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Social Investing Modeling for Sustainable Development of the Russian Arctic

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Abstract: The method of the social investing of the Arctic subsoil users is considered in this article. As the portfolio of social investments is formed based on the interests of indigenous peoples, the authors used expert assessment and sociological research for social investing modeling. A two-stage procedure for forming a portfolio of such projects is proposed. An approach has also been developed for assessing and selecting investment projects for the Arctic sustainable development according to different criteria of optimality. The authors substantiate the need for a new approach to sustainable development of the Arctic, based not on compensation for the negative consequences of industrial development used in many countries, but on social investment. In this article the proposed approach is tested on the case of the Arctic indigenous community in Taimyr and the optimal social investing portfolio is justified.

Keywords: sustainable development; social and economic development; social investing; modeling; Arctic; Russia; indigenous communities

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1. Introduction

The Arctic Strategy of the Russian Federation until 2035 is devoted to ensuring national security and could be described as largely socially oriented taking into account the interests of the local population. The Arctic investment projects are associated with the construction of modern social facilities adapted for polar conditions, energy-efficient and environmentally friendly housing, the development of traditional industries of the North, the development of Arctic tourism, medicine, the preservation of cultural traditions, the indigenous peoples, and the construction of fiber optical communication lines along the Northern Sea Route and the Arctic rivers to eliminate the "digital inequality" problem and to provide high-quality Internet connection to the Arctic regions [1].

These projects are generally aimed at improving the quality of life, promoting employment, and creating new jobs, including for the indigenous population, developing local crafts, reducing poverty, and increasing the incomes of the population of the Arctic zone [2].

The accident with the diesel fuel spill at TPP-3 in Norilsk on 29 May 2020 revealed social problems associated with the relationship between the mining company and the indigenous population of Taimyr in terms of supporting traditional industries, developing social, transport, and environmental infrastructure, and preservation of the culture of indigenous peoples [3].

The pace of development of the Arctic regions is largely determined by the discovery of new northern deposits on land and on the shelf, the creation of sea transport routes. This process is accompanied by high risks economically, politically, environmentally, etc. [4].

Over the past few decades, to eliminate conflicts between the mining companies and the local population, a mechanism has been formed in the mining regions. It is based on the signing of agreements on interaction and socio-economic development of the territory between the mining company and the population of the region. Such approach ensures the normalization of the interaction of mining companies with the indigenous population [5]. The most common measures are monetary compensation for losses due to a decrease in the productivity of traditional nature use [6,7]. It can be agreed that this approach is consistent with the social orientation of mining companies [8,9]. The disadvantage of this approach is the lack of prospects for the socio-economic development of the region after the completion of mining operations.

Despite the fact that Norilsk Nickel has fully compensated for the environmental damage caused and compensated for the losses of the indigenous small peoples of the North and their tribal communities, there is a need to develop and implement special investment projects for the sustainable development of this territory. We are talking about the development of a new model of interaction between business and indigenous peoples; optimization of investment projects at the expense of the mining company in order to ensure the sustainable development of the Arctic, i.e., social modeling of sustainable development [10].

2. Materials and Methods

One of the problems of the economic development of the Arctic regions is a violation of the way of life, a change in the landscape, pollution of the environment, and other negative effects that cause protest moods of the indigenous population. Various compensation projects are proposed to prevent social conflicts [11]. In these conditions, it is important to justify and select socially significant investment projects, financed by the mining company, in the interests of the population.

In the context of assessing the consequences of the accident at a thermal power plant with a diesel fuel spill in Norilsk, it is important to assess the environmental consequences of energy facilities during the implementation of development projects in the Arctic regions in the East of Russia.

According to Saneev B. G., Maysyuk E. P., and Ivanova I. Yu., active industrial development of mineral deposits and the development of related energy facilities may affect greenhouse gas emissions. From this point of view, the ecological situation in the Arctic regions of Eastern Siberia, in particular, the territory of the Taimyr-Turukhan zone, can be characterized as unfavorable, especially due to emissions from the Norilsk industrial hub. Environmental improvement in these territories, where many indigenous peoples live and carry out their activities, is associated with the implementation of a number of environmental and climate-saving projects [12].

According to Vasil'tsov V.S., Yashalova N.N., and Novikov A.V., abnormal natural phenomena (floods, fires, melting of permafrost) caused by climatic changes in the Arctic zone of the country, as well as environmental risks caused by past economic activities in the form of accumulated objects of environmental damage, can have a significant impact on the development of coastal Arctic territories [13].

Similar problems are typical for other Arctic regions, for example, for Alaska (USA). [14]. Thus, modern research shows that social investment projects of mining companies, including in the Arctic zone, should take into account the problems of climate change and adaptation of economic activities to it, which significantly affect the interests and needs of the local population [15].

On the other hand, the Murmansk region in the Russian Arctic demonstrates the possibility of implementing the "green growth" concept in the processing of waste from mining companies using the experience of Norway [16].

According to A. Sleptsov and A. Petrova, the impact of possible negative consequences during the implementation of projects for the development of mineral resources should be identified and assessed as part of the procedure for ethnological examination of projects,

which involves assessing the impact of the planned activity on the ethnological environment of the indigenous small-numbered peoples of the North, on the ethnos, and on traditional crafts [17].

Based on the results of the ethnological examination of projects and the assessment and compensation of possible harm caused to the indigenous peoples of the North as a result of the impact of the project on the territory of traditional nature use, special compensation funds can be formed [18].

The socially oriented economic development of the region implies a choice among economically efficient and highly justified projects corresponding to the interests of the population. They will ensure the socio-economic development of the region in the long term. The mining company intends to allocate investments for the implementation of regional development projects in the interests of the indigenous population. The problem is that in these projects the interests of the three parties: the mining company is interested in a high degree of justification of the costs and results of the project; indigenous groups are interested in the degree to which the project meets the requirements put forward; and the regional administration is interested in the long-term economic development of the region through the implementation of the project.

For the mining company acting as an investor, it is necessary to assess the degree of projects' feasibility. Usually, when assessing the possibility and feasibility of investing in a project, an assessment of economic efficiency is assumed based on the discounted cash flow (DCF) methodology.

Currently, mining companies (for example, Norilsk Nickel) are ready to invest in socio-economic development projects in the event of a high degree of justification of the required costs and obtaining the expected results. For such an assessment, it is advisable, along with the criteria from the DCF methodology (the criterion of net present value NPV is usually used), it is proposed to use the assessment of the validity of the initial data and the required investments. To assess the validity of the initial data, it is advisable to use a point scale to assess the validity of the initial data:

- expert judgment, deterministic values of indicators-1 point;
- calculated justification, deterministic values of indicators-2 points;
- expert judgment, interval values of indicators-3 points;
- calculated justification or expert assessment, interval assessment indicating the expected value-4 points.

The investment feasibility scale takes into account possible methods: expert assessment by the initiative group (1 point), calculation based on analogs (2 points), and experts of consulting companies in the field of valuation (3 points).

In the case of insufficient economic, environmental, and social feasibility of the project, one cannot be sure of its successful implementation, therefore, such projects should be excluded from consideration.

For the *indigenous population*, it is necessary to assess the degree of satisfaction of their interests and needs in the implementation of regional development projects. The interests of the population are formed taking into account their mentality, the prevailing way of life, traditions, and features of traditional economic activity [19].

It is advisable to consider their attitude to the choice of projects through a system of criteria that are understandable and interesting to them. At the same time, the interests of the population are not homogeneous. They vary greatly depending on age, occupation, and gender. Therefore, it is advisable to divide the indigenous population into groups that will reveal different preferences. This allocation of groups depends on the specific region. In this paper, three age groups are identified: youth, middle age, and retirement age. Within the middle-aged group, the main types of their activities were identified as reindeer herders, hunters and fishermen, pickers of berries, mushrooms, medicinal plants, and individual entrepreneurs.

Regional development projects should be socially oriented, i.e., correspond to the interests of the target groups of the population. Ultimately, such projects for the local

population should be aimed at solving specific social problems (employment, increasing income, developing traditional crafts, and developing infrastructure, etc.) [20].

The assessment of the interests of the indigenous peoples must be taken into account and reflected using a system of criteria, including the promotion of employment (creation of new jobs or the share of the local population involved in the implementation of the project), income growth, and reduction of environmental pollution, etc. Projects under consideration for the development of the region to varying degrees meet the evaluation criteria, which makes it possible to take into account the interest of the local population in these projects.

Social projects proposed for implementation by the company should also take into account the issues of sustainable development of tribal communities of indigenous peoples, since tribal communities are currently the main form of organizing traditional environmental management and organizing the life of indigenous peoples in the Arctic [21].

For local government it is necessary to take into account the contribution of such projects to the socio-economic development of the region, i.e., such aspects of projects as the life cycle and their economic efficiency, sales of products to other regions, and infrastructure development, etc. Projects that meet the selection criteria from the perspective of a mining company acting as an investor form a starting set, from which it is necessary to form a portfolio of projects, taking into account the restrictions on the volume of investments, meeting the interests of the local population, and their contribution to the socio-economic development of the region. Unfortunately, until now, these issues have not been developed in the scientific literature and, in practice, lead to a conflict of interests between business and indigenous peoples in the industrial development of the [22]. The contribution of this article to the theory consists in the development of a mechanism for justifying and selecting social projects of mining companies to ensure sustainable development of the Arctic traditional lands.

The object of the research is the territory of the Taimyr Dolgan-Nenets municipal district of the Krasnoyarsk region. It was selected because of active industrial development of the area (Norilsk Nickel and the Northern Sea Route facilities), as well as because there are traditional lands. Norilsk is a city-forming complex of one of the world's largest mining plants. The main share of manufactured products in Norilsk falls on non-ferrous metallurgy. Additionally, great attention was paid to this place on 29 May 2020 in connection with an accident at TPP-3 in Norilsk. The authors were involved in the group working on the elimination of the consequences of oil pollution.

The research object is located beyond the Arctic Circle on the Taimyr Peninsula. The basin of the Pyasina River, which was damaged as a result of the diesel spill, is located within the Taimyr Dolgan-Nenets municipal district and the Norilsk urban district. Pyasina is one of the largest rivers in Russia with a length of 818 km; it flows into the Kara Sea.

The research area is located beyond the Arctic Circle on the Taimyr Peninsula. The administrative center is Dudinka with a population of 73,986 people or 7.9% of the total population of the Krasnoyarsk region. The distance from Dudinka to Krasnoyarsk is 2028 km. The area of the district is 879,929 km^2 (37.17% of the area of the Krasnoyarsk region). In total, 98.3% of the local population is concentrated in Dudinka and the urban-type settlement Dikson. Other rural areas are Khatanga and Karaul (Figure 1).

Figure 1. Taimyr Dolgan-Nenets Municipal District in the Russian Arctic.

In the east, the region borders with the Republic of Sakha (Yakutia), in the west with the Yamalo-Nenets Autonomous Okrug, in the south with the Evenki municipal district of the Krasnoyarsk region, and in the north it is washed by the waters of the Kara Sea and the Laptev Sea. The region includes the Arctic archipelagos of Nordenskjold and Severnaya Zemlya, and the islands of Sibiryakov, Uedineniya, and Sergei Kirov, etc. The territory of the municipal region is the traditional lands of Dolgans, Nenets, Nganasans, Entsy, and Evenki. The highest rate of employment belongs to the industrial sector. The indigenous peoples number 10,132 or 29.5% of the local population among them: Dolgans 5393, Nenets 3494, Nganasans 747, Evenks 266, Enets 204, Kets 19, and Selkups 9. On 29 May 2020, an accident occurred with a diesel spill at CHP in Norilsk. It showed the social problems associated with the relationship between the mining company and the indigenous population of Taimyr in the field of supporting traditional crafts, developing social, transport, and environmental infrastructure, and preserving the indigenous [23].

Norilsk Nickel has fully compensated for the environmental damage, the losses to the indigenous peoples and their tribal communities. However, it is necessary to implement special investment projects for the sustainable development of this territory. In fact, we are talking about the development of a new model of interaction between business and indigenous peoples; optimization of investment projects at the expense of the mining company to ensure sustainable development of the Arctic.

Reindeer husbandry, hunting, and fishing are traditional economic activities of the indigenous peoples. Fishing is one of the main types of traditional economic activities of indigenous peoples. In the Pyasina basin, small indigenous peoples live in the village of Ust-Avam. The total number of indigenous peoples in this settlement is about 500 people, or more than 90% of its resident population. Dolgans and Nganasans prevail among the indigenous peoples of this basin, the number of Nenets and Evenks is stable. In the

composition of the indigenous small-numbered in the North of the Pyasina basin, the Dolgans make up 54.9%, the Nganasans 44.7%, the Nenets 0.2%, and the Evenks 0.2%.

The production and sale of reindeer products, reindeer meat and offal in the amount of more than 0.3 thousand tons per year is carried out by agricultural enterprises and tribal communities. Furthermore, meat is produced at the Norilsk meat processing for import. The agricultural land in the Pyasina basin is represented by reindeer pastures, with a total area of 9,998,649 ha, or 46.1% of the total area of the basin [24].

The Norilsk-Taimyr Energy Company, which is a part of Norilsk Nickel, paid compensation to indigenous peoples affected by the fuel spill in 2020. In addition, the company also carries out other measures to support the indigenous peoples and their traditional crafts, including new jobs, new industries, land reclamation, and culture preservation. Over the next five years, the company will implement programs to support the indigenous peoples totaling more than USD 31 million.

The perspectives of the Taimyr development include:

- development of the Norilsk industrial region, specializing in the extraction and processing of non-ferrous and platinum group metals;
- development of the Zapolyarnaya mine;
- development of an oil and mineral resource center on the basis of the Western Taimyr field, focused on the export of products along the Northern Sea Route;
- creation of the West Taimyr coal-mining cluster, focused on the export of products along the Northern Sea Route;
- development of the Popigai diamond deposits;
- development of the resources of the Taimyr-Severozemelskaya diamondiferous province;
- development of the seaports of Dikson and Dudinka, modernization of the airport network in the region, including the Khatanga airport;
- development of the Arctic tourist and recreational cluster in the region.

The modern pace of the Arctic development is determined by the depletion of old mineral deposits, the discovery of new northern deposits on land and on the shelf, and the creation of new sea transport routes. This process is accompanied by high risks economically, politically, and environmentally, etc. One of the problems of the Arctic economic development is the disruption of the way of life, landscape degradation, environmental pollution, and other negative effects that cause protest moods of the indigenous population. Various compensation projects are proposed to prevent social conflicts. Currently, this approach is practiced in many countries and regions, although experts recognize it as outdated, since it is not focused on the future sustainable development of the region. Much more attractive is the investment of mining companies in socio-economic projects that ensure sustainable development of the region in the long term. In these conditions, it is important to justify and to select socially significant investment projects, financed by the mining company, in the interests of the indigenous people [25].

The socially oriented economic development of the region presupposes a choice among economically efficient and highly justified projects. The problem is tripartite interests:

- the mining company is interested in a high degree of justification of the costs and results of the project;
- indigenous peoples are interested in the degree of satisfaction of the project according to their requirements;
- the regional administration is interested in the long-term economic development of the region through the implementation of the project.

The assessment of the interests of the indigenous population must be taken into account and should be reflected using a system of criteria, including the promotion of employment (creation of new jobs or the share of the local population involved in the implementation of the project), income growth, and reduction of environmental pollution, etc. [26].

For problem-solving posed in the article (forming a portfolio of socially oriented investment projects for the Arctic development), we used the following methods:

- to assess the preferences–the methods of multi-criteria ranking;
- to assess the economic efficiency of projects–the methods of financial mathematics;
- to take into account interval estimates of indicators–the methods of fuzzy mathematics;
- for the formation of an optimal set of the projects based on funding limitation–the methods of linear programming with Boolean variables [27].

3. Results

The social modeling will be realized through several stages.

Stage 1. Assessment of the feasibility and effectiveness of the project.

The result of this stage is an assessment of the degree of feasibility of the project $j = 1, 2, ..n$. This assessment is based on three criteria: h_{1j}—criterion of validity of initial data for project evaluation j, measured in points from 1 to 4; h_{2j}—criterion for assessing the effectiveness of the project j using the indicator NPV measured in million Euros [28]; h_{3j}—the criterion for assessing the feasibility of investments required for the implementation of the project j is measured in points from 1 to 3.

A corresponding calculation h_{2j} is carried out (as an estimate of net present value in deterministic form, based on an interval estimate or an interval estimate with an expected value) according to the Formulas (1)–(3):

$$h_{2j} = \sum_{t=1}^{T} (P_{jt} - Z_{jt})(1+r)^{1-t} \quad (1)$$

$$h_{2j} = 0.5\left[\sum_{t=1}^{T}\left(P_{jt}^{\max} - Z_{jt}^{\min}\right)(1+r)^{1-t} + \sum_{t=1}^{T}\left(P_{jt}^{\min} - Z_{jt}^{\max}\right)(1+r)^{1-t}\right] \quad (2)$$

$$h_{2j} = 0.25\left[\sum_{t=1}^{T}\left(P_{jt}^{\max} - Z_{jt}^{\min}\right)(1+r)^{1-t} + 2\sum_{t=1}^{T}\left(P_{jt}^{av} - Z_{jt}^{av}\right)(1+r)^{1-t} + \sum_{t=1}^{T}\left(P_{jt}^{\min} - Z_{jt}^{\max}\right)(1+r)^{1-t}\right] \quad (3)$$

where P_{jt}, $\left(P_{jt}^{min_{jt}^{max}}\right)$, $\left(P_{jt}^{min_{jt\ jt}^{av\ max}}\right)$—cost estimate of the result for different options for the validity of the initial data of the project implementation j in year t, m. Euro;

Z_{jt}, $\left(Z_{jt}^{min_{jt}^{max}}\right)$, $\left(Z_{jt}^{min_{jt\ jt}^{av\ max}}\right)$—cost estimate of required investments for different options for project implementation j in year t, m. Euro;

T—implementation period (life cycle) of the project, years;

r—discount rate.

Since the projects can be exclusively financially attractive business projects ($l = 1$), are aimed at environment protection and climate change prevention (environment or climate projects-$l = 2l = 2$), or preservation of both cultural and historical heritage (restoration projects etc.-$l = 3$), for each project j the type of the project tip_j must be marked. Such type takes values from 1 to 3. For different types of projects, the weight of the criteria will be different (Table 1). For example, the efficiency is extremely important for business projects, less important for environmental projects, and is not essential for restoration or conservation projects.

Table 1. Weights of the validity criteria λ_{kl} for different types of projects *.

Criteria for the Feasibility of Projects, k	Types of Projects, l		
	Business Projects, l = 1	Environmental Projects, l = 2	Restoration Projects, l = 3
Validity of the original data, $k = 1$	1	1	1
Efficiency mark, $k = 2$	1	0.7	0
Justification of investment, $k = 3$	1	1	1

* The table shows the weighting coefficients of the criteria proposed by the authors during field work in the Taimyr Dolgan-Nenets municipal district of the Krasnoyarsk region-a part of the Russian Arctic. Changing the values of the weights will not affect the developed calculation method.

Currently, the determination of ratings (priorities, weights) of the analyzed objects using several criteria is a very important and demanded task [29,30].

Based on the presented data, it is proposed to assess the feasibility of implementing projects of paired comparison methods according to the formula:

$$\rho_j = \sum_{\substack{s=1 \\ s \neq j}}^{n} \sum_{k=1}^{3} \lambda_{kl} \frac{h_{kj}}{h_{kj} + h_{ks}},\ j = 1, 2, ..n \tag{4}$$

where s is a number of the project, compared to the project j;

$l = tip_j$—identification of the project type j (business projects, environmental projects, cultural projects).

The normalized assessment of the feasibility of projects is determined by the formula:

$$\hat{\rho}_j = \frac{\rho_j}{\max\limits_j (\rho_j)},\ j = 1, 2, ..n \tag{5}$$

If such a normalized assessment of the feasibility of the project is below the threshold value, then the mining company does not consider this project for possible financing. In practical calculations, the threshold value based on the principle of simple majority was set equal to 0.5.

Stage 2. Assessment of meeting the indigenous peoples' requirements during project implementation.

Such expertise is made during impact assessment and special round tables with the participation of local government, business, indigenous peoples and their tribal communities, and civil society organizations [31].

To solve this problem it is advisable to use J. Leung's method. When carrying out such an examination, data are collected on the preferences of indigenous groups of the system of criteria reflecting the results of the implementation of projects for the economic development of the region (Figure 2). As a result, a matrix R of assessments of the interests of population in the criteria for project results will be obtained. A special expert commission evaluates the achievement of the criteria and results of the projects under consideration. This makes it possible to obtain a matrix S of the degree of achievement of these criteria.

Based on these matrices, it is necessary to find a matrix T for assessing the degree of interest of population in projects by the formula:

$$T_{ij} = \frac{\sum_{e=1}^{E} R_{ej} S_{ei}}{\sum_{e=1}^{E} R_{ej}},\ j = 1, 2, \ldots n;\ i = 1, 2, \ldots m \tag{6}$$

Then, a matrix W of the intersection of project preferences by population groups is formed on the basis of enumerating all project options in pairs:

$$W_{ig} = min\{T_{ij}, T_{ik}\};\ j, k = 1, 2, \ldots n;\ k \neq j; i = 1, 2, \ldots m;\ g\text{–serialnumber} \tag{7}$$

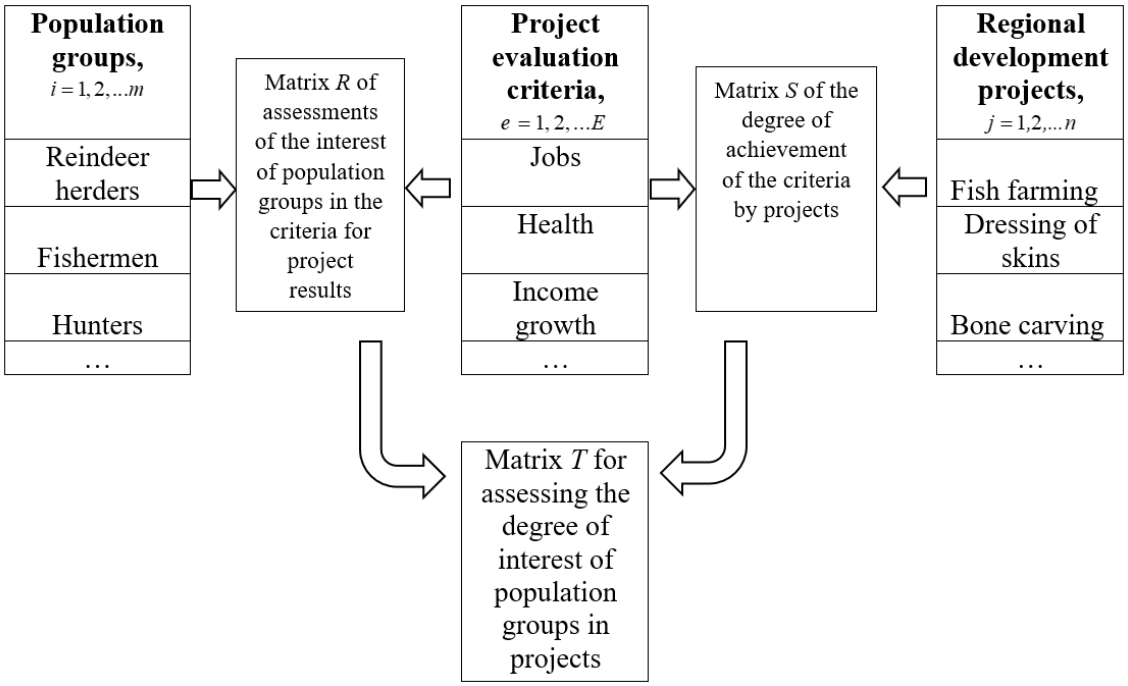

Figure 2. Scheme for the formation of assessments by the local population of projects of sustainable development of the region.

The threshold value π for abandoning the project is determined by the formula:

$$\pi = max\left[T_{ij}\middle|T_{ij} < \min_{g}\max_{i=1,2...m}\left(W_{ig}\right)\right], \tag{8}$$

The matrix for assessing the degree of interest of population groups in projects, taking into account the rejection of those projects for which the value of preference is below the threshold value, is found by the formula:

$$\widetilde{T}_{ij} = \begin{cases} T_{ij}, & \text{если} \quad T_{ij} \geq \pi \\ 0, & \text{если} \quad T_{ij} < \pi \end{cases}, \; j = 1, 2, \ldots n; \; i = 1, 2, \ldots m \tag{9}$$

Based on the matrix $\widetilde{T}_{ij}$, an assessment of the interest of individual groups of the population in the implementation of all analyzed projects α_i and the priority of projects for the population as a whole β_j are determined according to the Formulas (9) and (10).

$$\alpha_i = \sum_{j=1}^{n} \widetilde{T}_{ij} \tag{10}$$

$$\beta_j = \left(\sum_{i=1}^{m} \widetilde{T}_{ij}\right)\left[\max_{j=1,2,...n}\left(\sum_{i=1}^{m} \widetilde{T}_{ij}\right)\right]^{-1}, \; j = 1, 2, \ldots n \tag{11}$$

Stage 3. Assessment of the project's contribution to the economic development of the region.

The result of this stage is an assessment of the contribution to the regional economic development of the project $j = 1, 2, ..n$. The system of criteria used at this stage should give an idea of the duration of the project d_{1j}, its economic efficiency d_{2j}, and also reflect the specifics of this project. In the study, the criteria for the growth of the Arctic tourism potential of the territory under consideration d_{3j} were used and sales of manufactured products to other regions of the country d_{4j}.

The criterion for the duration of a project is measured by its life cycle in years; project performance criterion (based on NPV, reviewed at stage 1 and measured in million Euros); the criterion for the growth of the Arctic tourist potential of the territory is estimated in unit fractions; the criterion of sales of manufactured products to other regions is measured by a binary sign (1-there is sales to other regions or 0-otherwise). Since different types of projects are aimed at solving various social, economic, environmental, and climatic problems, then by using weighting factors it is possible to solve the problem of comparative comparison of the projects under consideration (Table 2).

Table 2. Weights of the criteria μ_{vl} for the contribution to the development of the region for different types of the projects *.

Criteria for the Contribution of Projects to the Development of the Region, v	**Types of Projects, l**		
	Business Projects, l = 1	**Environmental or Climate Projects, l = 2**	**Projects for the Preservation of Cultural Heritage and Ethnos (Cultural Projects), l = 3**
The duration of the project, $v = 1$	0.30303	0	0
Efficiency assessment, $v = 2$	0.30303	0.333333	0
Growth of the Arctic tourism potential of the region, $v = 3$	0.09091	0.666667	1
Sales of manufactured products to other regions, $v = 4$	0.30303	0	0

* The table shows the weighting coefficients of the criteria proposed by the authors during field work in Taimyr Dolgan-Nenets municipal district of the Krasnoyarsk Territory, a part of the Russian Arctic. Changing the values of the weights will not affect the developed calculation method.

Based on the data presented, it is proposed to assess the contribution of each project to the sustainable development of the region using the method of paired comparisons according to the formula:

$$\omega_j = \sum_{\substack{s=1 \\ s \neq j}}^{n} \sum_{v=1}^{4} \mu_{vl} \frac{d_{vj}}{d_{vj} + d_{vs}} \quad (12)$$

where s—number of the project, compared to the project j;

$l = tip_j$—identification of the project type j (business projects, environmental, cultural projects). The normalized assessment of the contribution of projects to the development of the region is determined by the formula:

$$\hat{\omega}_j = \frac{\omega_j}{\max\limits_j(\omega_j)}, \; j = 1, 2, ..n \quad (13)$$

Stage 4. Formation of a portfolio of socio-economic projects for the regional development.

As a result of the implementation of stage 4, an optimal portfolio of projects for the economic development of the region will be obtained. It will satisfy two criteria:

$f_1(x)$—maximizing the total priority of projects for the population of the region;

$f_2(x)$—maximizing the total contribution of projects to the sustainable development of the region.

The formation of a portfolio of projects is carried out from that part of projects $j \in J$ for which the assessment of the feasibility of the project is higher than the a priori specified threshold value (at stage 1). At the same time, the choice of projects should be carried out taking into account two types of restrictions: restrictions on the amount of funding

and restrictions on achieving the interests of the population in the context of its individual groups [32].

To solve this problem, it is necessary to form a mathematical model. Formalized presentation of the two previously mentioned criteria:

$$f_1(x) = \sum_{j \in J} \beta_j x_j \to max \tag{14}$$

$$f_2(x) = \sum_{j \in J} \hat{\omega}_j x_j \to max \tag{15}$$

where x_j—the desired variable, which takes the value 1 if the project is included in the formed portfolio, or 0 otherwise.

The limitation on the maximum amount of funds allocated by the mining company for the formation of an optimal portfolio of projects is as follows:

$$\sum_{j \in J} z_j x_j \leq B \tag{16}$$

where B—the volume of financing for projects of regional economic development;

z_j—costs required to implement the project j.

In addition, in order to achieve the interests of population groups $i = 1, 2, \ldots m$ with a given level γ, measured in fractions of a unit, the system of restrictions should be taken into account:

$$\sum_{j \in J} \widetilde{T}_{ij} x_j \geq \alpha_i \gamma, \; i = 1, 2, \ldots m \tag{17}$$

The level of achievement of the interests of population groups γ is determined at the meetings of indigenous peoples. In practical calculations, the threshold value was taken at the level of 0.5.

The resulting model has two optimality criteria (14) and (15), therefore, the maximum values of each criterion should be found by solving two problems: (14)–(17) and (15)–(17). As a result of solving these problems, the local maximum values of the optimized criteria are determined f_1^* и f_2^* [33]. These values make it possible to represent the model (14)–(17) with an optimality criterion that minimizes deviations from local maximum values:

$$f_{1,2}(x) = max \left[\frac{f_1^* - \sum_{j \in J} \beta_j x_j}{f_1^*}, \frac{f_2^* - \sum_{j \in J} \hat{\omega}_j x_j}{f_2^*} \right] \to min \tag{18}$$

As a result, the model (16)–(18) will make it possible to find a compromise solution for both optimality criteria, i.e., deviations from local maximum values for each of the criteria will be minimized and a compromise will be reached between meeting the interests of the population and the contribution of projects to the economic development of the region. The found projects will make it possible to form a portfolio of socially oriented economic developments of the region.

4. Discussion

To substantiate and to select socially oriented projects for the development of Taimyr with the participation of a mining company, six groups were identified as part of the indigenous population:

(1) Reindeer herders.
(2) Fishermen.
(3) Hunters.
(4) Procurers of berries, mushrooms, and medicinal plants.
(5) Entrepreneurs in tourism, traditional crafts, and production of souvenirs.
(6) Public sector employees (school, hospital, local government, etc.).

Table 3 presents a set of investment projects for the sustainable development of Taimyr, which was formed on the basis of field research and sociological surveys of the population.

Table 3. Projects identified as a result of trilateral negotiations involving indigenous peoples, business, and government.

Number of Projects	Project	Type of the Project	Life Cycle, Years
1	Fish farms	Economic	15
2	Processing of deer and wild animal skins, development of crafts, bone carving (tusks of walrus, mammoths)	Economic	10
3	Protection of the Nenets ethnic settlement "Tyakha" ("Deer River")	Social	10
4	Deep processing of fish, meat	Economic	15
5	Reclamation of disturbed lands as a result of the activities of the mining company	Environmental	2
6	Reducing environmental pollution from mining	Environmental	12
7	Strengthening the riverbank near the pagan altar	Restoration	15
8	Creation of reindeer passes through oil and gas pipelines	Environmental	1
9	Construction and operation of a business center for tourism development	Social	15
10	Restoration and preservation of monuments and cultural heritage sites	Restoration	15

Stage 1. In Table A1 shows the results of the analysis of the feasibility of the proposed projects ρ_j. The assessment of the feasibility of the projects' implementation is determined by the method of paired comparisons according to the Formula (4). The last line of Table A1 shows a normalized assessment of the feasibility of the proposed projects according to the Formula (5).

For the threshold value of validity of 0.5 adopted in the calculations, project 10 is excluded from consideration, since it turned out to be insufficiently justified. This project can be included for consideration again if its results and required implementation costs are estimated more correctly.

Stage 2. To assess the interest of the indigenous population of Taimyr in the implementation of projects, the information obtained in the process of impact assessment is used (Table A2).

To assess the interest of population groups, five criteria were used: employment, population health, income growth, preservation of cultural and historical heritage, and language, and environmental protection and climate preservation.

The results of the analysis of the degree of satisfaction of projects with the criteria used are presented in Table A3.

As a result of calculations using Formulas (6)–(11), assessment of the interest of population groups in the implementation of projects were determined (Table A4).

The last column and the last line of the Table A4 shows the indicators that are used in the formation of a numerical model for the formation of an optimal portfolio of regional development projects.

Stage 3. When assessing the contribution of projects to the regional development, four criteria were used: the duration of the project, its economic efficiency, the Arctic tourism potential increasing of the region, and the expected sales of products to other regions. The values of the first criterion are taken from the technical and economic description of the project and the quantitative assessment of the second criterion was carried out at the first stage of calculations. The third and fourth criteria are determined by experts. The weight

coefficients of the criteria for the contribution to the development of the region for different types of projects are given in Table 2. The calculation of the assessment of the contribution of projects to the development of the region (Table A5) is carried out according to the Formulas (12) and (13).

Stage 4. To form an optimal portfolio of projects, the information obtained in the previous stages should be used. Since at the first stage the tenth project was recognized as insufficiently substantiated, the portfolio is formed of the first nine projects. Let us consider the formation of a numerical model (14)–(17) sequentially.

The criterion for maximizing the total priority of projects for the population of the region is formed on the basis of the last row of Table A4:

$$f_1(x) = 0.18x_1 + 0.07x_2 + 0.05x_3 + \ldots + 0.73x_9 \rightarrow max$$

To construct a criterion for maximizing the total contribution of projects to the sustainable development of the region, the coefficients should be taken from the last row of the Table A5:

$$f_2(x) = 1.00x_1 + 0.83x_2 + 0.98x_3 + \ldots + 0.20x_9 \rightarrow max$$

The first investment limitation is formed on the basis of the costs required for the implementation of each of the projects and the volume of investments allocated by the mining company. The costs z_i of project implementation are taken from their feasibility study, and the volume of investments B—from the option proposed by the mining company to ensure the implementation of projects for the sustainable development of the region. Below is the limitation with the parameters used from these sources:

$$80.00x_1 + 65.00x_2 + 80.00x_3 + \ldots + 120.00x_9 \leq 230$$

Restrictions on meeting the interests of certain groups of the population are based on estimates $\widetilde{T}_{ij}$ from Table A4. On the right side of the inequalities are the total estimates from the last column of the Table A4. They are adjusted for the level of achievement of the interests of social groups γ, which was determined at the general meeting of active representatives of the indigenous population, equal to 0.5. As a result, we get a system regulating the satisfaction of the interests of indigenous groups (17) at the level of 50%.

Optimizing for each of the two criteria separately within the framework of the formed constraints, we obtain the local optimal values of the criteria:

$$f_1^*(x) = 2.89 \text{ and } f_2^*(x) = 3.18.$$

To form a criterion that makes it possible to achieve a fair compromise between the criteria used, we use Formula (18). As a result, a portfolio of investment projects was formed, as shown in Table 4.

It can be seen from this table that local solutions according to the criteria for maximizing the total priority of projects and maximizing the total contribution of projects to the economic development of the region largely coincide (projects 4–7 are selected in both cases), but according to the first criterion, project 8 is additionally selected, while the second, project 1. When searching for a compromise solution, projects 1, 8, and 4–6 are selected.

This ensures the minimum deviation from the local optimal values of the criteria $f_1^*(x)$ and $f_2^*(x)$. The compromise solution found satisfies both the interests of the indigenous peoples and provides the best contribution to the development of the region. The calculation results were implemented in practice in the Taimyr Dolgano-Nenets District of the Krasnoyarsk region to substantiate projects for the sustainable development of the territory and optimize the use of the mining company's funds, taking into account the interests and priorities of the local population.

Table 4. Formation of the optimal portfolio of investment projects for the sustainable development of the region.

Project	Local Optimization by Criterion		Compromise Solution $f_{1,2}(x)$-Optimal Portfolio of Projects
	$f_1(x)$	$f_2(x)$	
Fish farms	0	1	1
Processing of deer and wild animal skins, development of crafts, bone carving (tusks of walrus, mammoths)	0	0	0
Protection of the Nenets ethnic settlement "Tyakha" ("Deer River")	0	0	0
Deep processing of fish, meat	1	1	1
Reclamation of disturbed lands as a result of the activities of the mining company	1	1	1
Reducing environmental pollution from mining	1	1	1
Strengthening the riverbank near the pagan altar	1	1	0
Creation of reindeer passes through oil and gas pipelines	1	0	1
Construction and operation of a business center for tourism development	0	0	0

5. Conclusions

The implementation of the Strategy for the Development of the Russian Arctic in the future involves the implementation of a number of investment projects for the development of this territory. Such projects should have a social orientation and take into account the interests of the local population, which is associated with the construction of modern social facilities adapted for polar conditions, energy-efficient and environmentally friendly housing, the development of traditional economy, the development of Arctic tourism, and the preservation of cultural traditions and the ethnic group of the peoples of the North, etc. Ultimately, the industrial development of the Arctic should be aimed at improving quality of life, promoting employment and creating new jobs (including for the indigenous peoples), local economic development, reducing poverty, and increasing the incomes of the Arctic population.

The approach practiced in many Arctic countries, which is mainly related to compensation for harm caused to indigenous peoples in places of traditional nature management, does not seem to be effective enough. In order to harmonize the interests of business and indigenous peoples, an approach to social investment of mining companies in sustainable development projects of the Arctic territories is substantiated on the case of Norilsk Nickel. To assess the effectiveness and select socially significant projects for the economic development of the Arctic region into the investment portfolio, it is proposed to take into account the contribution of such projects to the sustainable development of the region along with the criteria for discounted cash flows (DCF), i.e., such aspects of projects as the life cycle and their economic efficiency, product sales to other regions, and infrastructure development, etc.

The proposed approach was implemented to harmonize relations between business (Norilsk Nickel) and the indigenous peoples in the Taimyr Dolgano-Nenets municipal district of the Krasnoyarsk region. As a result, the optimal portfolio of socially significant projects for the development of the territory was substantiated. This approach can be implemented in other Arctic countries and regions to model the interaction between business and the indigenous peoples in order to ensure sustainable development of the territory, preserve the traditional lands, support the development of traditional nature management,

and preserve culture and traditions. As part of the study, a set of investment projects implemented by a mining company in the interests of the indigenous population was substantiated, as well as a classification of such projects by type (economic, environmental, social, and restoration) and the timing of their implementation (by the life cycle of projects).

For example, projects for the artificial breeding of fish, the processing of skins of wild animals, the processing of mammoth tusks, and the processing of fish and meat are considered economic projects. Reclamation of disturbed lands and reduction of environmental pollution during mining are related to environmental projects, preservation of cultural monuments to restoration projects, and protection and equipment of reindeer camps to social projects.

The paper substantiates the options for Arctic projects in terms of such indicators as the availability of initial data, efficiency assessment (NPV), the feasibility of attracted investments, and the feasibility of implementing projects.

To assess the interest of the indigenous population of Taimyr for target groups of the population (reindeer herders, fishermen, hunters, etc.), projects were assessed based on such criteria as creating jobs, ensuring health and increasing incomes of the local population, preserving the ethnic group and cultural heritage of indigenous peoples, and protecting the environment and climate change problem-solving.

For each type of project, an assessment was made of the degree of their influence on the socio-economic development of Taimyr, and the degree of interest of the local population in the implementation of these projects was determined.

Ultimately, an optimal portfolio of investment projects was formulated that meet the requirements of the considered criteria and are aimed at sustainable development of the area under consideration.

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Appendix A

Table A1. Analysis of the feasibility of the proposed Arctic projects.

Indicators	Metric Values for Projects									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Validity of the original data	1	2	2	4	4	4	2	2	4	1
Efficiency assessment (NPV), million euros	203.7	97.2	65.9	13.7	100.4	15.1	0.0	0.0	0.0	0.0
Justification of investment	2	3	3	3	2	2	3	2	3	1
Assessment of the feasibility of project ρ_j implementation	13.9	15.6	15.1	14.9	16.9	14.7	11.9	10.9	13.4	7.7
Normalized assessment of the feasibility of project $\hat{\rho}_j$ implementation	0.83	0.92	0.90	0.89	1.00	0.87	0.70	0.65	0.80	0.46

Table A2. Assessment of the interest of the indigenous population of Taimyr in the implementation of projects.

Social Groups	Criteria Importance Assessment				
	Employment	**Population Health**	**Income Growth**	**Preservation of Cultural and Historical Heritage**	**Environmental Protection and Climate Preservation**
Reindeer herders	0	1	0.8	0.8	1
Fishermen	0	1	0.8	1	1
Hunters	0	0.7	0.2	0.8	1
Procurers of berries, mushrooms, herbs	0.35	0.8	0.5	0.8	1
Entrepreneurs (tourism, traditional crafts, production of souvenirs, traditional clothes, shoes)	0	1	0	1	1
Public sector employees (school, hospital, local government)	1	1	1	0.3	0.5

Note: to assess the importance of the criteria, the results of sociological surveys of the local population were used.

Table A3. Degree of satisfaction of sustainable development projects to the criteria.

Number of Projects	Assessment of the Degree of Achievement of the Criteria				
	Employment	**Population Health**	**Income Growth**	**Preservation of Cultural and Historical Heritage**	**Environmental Protection and Climate Preservation**
1	0.4	0	0.3	0	0
2	0.2	0	0.2	0	0
3	0.1	0	0.2	0	0
4	0.4	0	0.4	0	0
5	0.1	0.3	0	0.1	0.6
6	0.1	0.4	0	0.2	0.8
7	0.1	0	0	0.7	0
8	0	0	0.1	0	0.6
9	0	1	0	0	0
10	0	0	0	1	0.1

Table A4. Assessment of the interest of the local population in the implementation of projects.

Social Group i	Assessment of Public Interest in Project Implementation ($\tilde{T}_{ij}$, j = 1, 2,..n)										Assessment of the Interest of Social Groups in the Implementation of All Projects α_i
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Reindeer herders	0.18	0.00	0.00	0.24	0.72	1.00	0.41	0.50	0.74	0.66	4.44
Fishermen	0.00	0.00	0,00	0.23	0.71	1.00	0.50	0.49	0.71	0.79	4.43
Hunters	0.00	0.00	0.00	0.00	0.72	1.00	0.45	0.50	0.56	0.73	3.96
Procurers of berries, mushrooms, herbs	0.22	0.00	0.00	0.26	0.73	1.00	0.45	0.49	0.61	0.68	4.44
Entrepreneurs (tourism, traditional crafts, production of souvenirs, traditional clothes, shoes)	0.00	0.00	0.00	0.00	0.71	1.00	0.50	0.43	0.71	0.79	4.14
Public sector employees (school, hospital, local government)	0.70	0.40	0.30	0.80	0.73	0.96	0.31	0.40	1.00	0.35	5.95
Priority of projects for the population β_j	0.18	0.07	0.05	0.26	0.73	1.00	0.44	0.47	0.73	0.67	-

Table A5. Assessment of the contribution of projects to the sustainable development of the region.

Criteria	Quantification for Projects j = 1, 2,..n									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Project duration, years	15	10	10	15	2	12	15	1	15	15
Economic efficiency of the project (NPV), million euros	203.7	97.2	65.9	13.7	100.4	15.1	0.0	0.0	0.0	0.0
Tourism potential increasing of the region, share	0.1	0.2	0.3	0	0.4	0.4	0.7	0.5	0	0.8
Expected sales of products to other regions (1-yes, 0-no)	1	0	1	0	0	0	0	0	0	0
Assessment of the contribution of each project to the economic development of the region, ω_j	32.15	26.66	31.63	23.56	18.50	15.50	12.50	9.50	6.50	3.50
Normalized assessment of the contribution of projects to the regional development, $\hat{\omega}_j$	1.00	0.83	0.98	0.73	0.58	0.48	0.39	0.30	0.20	0.11

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