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SPATIAL FEATURES OF SECTORAL DEVELOPMENT

Large-Scale Interregional Railway Projects: Assessing the Comparative Efficiency of Alternatives

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Abstract—The article analyzes options for large-scale railway projects: the Barents Sea–Komi–Ural rail line (Barentskomur) and the North Siberian Railway (Severosib). The feasibility of constructing these projects has been discussed for almost a century. The uncertainty of the results of these latitudinal megaprojects and the costs of their implementation is of strategic importance for Russia. In the long term, the results of these megaprojects may have mixed effects on public performance. In existing methods, uncertainty is associated with a particular degree of risk. To justify the designs, sets of measures are proposed that minimize risks (of a probabilistic and non-probabilistic nature). This article presents an alternative approach when the uncertainty factor is analyzed constructively, in terms of future opportunities. To solve the problems that arise here, the tools of neosystems analysis according to Ya. Kornai and G.B. Kleiner, understood as design of a multidimensional future using a holistic system for assessing large-scale projects with the support of information and expert technologies. It is shown how a set of Russian software products developed at Institute of Economics and Industrial Engineering, Siberian Branch, Russian Academy of Sciences and the Siberian State Transport University is expanding the capabilities of expert technologies in developing recommendations for people making complex investment decisions under conditions of risk and uncertainty.

Keywords: interregional large-scale projects, Barentskomur, Severosib, uncertainty, social performance, objective tree, evaluation structure, decision theory criteria, software products

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INTRODUCTION

Interregional large-scale railway projects are extraterritorial; the facilities under construction are located partly in northern of European Russia and partly in Asian Russia. The article analyzes two such projects: *the Barents Sea–Komi–Ural* (*Barentskomur*) *rail line* and *the North Siberian Railway* (*Severosib*). Discussion of the feasibility of their construction began in the last century and has continued in the present, while in the new geopolitical situation of Russia's confrontation with the collective West, in our opinion, it has acquired particular relevance. The uncertainty of the results and costs for both projects plays a strategic role and in the long term may have an ambiguous impact on their social efficiency. In existing methods, uncertainty is associated with a particular degree of risk. To justify the designs, sets of measures are proposed that minimize risks (of a probabilistic and non-probabilistic nature). This article presents an alternative approach when the uncertainty factor is analyzed constructively, in terms of future opportunitie.

HISTORICAL REFERENCE

The literature on this issue comprises dozens of publications. A simple list of sources would not leave enough room for the contents of this article. Therefore, a retrospective of projects that interest us will be constructed from two fundamental publications (Lamin, 1996; Suslov, 2008). Other primary sources on the topic are mentioned by reference, to clarify some important details not reflected in the basic publications.

Let us begin with Severosib and the fundamental publication (Suslov, 2008), which systematically covers the history of this project. Interest in the construction of railways in Siberia and the Far East was manifested in prerevolutionary Russia since the 1830s, and after the defeat in the Crimean War of 1853–1856, it became more specific. By the early 1980s, after 100 years of discussion of design plans, three latitudinal options for railway lines crossing Asian Russia from the Urals to the Pacific coast were identified.

The *"polar" option* provided access to the northern ports of Murmansk and Arkhangelsk and at the same time support for a difficult segment of the Northern Sea Route. In Western Siberia, the railway passed through the lower reaches of the Ob River to the lower or middle reaches of the Yenisey River, thence through Yakutsk to the coast of the Sea of Okhotsk.

In the *"northern" option*, as well as in the polar, the railway began in northern ports, passed through the established trading centers of Tobolsk (Surgut), Tomsk, Yeniseysk, and Kirensk, and ended passing through southern Yakutia through gold-bearing areas, at the mouth of the Amur or at another convenient point for future shipping on the coast of the Strait of Tartary. The problem of this option was understood as development of the riches of the Russian Near North.

In the *"main" option*, the line began in Central Russia, passed through Omsk, Novosibirsk (Novo-Nikolaevsk until 1926), Krasnoyarsk, and farther, bypassing Lake Baikal from north or south, reaching the Pacific ports in Nakhodka, Vladivostok, and Posyet. This was the direction of the main cargo flow that had developed by the mid-19th century, and this direction determined the route of the Trans-Siberian Railway: it was given preference when compared with the polar and northern options. In addition, the decision to build the Trans-Siberian Railway was motivated by military-strategic considerations due to the war with Japan. And although the railway could not help Russia in the war with Japan due to the late start of construction, the Trans-Siberian Railway proved economically efficient. In the area of its gravity, the rail line generated multiplier effects that were unexpectedly high, primarily due to intersection with the great Siberian rivers, which flow merdionally.

To date, the Trans-Siberian Railway has become a modern superrail line, which, together with the reconstructed Baikal-Amur Mainline (BAM), solves the problem of overcoming Russia's isolation from Asia-Pacific countries and capacious Asian markets. A different future awaited the polar and northern options. Let us consider the first of them.

In December 1941, the North Pechora Railway came into operation, opening the way for Vorkuta coal to industrial areas of the Russian European North. Almost immediately, an attempt was made to continue the new rail line northeast to Cape Kamenny, a potential port on the western shore of the deep-water part of the Gulf of Ob. The attempt was unsuccessful due to poor quality research, and the route changed. In accordance with the General Scheme for the development of the country's railway network in 1946, it was planned to build a line east to the Yenisey River (via Labytnangi and Salekhard) and create a seaport in Igarka, then extend the route to Norilsk. Reliable transport links with one of the main metallurgical bases of the USSR was an efficient solution; it was planned to continue this railway to Yakutsk and farther to regions of the extreme northeast to Anadyr with a base in Magadan.

However, after the death of I.V. Stalin, who had initiated construction of the rail line, construction 501-503 was stopped, capital expenditures for its implementation were writeen off, and thousands of lives of convict construction labor were ruined due to the inhumane conditions of work in the extreme natural–climatic conditions of the polar zone.[1] Now, within the framework of the Northern Latitudinal Railway (NLR) project, work on the Stalin route continued in a sluggish design, investment, and construction mode.

The northern option in the first third of the 20th century was called the Great Northern Railway (GNR). A special interdepartmental meeting held in November 1916 to develop a railway construction plan for the five-year period of 1917–1922 favored the earliest possible start of its implementation. This decision was prolonged in the first years of Soviet power, when in February 1919, signed by V.I. Lenin, the Council of People's Commissars issued resolutions On the Great Northern Route and On the Granting of a Concession for the Great Northern Railway Route. The concession did not work out either then or since, but nevertheless, there were many options for continuing the project. Any of them provided for the development and continuation of lines built in Tsarist Russia and provided access from Northern Siberia to the ports of the Baltic, White, and Barents seas. The option of GNR access to the ice-free part of the Barents Sea, to Indiga Bay, was chosen and at the beginning of 1931 even began to be implemented, which, compared to Murmansk, shortened the route from Siberia by 1500 km. It would have been possible to build a deep-sea seaport in the bay, which was then called the Eurasian Ocean Port. Now the rail line to this potential port is called Barentskomur (Barents Sea–Komi–Ural); usually it passes along the route from Polunochnoe (Fig. 1).

DISCUSSION OF OPTIONS AND FORMULATION OF THE PROBLEM

The background for further consideration of the "northern" option was order of the President of the Russian Federation V.V. Putin to the Russian govern-

[1] By spring 1953, of the 1700 km of the Vorkuta–Salekhard–Igarka–Norilsk line, 850 km were at various stages of operation, a railway ice crossing across the Ob River was working, and train traffic was traveling on 673 km of railway. By that time, RUB 6 bln (in prices of those years) had already been invested in the line, and to fully develop the construction limit, a further investment of RUB 700–800 mln was needed. Nevertheless, in May 1953, construction work was stopped by special telegram; the convists working on them were evacuated, and by the end of 1955, the unfinished railway was "dead" (Lamin, 1996, p. 46). The lost benefit for the country was, according to the calculations of Academician A.G. Aganbegyan, "at least a billion" (Lamin, 1996, pp. 48–49).

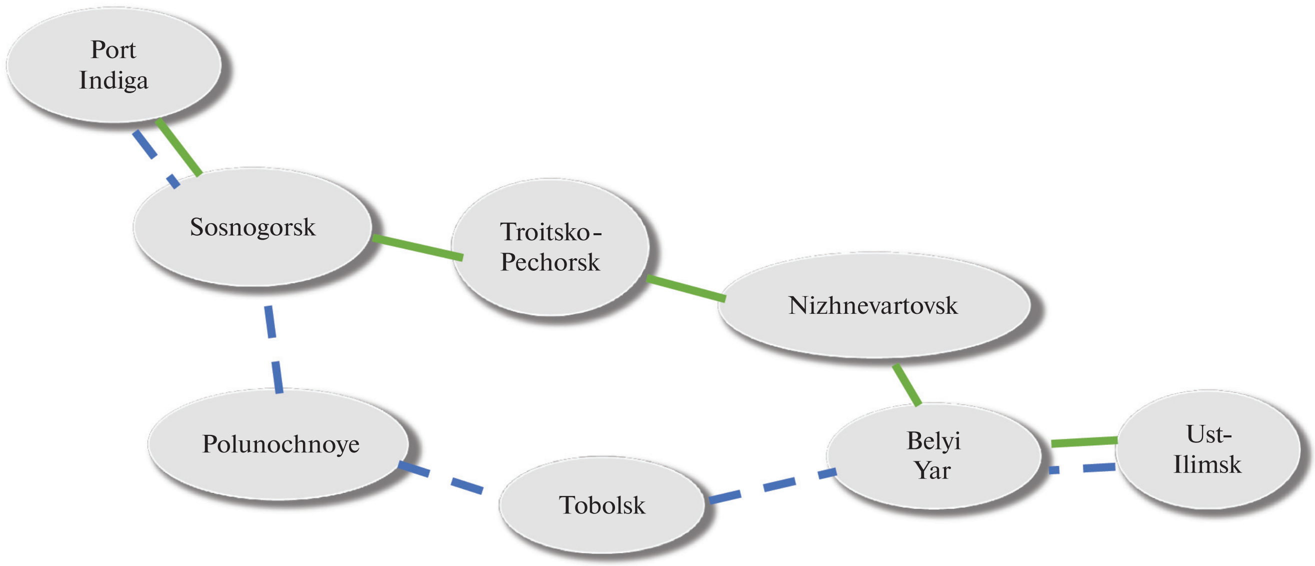

Fig. 1. Barentskomur and North Siberian Railway as an incarnation of the Great Northern Way (GNR). Option 1—green line; option 2—blue dashed line.

ment to submit proposals for the creation of a railway route from Sosnogorsk to the ice-free bay of the Barents Sea near the existing village of Indiga.[2] The site specified in the president's order is only part of the Barentskomur system and allows the question that, as it were, concludes a long-term discussion: which of the two options for reviving this system in its expanded sense is most efficient from the standpoing of social efficiency?

Let's consider options for the expanded Severosib system (see Fig. 1). Option 1 involves construction of a line from Ust-Ilimsk with subsequent access through Bely Yar, Nizhnevartovsk, Troitsko-Pechorsk, and Sosnogorsk to the port of Indiga. Option 2 involves construction of a line from Ust-Ilimsk to Bely Yar with subsequent access through Tobolsk, Polunochnoe, and Sosnogorsk to the port of Indiga.

Both options have their advantages and disadvantages, and the problem lies in choosing the most socially efficient in the long term. Option 1 is hereafter referred to as Barentskomur 1, option 2 is referred to as Barentskomur 2.

The Severosib as a railway line is a continuation of the BAM to the west and in many ways is intended to become a parallel and duplicate line with respect to the Trans-Siberian Railway. For a long time, there has been a discussion in the scientific literature about what is more profitable: reinforcing the Trans-Siberian Railway (for example, constructing a third track) or building the Severosib. As far as we know, feasibility studies have not been completed. However, decisions to build the Severosib were made repeatedly (Kibalov et al., 2005, 2008), but not implemented. The fact is that, along with undoubted positive factors for the development of the territories and economy of Siberia, there were and are controversial and ambiguous circumstances:

(1) There are still no substantiated data on the volumes and structure of freight traffic that will move along the Severosib in both directions, including dynamics. Underutilization of the new rail line will negatively impact the economic performance of areas where transport enterprises are located. In particular, small volumes of cargo transportation may lead to significantly higher costs of rail transportation along the Severosib compared to transportation along the Trans-Siberian Railway. And this, in turn, will lead to an increase in transport tariffs and, consequently, to a decrease in the competitiveness of the line.

(2) The management structure and placement of linear railway transport enterprises (locomotive and carriage depots, track distances, signaling and communications, power stations, etc.) have not been clearly outlined. This will create even more problems, given that in the "new transport development areas" lack things necessary to attract an able-bodied, qualified, active, and mobile population to the industry. The loaded direction on the line in question will be "east– west," and the empty direction, it seems, will be "west–east," as on the Trans-Siberian Railway. This predicted reorientation of Russia's export–import supplies to the east[3] will require a change in the

[2] Prime Minister M.V. Mishustin was made responsible for execution of the order (https://www.kommersant.ru/doc/5170827).

[3] https://riamo.ru7article/608456/v-rzhd-vostochnoe-napravlenie-nazvali-dorogoj-zhizni-dlya-rossij?ysclid=lopop8y9xm685025013. Accessed April 7, 2023.

organizational design at the Russian Railways Eastern zone, which will entail considerable costs.

(3) In the East, where all mass transportation of goods follows the highly equipped double-track and fairly high-speed Trans-Siberian Railway, the BAM and the Central Siberian Mainline do not play a significant role compared with the Trans-Siberian Railway in terms of traffic density and volume of freight and passenger turnover. It is necessary either to specialize the future line for the transportation of certain types of cargo (e.g., liquid cargo parallel to the oil pipeline under construction) or to create a competitive environment for individual carriers on all latitudinal routes in the East.

(4) The construction of the Severosib and its meridional connections with the Trans-Siberian Railway, BAM, and other lines gives grounds to talk about a railway network in the East. However, it is known that the Trans-Siberian Railway uses direct current electric traction, the Central Siberian Mainline and the BAM use alternating current, and most of the meridional lines connecting the Trans-Siberian Railway use the Central Siberian Mainline. , while exits to the Severosib run on diesel traction. Such differences create difficulties in maneuvering locomotives on different lines. And in this case, during the initial development period, with a small volume of traffic, the Severosib will "get" diesel traction, as it is more autonomous and not associated with large investments in infrastructure. In any case, an increase in the operating fleet of locomotives and cars will be required, which will increase the load on existing depots in the area of gravity of the newly built rail line.

(5) In the event of problems with volumes of oil and gas production in Northern Siberia, the Severosib can compete with the new pipeline being built, since pipeline transport is efficient only with very significant pumping volumes, and rail transport in the general case is efficient with any volumes (if there are not only liquid cargoes).

(6) If we consider the construction of the Severosib in light of formation in Russia from the perspective of competitive vertically integrated railway companies, then, according to the former senior vice president of JSC Russian Railways B.M. Lapidus, "If we build the North Siberian Railway, maybe one day these two directions—the northern and southern Trans-Siberian routes—can become competitors" (2008). Indeed, in terms of socioeconomic consequences for the East and for the Siberian regions, the construction and operation of the Severosib are quite comparable to the construction and operation of the Trans-Siberian Railway.

(7) From the viewpoint of low cost and efficiency of developing transit flows of goods in the short term, the option of reinforcing the Trans-Siberian Railway and duplicating it with the Central Siberian and Baikal-Amur Mainlines is most likely beneficial. All these superrail lines (North Siberian, Circumpolar, etc.) will, like the BAM, exist with the existing traffic volumes as inactive railways, since the Trans-Siberian Railway alone will cope with the probable traffic volume. In terms of equipment, cost, and all other parameters, including demographic and climatic, the Trans-Siberian Railway is the most advantageous among all the rail lines. The latter will be able to earn its full potential only if the mainland—Sakhalin—Hokkaido crossings are built and through the Japanese Islands to South Korea through the Tsushima Strait, the Bering Strait crossing to North America, and corresponding volumes of traffic appear.

(8) The lack of transportation and throughput capacity in the eastern direction has intensified due to the reorientation of cargo flows recently. In 2022, against the backdrop of sanctions and logistics restrictions, there was increased demand for sending cargo in the eastern direction; in 2023, the load on the Eastern zone is only increasing. At the end of 2022, 152.9 mln t of cargo were shipped, which is 5.4% higher than the previous year. Coal shipments increased by 7.4%. Throughout 2022, against the backdrop of large-scale infrastructure development work, an increase in the carrying capacity of the Eastern zone was achieved by implementing new technological solutions. For example, in 2022, 16000 trains weighing 7100 t operated in the eastern direction; double trains weighing 14200 t began passing through. At the end of 2022, the carrying capacity of the Eastern zone reached 158 mln t.[4]

As follows from the above, the options for an expanded Barentskomur (due to the addition of Severosib) are large-scale projects in terms of the funds spent and the multifaceted nature of socially significant results. The uncertainty in assessing their efficiency is a consequence of the scale of the projects: by their implementation, these megaprojects affect the proportions of economic development and, consequently, the price system, taking into account which the projects could be justified. Small-scale railway projects do not have this quality, since their implementation, by assumption, does not affect the parameters of the economy that hosts them.

Points 1—8 are a verbal description of the problems that arise already at the stage of pre-investment substantiation for the Barentskomur and Severosib projects. In our opinion, from the description clearly follows the limited suitability of existing traditional methods for assessing the social efficiency of such projects. For reasons existing in the methods of "distortions" towards: (a) financial evaluation criteria to the detriment of economic ones[5]; (b) formal mathematical models to the detriment of verbal models of

[4] https://www.rzd-partner.ru/zhd-transport/opinions/v-2023-godu-nagrazka-na-vostochnyy-poligon-budet-tolko-uvelichivatsya-propusknykh-i-provoznykh-sposo/?ysclid=lg65vz4oca59651059. Accessed April 7, 2023.

system analysis; (c) statistical information models to the detriment of expert models; (d) probabilistic models to the detriment of non-stochastic models.

To solve the problems arising here, the following tools are used: *neosystems analysis* after Ya. Kornai (2002) and G.B. Kleiner (2007), understood as design of a multidimensional future using a holistic system for assessing large-scale projects (with the support of information and expert technologies). As demonstrated by Ya. Kornai (2002) and G.B. Kleiner (2007), a common drawback of modern methods for assessing such projects is the tendency to excessively mathematize decision-making models, which reflects the interests of some mathematicians who strive, using an axiomatic approach, towards an in depth study of a narrowly posed problem. This is in detriment of a systems analysis of the applied axioms (unprovable), declared goals (exogenous) and consequences (uncertain) attributed to the analyzed design alternatives.

Therefore, this article applies a systems approach when verbal and formal methods for assessing the social efficiency of large-scale events (projects) are integrated into a holistic assessment system using a logical-heuristic model (LHM), which seems free of some of the noted shortcomings.

EVALUATION AND SELECTION PROCEDURES

Let us present the proposed approach step by step.

Step one is carried out at the preinvestment stage of substantiation, when the problem of assessing and selecting the most preferable design alternative is at the stage of discussion of the design plan and investment intentions of potential project participants. The beginning of the substantiation stage is for Russia traditionally marked by a public statement or instruction from the President of the Russian Federation regarding a particular project (in our case, a large-scale railway project). This was the case, e.g., with the mainland–Sakhalin and Sosnogorsk–Indiga projects. According to precedent, it should be expected that the government will charge JSC Russian Railways with a substantiating the efficiency of the Sosnogorsk–Indiga project by a certain date. The substantiation is expected to be done using financial criteria such as NPV; i.e., in quantitative form, uncertainty is taken into account as stochastic, and nonprice factors, according to the ceteris paribus principle, i.e., in no way. After this, the project will either begin to be implemented or it will be postponed indefinitely. In the latter case, it becomes possible to obtain a more reasonable, systematic assessment of costs and benefits in a situation of radical uncertainty. The initial premises here are:

(a) consideration that the external environment of projects (the economy and society of Russia) is a weakly structured system and its targeted structuring by a group of experts is the problem of the present step;

(b) statement that during discussion of the Barentskomur and Severosib projects, large amounts of semantic information have been accumulated and the problem of subsequent steps is to transform it into pragmatic information, i.e., suitable for investor decision-making.

Solution of the problem at the first step by a group of experts gives an assessment and target structure of projects,[6] shown in Fig. 2.

Step two. The solution to the problem of this step is based on premise (b). Within its framework, it is accepted that the construction length of the railway line of the Ust-Ilimsk–Bely Yar–Nizhnevartovsk–Surgut–Troitsko-Pechorsk (Severosib) and Ust-Ilimsk–Bely Yar–Tobolsk–Khanty-Mansiysk–Polunochnoe–Troitsko-Pechorsk (Barentskomur) systems are approximately the same; the natural–climatic conditions of the routes are also similar. Then, the most preferable option is determined by the maximum of the integral indicator, calculated using the evaluation structure shown in Fig. 2. For this purpose, auxiliary Tables 1 and 2 are compiled.

Table 1. Combinations of pairs "project + scenario"

Combination	Composition of combination
I	Barentskomur 1 + scenario 1
II	Barentskomur 1 + scenario 2
III	Barentskomur 1 + scenario 3
IV	Barentskomur 2 + scenario 1
V	Barentskomur 2 + scenario 2
VI	Barentskomur 2 + scenario 3

Table 1 presents the pairs "project + scenario." Many pairs form a set of independent systems (combinations), which are competing means of achieving the general goal indicated in Fig. 2. In contrast to the case of probabilistic uncertainty, when the probabilities of updating different scenarios of the same statistical population add up to 1, with radical uncertainty, the introduction of a probabilistic measure makes no sense. There are two approaches to solving the problem that arises in the latter case. According to A.B. Khutoretsky, there are six combinations from Table 1 to rank the degree of usefulness for achieving the subgoals of the general goal of the projects. We used this approach in (Sistemnoe ..., 2014, pp. 294–

[5] Economic criteria are also understood here as taking into account not only the direct costs and results of large-scale railway projects, but also indirect, "external" effects, including multiplier ones.

[6] We have described the methodology for forming an assessment structure by a group of experts in (Kibalov and Khutoretskii, 2015).

Table 2. Expert survey results

Pair project + scenario	Subgoal of general goal								
	0.1. Economic			0.2. Social			0.3. Institutional		
	rank	ASPER	normalized degree	rank	ASPER	normalized degree	rank	ASPER	normalized degree
I	1	0.3450	1.0000	6	0.0553	0.1603	6	0.0553	0.1603
II	2	0.2392	1	1	0.3450	1.0000	3	0.1658	0.4806
III	3	0.1658	0.4806	2	0.2392	0.6933	5	0.0797	0.2310
IV	4	0.1150	0.3333	3	0.1658	0.4806	4	0.1150	0.3333
V	6	0.0553	0.1603	5	0.0797	0.2310	1	0.3450	1.0000
VI	5	0.0797	0.2310	4	0.1150	0.3333	2	0.2392	0.6933
Total	–	**1**	–	–	**1**	–	–	**1**	–

Table 3. Evaluation matrix for large-scale rail projects

Project	Scenario		
	scenario 1 (optimistic)	scenario 2 (most probable)	scenario 3 (pessimistic)
Barentskomur 1	0.4962	0.3521	0.7246
Barentskomur 2	0.3824	0.5186	0.4637

361). This article further describes the application of T. Saaty's approach when pairs are compared using the theory of very complex systems (Saaty, 1977, p. 40).

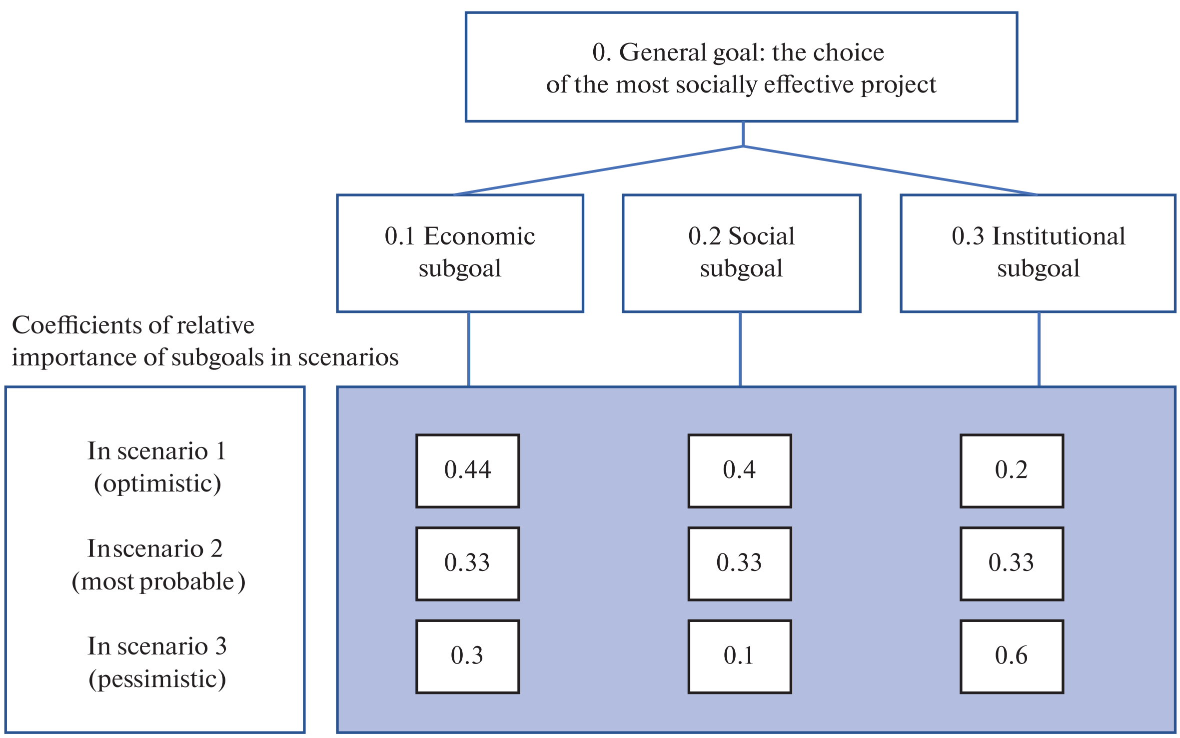

Fig. 2. The Barentskomur and North Siberian Railway project options: quantified tree of goals.

Table 4. Selection of most preferable project according to decision theory criteria

Project	Criterion								
	Wald	maximax	Savage	Gurvic	Bayes	Laplace	Generalized Hurwitz	Hodge–Leman	Germeier
Barentskomur 1	+	+	+	+		+	+		
Barentskomur 2	+				+			+	+

The general formula that allows you to find the number of comparisons from *n* objects by *k* has the form:

$$\binom{n}{k} = C_n^k = \frac{n!}{k!(n-k)!}.$$

For $n = 6$ and $k = 2$ (see Table 1), the number of comparisons of means to achieve one of the three subgoals of the general goal in Fig. 2 will be 15, and for three subgoals, $15 \times 3 = 45$.

Step three. Having processed the orderings presented in Table 2 (columns “Rank”) by the ASPER (NScen) program, the resulting vectors are normalized by dividing their components by the value of the largest component. The values of the normalized vectors are placed in the column “Normalized degrees of goal achievement” of Table 2.

Step four. The normalized degrees of achieving goals from Table 2, previously written as a column matrix, are multiplied by the coefficients of the relative importance of subgoals of rank 1 of the quantified objective tree. Thus, we obtain the degree of achievement of the general goal 0. We represent the result as an evaluation matrix in Table 3. The algorithm used to process the data in the table was incorporated into the NScen software product[7] and is used to obtain Table 3.

Analysis of Table 3 using GlobalD software[8] allowed us to obtain the results shown in Table 4.

DISCUSSION AND CONCLUSIONS

As follows from Table 4, according to most decision theory criteria, the Barentskomur 1 project is the most preferable. If this recommendation matches the quantitative calculation by traditional methods, then for the decision maker, this may be sufficient for an unambiguous decision in favor of Barentskomur 1. If doubts remain, the decision maker should follow the recommendations below.

Since qualitatively described goals of the projects Barentskomur 1 and Barentskomur 2 (economic, social, institutional, defense, environmental[9]) are poorly commensurate with the financial goals, they are considered achieved in comparable projects to an equal extent (the condition “ceteris paribus”). Such a strong premise can lead to erroneous decisions, which happens frequently. The theory in this case recommends that the decision maker solve the problem of commensurability personally, based on the value system of the organization that he represents (Martino, 1977, pp. 347–352; Osipov, 2023; Pospelov, 1979).

Thus, it is shown how the initial uncertainty at the preinvestment stage of substantiation is gradually revealed by the methods of system analysis.

In the first step, this is done by introducing the premise that the external environment (the economy) is a weakly structured system, from which it follows that a narrowly deterministic approach to the assessment of large-scale railway projects can lead to incorrect decisions.

At step two, an evaluation framework is proposed that allows assessing the comparative efficiency of competing projects in situations of stochastic and non-stochastic (radical) uncertainty, which expands the range of methods for supporting complex investment decisions.

At the third and fourth steps, the used set of domestic software products developed at the Institute of Economics and Industrial Engineering, Siberian Branch, Russian Academy of Sciences and the Siberian State Transport University expands, the capabilities of expert technologies in developing recommendations for individuals making complex investment decisions under conditions of risk and uncertainty

Concluding this section, we emphasize that the interregional large-scale railway projects discussed in the article are extraterritorial; the facilities under construction are located partly in northern European Russia and partly in Asian Russia. The article analyzes two such projects: the Barentskomur 1 and Barentskomur 2 railways. The discussion of the feasibility of

[7] See: Certificate on state registration of computer programs 2021666964 Russian Federation. NScen/Pyataev M.V. Applicant and copyright holder Federal State Budgetary Educational Institution of Higher Education “Siberian State Transport University” (SGUPS) (RU)—2021666064. Application October 13, 2021 Publ. October 22, 2021 Registry of computer programs. 1 p.

[8] See: Certificate on state registration of computer programs 2018660190 Russian Federation. GLOBALD/Shibikin D.D. Applicant and copyright holder Shibikin D.D. (RU) - 2018618087. Application July 16, 2018 Publ. August 17, 2018 Registry of computer programs. 1 p.

[9] The environmental subgoal is not included in the system of rank 1 subgoals in Fig. 2 on the premise that it is achieved equally in competing projects.

their construction began in the last century and continued into the present century, while in the new geopolitical situation of the confrontation between Russia and the collective West has acquired particular relevance. The uncertainty of the results and costs for both projects plays a strategic role and in the long term can have an ambiguous impact on their social efficiency. In existing methods, uncertainty is associated with one or another degree of risk. To substantiate the designs, sets of measures are proposed that minimize risks (of a probabilistic and non-probabilistic nature). This article presents an alternative approach when the uncertainty factor is analyzed in terms future opportunities, i.e., constructively.

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CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

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