia this number of wells has decreased by five times), as a result, the structure of the resource base significantly declined, and now it requires an increasing amount of investment resources. Tough competition in international and fuel energy markets, the volatility of hydrocarbon prices, the presence of a significant geopolitical factor, sanction pressure on Russian energy companies, – these are the factors that determine the need to increase investment in expanding the reproduction of the mineral resource base and improving the overall performance of the oil and gas complex. But they also require the search for new industry development models that are capable to enhance the use and increase oil and gas potential on a national scale.

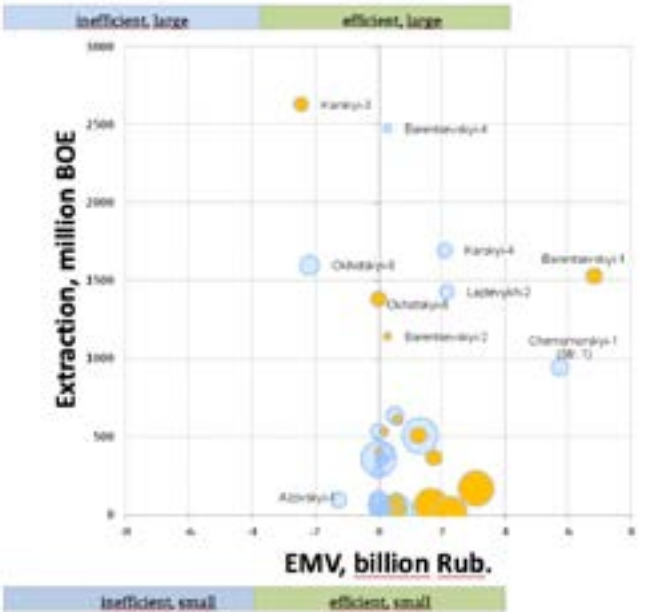
The role of the Russian shelf

Due to its unique resource potential, a special role in the development of the oil and gas industry is assigned to the Russian shelf, especially the Arctic one. The development of this shelf can prepare a new hydrocarbon resource base, and also, according to the international experience (Norway, Brazil), become the driving force of the whole national economy, in other words, to ensure the growth of an entire chain of related industries due to the high multiplier effect [Bystryakov, Kondratenko, 2017].

The choice of the strategy for developing oil and gas resources of the Russian shelf, which is necessary to accelerate economic growth, requires an in-depth analysis of government policy and practical experience of countries that have achieved significant success in the development of energy resources and have been able to use them as a foundation to increase the population's prosperity and catalyst for innovative development. The study of such experience is necessary for developing the principles of unified state policy. Such a strategy is aimed at using the potential of the oil and gas industry to achieve the best possible effect and qualitatively new growth of the Russian economy as a whole.

Currently, despite the presence of relevant documents on the development of the oil and gas complex, there is no single strategy for the development of oil and gas resources of the Russian Arctic shelf. With limited financial resources and in a short time, the implementation of such a strategy would make it possible to achieve the maximum economic effect in the development of the northern territories. Most modern approaches to the development of shelf resources are implemented by vertically integrated companies independently of each other and by projects, the assessment of which does not allow the full use of innovative approaches for the implementation of production in total.

Figure 1. Ranking of projects by economic and geological criteria



The specifics of the development of the Russian shelf (poor exploration of territories, lack of infrastructure, ice conditions) is due to the need to take into account a broader range of issues and a systematic approach to their analysis.

A standard corporate approach to ranking oil and gas projects consists of three criteria: (1) economic efficiency (for projects in the geological exploration stage, the indicator of expected monetary value (EMV), (2) the level of hydrocarbon production, (3) geological success [Kondratenko, 2017].

The results of such a ranking can be presented in the form of a bubble chart (**Figure 1**), where the X-axis shows the EMV values, the Y-axis shows hydrocarbon production indicators, the bubble diameter indicates the probability of geological success, the color is the type of hydrocarbon (yellow – oil, blue – gas).

This approach is widely used in industry practice but does not take into account related aspects of shelf projects (ecology, technology accessibility, socio-economic importance). It is expedient to use multi-criteria evaluation methods to identify priority projects that allow you to take into account all relevant characteristics of the studied objects.

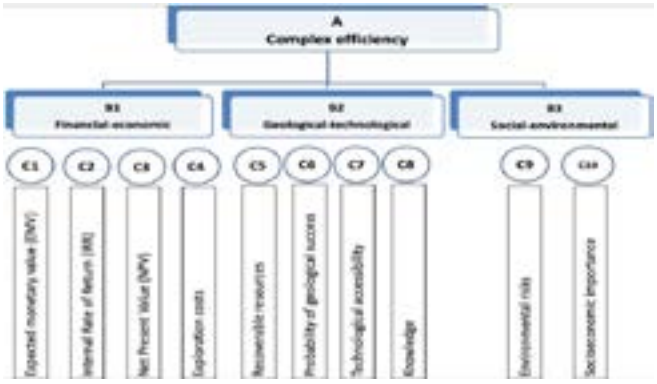
The shelf projects portfolio

To analyze the shelf projects portfolio, it is suggested to use three groups of criteria: (1) financial and economic; (2) geological and technical; (3) socio-environmental. **Figure 2** shows the hierarchy of selected criteria.

The criteria for evaluating the effectiveness of the shelf project portfolio may differ depending on the market situation and the strategy of the subsoil user and the state.

The author analyzed 42 licensed areas of the Russian shelf in the course of the research. The Okhotsk, Caspian,

Figure 2. Hierarchy of performance criteria



Black, Azov, Barents, Kara, Pechora, Chukchi and Laptev seas areas were selected; the deposits were discovered in seven areas. A discount rate of 15% was used to determine economic indicators; Brent crude oil price: 40 US dollars per barrel for 2016 and 70–75 US dollars for 2017–2019; US dollar exchange rate: 65 rubles per dollar for 2016 and 50 rubles per dollar for 2017–2019.

The assessment of the resource base for the given areas was confirmed by the independent appraiser DeGolyer and MacNaughton Corp.; geological risks were assessed using the Petrel software product.

An example of ranking projects, according to the probability of geological success, is presented in **Figure 3**. Here, we can see that almost in the entire portfolio, the indicator is below 25%.

A different degree of importance of the criteria under consideration defines the need to calculate weighting factors (priority vector). Due to the interconnections of the considered criteria, it is suggested to use the Saati method of hierarchies analyzing. The criteria priority vector is shown in **Figure 4**.

In the framework of multi-criteria evaluation for ranking projects, three schemes of compromise were simultaneously used: (1) weighted additive convolution of criteria; (2) guaranteed result (Bellman-Zadeh principle); (3) ranking of alternatives (Bord's procedure). This allows us to reveal projects that are comparable in overall efficiency.

In the first case, the compromise criterion (consolidated indicator) has the form:

$$K_{св}^{j} = \sum \alpha_i \omega_{ij} \qquad (3)$$

Where α_i is the substance (significance) of the *i*-th criterion; ω_{ij} is the meaning of the normalized *i*-th criterion for the *j*-th shelf project.

In the second case:

$$K_{св}^{j} = \text{MAX MIN } \alpha_i (\mu_{ij}), \qquad (4)$$

Where μ_{ij} is the function of belonging of the *j*-th shelf project to the worst value by the *i*-th criterion.

In the third case:

$$r(x) = \sum r_i (x) \qquad (5)$$

The values of $r_i(x)$ are defined as follows:

$$r_i(x) = \{b \in A : P_i(x) < P_i(b)\ \varepsilon i\} \qquad (6)$$

Figure 3. The probability of geological success, in %

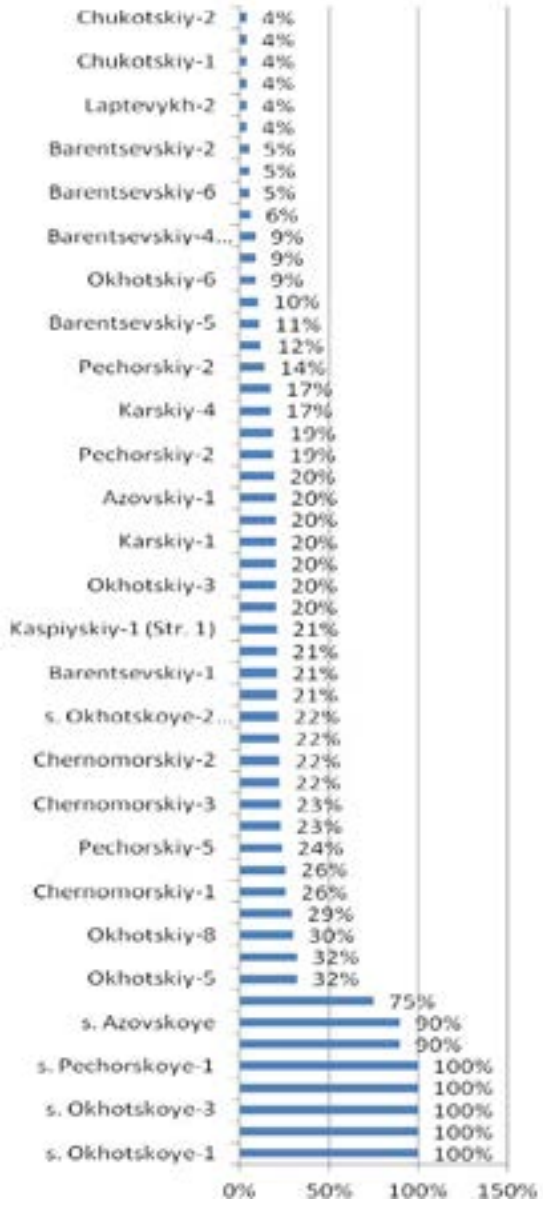
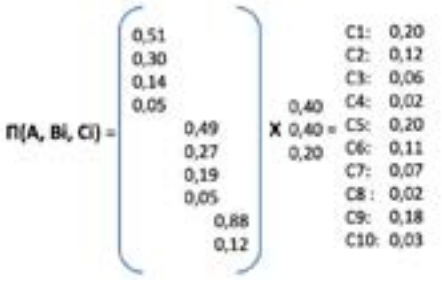


Figure 4. Priority vector of selected criteria



Where *b* are proposals in which the value of the *i*-th parameter $P_i(b)$ is better than the value $P_i(x)$ – the *i*-th parameter of the proposal x; ε_i is the characteristic of «sensitivity» [Stepin, Trakhtengerts, 2007].

At the last stage, projects are divided into three groups based on the obtained values. To do this, it is necessary to set the limits of the final values for each of the three compro-

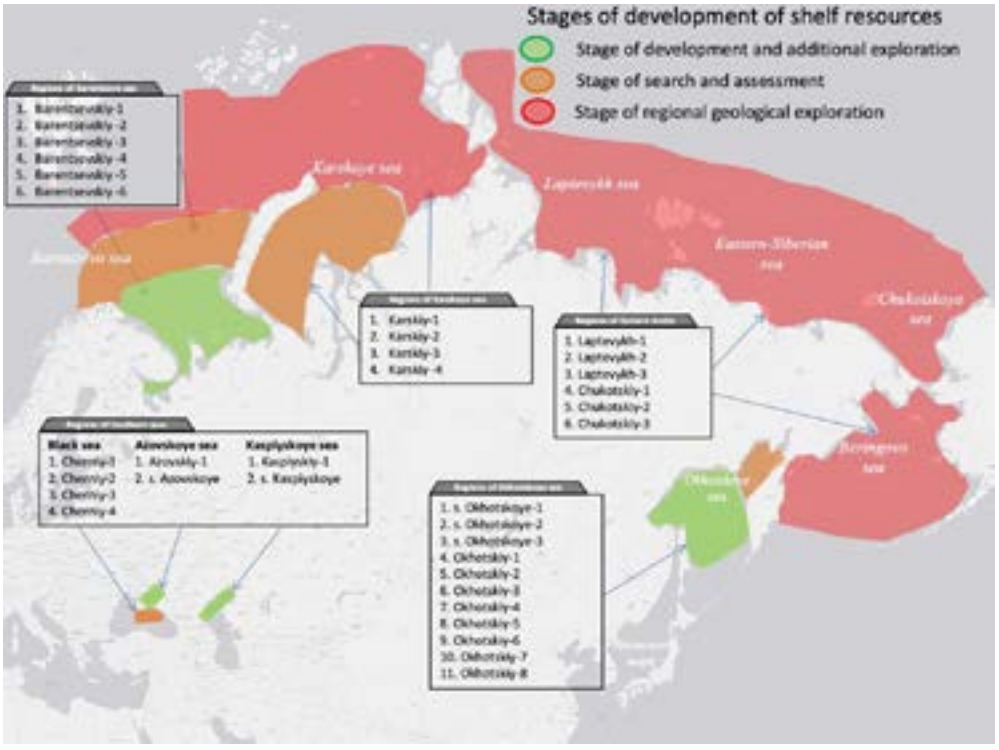
mise schemes. For example, for the first group $\sum\alpha_i \omega_{ij}$ = 20 – 35; MAX MIN α_i (μ_{ij}) = 0; r(x) = 47 – 127. For the second group $\sum\alpha_i \omega_{ij}$ = 36 – 49; MAX MIN α_i (μ_{ij}) = 0,01 – 0,09, r(x) = 128 – 207. For the third group $\sum\alpha_i \omega_{ij}$ = 50 – 60; MAX MIN α_i (μ_{ij}) = 0,1 – 0,39; r(x) = 208 – 286. The final result (assignment to a specific group) is designated by the intersection of the sets of projects for each group, which obtained by using the selected compromise schemes.

The results obtained in the framework of the proposed multi-criteria analysis (**Table 1**) make it possible to scientifically substantiate a phased model for the development of resources on the Russian shelf, form a consistent work program, and give a scientific reason for managerial decisions at the state and corporative levels.

Table 1. Project Ranking

Name of the site	Ranking										Final Rank	MIN value of the μij indicator of the project	Borda
	EMV	IRR	NPV	Exploration costs	Resources	Chance of geological success	Technological Accessibility	Site exploration	Ecology	Socio-economic Importance			
Karskiy-1	0,00	0,64	0,87	1,00	1,00	0,17	0,25	0,75	0,25	0,25	45	0.00	167
m. Pechorskoye-1	0,76	0,71	0,39	0,91	0,03	1,00	0,50	0,75	0,50	0,50	55	0.39	201
Barentsevskiy-4 (p. 2)	0,52	0,96	0,98	0,33	0,62	0,05	0,25	0,25	0,25	0,75	50	0.10	164
Pechorskiy-1 (p. 1)	0,73	0,95	0,41	0,98	0,07	0,19	0,50	0,75	0,50	0,50	49	0.07	211
Chernomorskiy-2	0,76	0,69	0,48	1,00	0,28	0,19	0,50	0,50	0,50	0,75	52	0.18	229
Chernomorskiy-3 (p. 1)	0,70	0,93	0,36	0,88	0,09	0,20	0,50	0,50	0,50	0,75	49	0.09	167
Chernomorskiy-1 (p. 1)	0,05	0,56	1,00	1,00	0,30	0,18	0,50	0,50	0,50	0,75	39	0.05	203

Figure 5. Stages of Russian shelf development



The development of the Russian shelf

Considering the diversity of Russian water areas, a significant part of shelf projects is not ready for development because of the technological, environmental, economic and infrastructural factors. At the same time, some projects are technically available; although it is characterized by some environmental risks it provides an acceptable level of profitability. This emphasizes the efficiency of such a phased concept for the development of hydrocarbon resources of the Russian shelf. This concept allows reducing environmental risks and, at the same time, activates import substitution work; that is, it has the best effect on the growth of the Russian economy.

It is proposed to identify three stages in the development of the shelf:

The stage of development and additional exploration;

Search and evaluation stage;

Regional geological exploration.

The first stage includes work in areas with mineral deposits on the surface or in areas prepared for drilling, while environmental risks are controllable (the presence of means to reduce any environmental risks). It is also supposed that there is practical Russian or foreign experience (as a criterion for making an investment decision, it is possible to consider to reduce risks to the level of work on the high seas).

The results of the multi-criteria analysis show that the geography of this stage covers the Azov, Caspian, Black, Pechora seas, the central and southern parts of the Sea of Okhotsk, and the southern part of the Barents Sea (**Figure 5**). These territories are characterized by the presence of proper infrastructure and mineral deposits on the surface [Kondratenko, 2017].

The application of the proposed methodology for the multi-criterial analysis of the shelf projects portfolio allows us to justify the amount of exploration work, the level of financing, determine the necessary equipment and human resources required for the implementation of the phased program for the development of the Russian shelf.

Table 2. Amount of investments for the implementation of the proposed program

	2019	2020	2021	2022	2023
Drilling	4 116	13 474	19 731	20 469	35 938
Marine IGI	245	532	679	1 463	1 062
Seismic exploration 2D	289	1 556	2 524	2 826	2 235
Seismic exploration 3D	978	2 610	2 600	440	4 730
Total	5 628	18 172	25 534	25 198	43 965

Table 3. The need for new specialists for shelf projects

Qualification	The need for specialists, people per year					
	2019	2020	2021	2022	2023	Всего
Project management	12	8	7	6	5	**38**
Work Management	32	38	46	35	27	**178**
Geology	43	42	54	34	28	**201**
Geophysics	31	37	46	23	7	**144**
Drilling	83	45	47	43	41	**259**
Logistical Support	31	27	32	26	31	**147**
Engineering Survey	12	2	1	0	0	**14**
Industrial safety, labor protection and the environment	39	15	8	2	0	**32**
Information Technology	7	8	3	5	3	**26**
Developers	23	51	103	13	7	**199**
Total:	**313**	**271**	**347**	**187**	**149**	**1268**

Figure 6. Phased exploration program

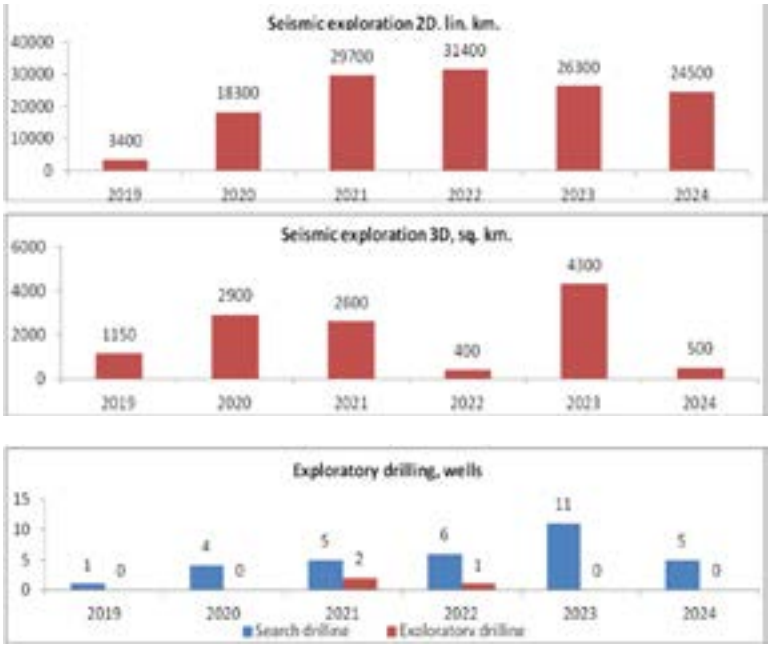
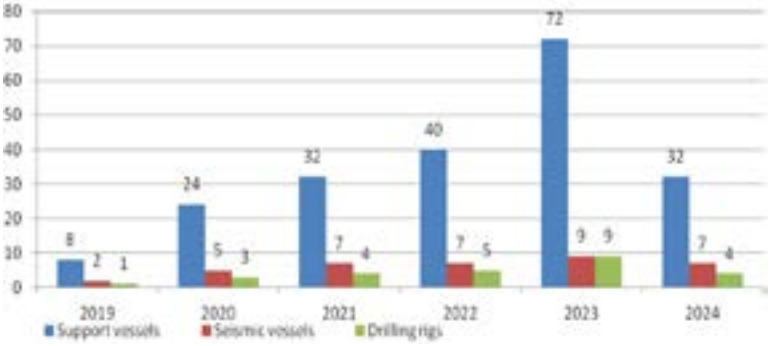


Figure 7. The need for ships and marine equipment



In the next five years, the implementation of this phased program supposes 87400 kilometers of 2D seismic surveys, 11350 square kilometers of 3D seismic surveys, drilling of 27 search and evaluation wells and 3 exploration wells (**Figure 6**).

The amount of required investments for the implementation of the program for the next five years is approximately 120 billion rubles (**Table 2**).

Figure 7 shows the assessment of the needs of Russian subsoil users in the number of ships and drilling rigs in the implementation of the proposed program.

Working on the shelf will require the involvement of new specialists. The implementation of this exploration program in the next five years implies the necessity of attraction more than a thousand highly qualified specialists (**Table 3**). Transferring projects to the preparation stage will lead to a multiple increase in these figures.

Conclusion

An accurate understanding of the needs of the industry makes it possible to plan the development of related branches of the economy, allows a systematic approach to the issue of localization of oil and gas equipment production, to prepare domestic qualified personnel in advance.

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