The Interval Preferences used for Multicriteria Selection of Arctic Projects

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***Abstract*— In the conditions of severe competition in the Arctic, large-scale integrated projects of regional and macro-regional development that ensure qualitative changes in the economy acquire the priority. The procedure for selecting the best strategic solutions in major national projects for the development of the Arctic territories is considered. The necessity of application of multicriteria choice procedures in the decision making system, taking into account the existing uncertainty of the environment through the use of interval preferences, is shown in this paper.**

Keywords— strategic decisions; Arctic projects; multi-criteria choice; the ratio of interval preferences

I. INTRODUCTION

The Arctic is a subject of considerable interest from the point of view of three main aspects: society and environment, resource and transport. The development of the Arctic zone today is the subject of interest of many countries, including those remote from the Arctic territory, such as China (the way of the "snow dragon"). In this connection, it is important to study the possibilities of using mathematical methods, first of all, multi-criteria choice for the formation of effective programs for the selection of projects aimed at developing the Arctic.

II. PROJECT APPROACH TO THE DEVELOPMENT OF THE ARCTIC REGION

At the present stage, the development of the Arctic zone becomes a strategic task for the development of the Russian Federation. This is determined by the need to expand the mineral and raw materials base of the country's economy, the growth of the geopolitical significance of this region.

Recently there has been a change in approaches to the development of the Arctic. For example, if previously Western European countries focused on the conservation of the polar environment, now the European policies privilege the rational use of natural resources with broad international participation and observance of advanced standards, the development of alternative energy, ecosystem management aimed at conserving biodiversity and taking into account the values of traditional culture small-numbered peoples, the creation of water-territorial clusters with the participation of universities and research centers. In North America, priority is also given to the development of high-tech industries, increasing the share of the information economy in the Arctic region, the development of environmental and transport infrastructure [1].

Until recently, the Russian Federation did not pay enough attention to the development of this direction. In fact, only the Russian Academy of Sciences had a specialized program of scientific research focused on Arctic territories with funding of 200 million rubles, approved by the Decree of the Presidium of the Russian Academy of Sciences on February 11, 2014 No. 22 [2].

As a result, according to official statistics, the share of science-intensive goods, works (services) of organizations in the total volume of shipped goods, works performed (services) in the Arctic zone of the Russian Federation in 2014 was less than a similar all-Russian indicator by more than seven times [3].

Specificity of the approach to the development of the Arctic zone in the Russian Federation, defined in the latest regulatory documents [4, 5, 6] consists, on the one hand, in the allocation of support zones, on the other hand, in an integrated approach to the implementation of strategic projects.

From the point of view of selection of strategic projects, this approach means taking into account different aspects: geopolitical, economic, social, ecological. The consideration also is necessary of the development opportunities of the region in a broader context, both in the territorial and sectoral facets. For example, to develop the region's energy base, it is necessary to solve the problem of developing alternative energy, taking into account the economic inexpediency of creating large energy capacities. This required, for example, Rosatom to adopt a program to create a line of nuclear reactors of small and medium power, including, whose using dual-use technologies, as a strategic direction of innovation development [7].

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When considering the competitiveness of the samples in question and the corresponding investment projects, it is necessary to take into account not only the economic side (capital and current costs), but also the problems of reliability, environmental safety, the possibility of autonomous functioning, etc. [8]. Another problem is the considerable uncertainty of the data used for calculations, generated both by the problems of measuring and processing data, and by the stochastic nature of the predicted processes. This is even more relevant to territorial programs for the development of reference zones [6].

III. Algorithm of Selection Alternatives

The quality of managerial decisions depends to a large extent on the choice of alternatives. To manage large and complex economic projects, it is necessary to specially develop a system of indicators, including, among other things, decision-making criteria, as well as a system for analyzing and forecasting the development of problem situations and selecting project alternatives. [9]. In the case of strategic decisions, we are talking about a significant amount of resources, the optimization of their use can significantly improve the efficiency of the economic system.

The algorithm for selecting alternative options for strategic projects includes: developing a system of indicators for assessing efficiency, selecting a method for ranking alternative options, calculating the predicted values of the indicators used, taking into account the existing uncertainty, determining the best option based on the chosen ranking method.

The development and implementation of multicriteria methods of investment decision making in a wide practice becomes a urgent task in conditions of active development of the Arctic regions.

The Sate program for the development of the Arctic zone of the Russian Federation singles out the economic, social and environmental aspects. Each of the directions is characterized by its own set of indicators that reflect qualitatively different phenomena. For measurement, different types of scales are used, and the decision-maker can judge only the interval in which the measured value is located.

Because of the complexity of evaluating the effectiveness of investment projects, as well as the variety of evaluation criteria and related factors, it is natural to assume that decision-makers (managers, administrators, responsible persons) do not have an unequivocal opinion about the preference of some submitted project options to others.

Given the use of interval values of criterial indicators, as well as the incomparability of particular criteria calculated in the same way in different units of measurement, it seems advisable to choose a comparison scheme for alternative projects based on interval preferences introduced in [10].

This approach allows us to use not one value of the membership function to compare pairs of variants, but an interval of values of this function, to determine the proximity of a concrete alternative to the set of Pareto-optimal projects [10, 11].

The use of the apparatus of interval preferences for multi-criteria selection allows more flexible reflection in the decision-making procedure of the real conditions of project implementation [12].

It is natural to consider the creation of a system of indicators for making management decisions separately for each group of selection criteria corresponding to one of the highlighted aspects, and then develop a scheme for making a managerial decision based on a generalized indicator of the effectiveness of the project.

We will include in the group of economic criteria indicators of economic efficiency and competitiveness of the project. To better take into account the uncertainty of the external environment, we use an approach based on the calculation for each analyzed alternative of net discounted income, the discounted payback period, the internal rate of return [13].

Each of the selected indicators characterizes the efficiency of the investment project. However, each of them has features that allow a decision-maker to evaluate the project from various angles. It should be noted that the indicator of net present value is considered on the basis of cash flow accounting. In this case, the view of the business manager is reflected, for which it is important to have an idea of the available funds that can be allocated for investment. In the second case, the needs of the capital owner are taken into account, for which the effect is the profit to earn.

Following [11, 12], we will construct the intervals of fluctuations of the final indicator of economic efficiency on the basis of intervals of fluctuations of these particular criteria of economic efficiency of the investment project.

Let's designate $I = \{I_\alpha, \alpha = 1...n\}$ – as the set of variants of investment projects, $Э_1(I_\alpha) = [A_1(I_\alpha); B_1(I_\alpha)]$ – the received estimations of economic efficiency of investment projects in an interval.

Using the experts' estimates, we can construct interval indicators of the competitiveness of projects in the ranking scale $Э_2(I_\alpha) = [A_2(I_\alpha); B_2(I_\alpha)]$.

Obviously, the best values for the selected economic indicators will correspond to the best project.

We assign to the social group of criteria the level of employment and the life expectancy of the population. The level of employment is estimated as the ratio of the number of employed workers to the total number of able-bodied residents of the region.

Interval expression for this indicator is represented as $C_1(I_\alpha) = [D_1(I_\alpha); G_1(I_\alpha)]$.

The best project should be chosen according to the maximum value of this indicator.

The indicator of life expectancy in the region is set by the interval $C_2(I_\alpha) = [D_2(I_\alpha); G_2(I_\alpha)]$ for each project. Here, the choice also corresponds to the maximum value of the indicator.

The group of environmental indicators should be compiled from indicators of the risk of damage caused by projects to the environment. For example, depending on the direction of the project, the risk of spilling oil should be minimized or the risk of damage to the permafrost layer is to be minimized. These indicators will be evaluated by quantitative analysis methods, including statistical analysis, scenario building, expert assessments and approaches to simulation modeling [13].

The corresponding estimates can also be represented in the interval form: $ЭК_1(I_\alpha) = [E_1(I_\alpha); F_1(I_\alpha)]$ и $ЭК_2(I_\alpha) = [E_2(I_\alpha); F_2(I_\alpha)]$.

For each of the groups of indicators, we apply the comparison procedure for alternative projects based on the construction of interval preferences [10, 11, 12]. If different groups of indicators will be obtained the same ordering options (same tuples Pareto), the final choice corresponds to this tuple. Otherwise, the following scheme for decision making can be proposed.

Let, for example, think that as a result, three different Pareto tuples are obtained: $II_1=\{I_1,I_2,I_3\}$. $II_1=\{I_1,I_3,I_2\}$, $II_1=\{I_2,I_1,I_3\}$. We use the Saati method and construct a matrix of pairwise comparisons of the importance of different groups of exponents $L = \|l_{ij}\|_{i,j=1..3}$ [5].

We find the eigenvector of the matrix corresponding to the maximal eigenvalue, and normalize it. We denote the resulting vector by $V = \|v_i\|_{i=1..3}$.

Let express dominance of alternatives in the tuple Pareto scores from 1 to 3 and construct a generalized assessing the effectiveness projects OEi$_i$, i=1..3, taking into account the received indicators of their relative importance.

As a result, we get

$$ОЭ_1 = 3*v_1 + 3*v_2 + 2*v_3$$
$$ОЭ_2 = 2*v_1 + 1*v_2 + 3*v_3\ .$$
$$ОЭ_3 = 1*v_1 + 2*v_2 + 1*v_3$$

For example, for V^T = (0.5,0.3,0.2) we will have OE_1 = 2.8, OE_2 = 1.9, OE_3 = 1.3.

Therefore, the first project should be recognized as the best by preference.

IV. CONCLUSION

The described approach to the selection of strategic Arctic projects takes into account the existence of various interest groups inherent in a large socio-economic system, as well as the presence of uncertainty in the environment of its functioning. It corresponds to the real conditions for making strategic decisions.

The decision-making system is provided with the analytical tools that take into account the uncertainty of the external and internal environment of the economic system that is the object of management. This analytical approach creates the possibility of making optimal decisions for these conditions.

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