Journal of Siberian Federal University. Humanities & Social Sciences
2024 17(12): 2494–2503

EDN: VFYQRY
УДК 164.1:622

# Assessment of the Rationality of Integrated Logistics Systems

**Yuliya A. Arkhipova*[a] and Rudolf G. Leontiev[b]**
[a]*Mining Institute of Far Eastern Branch of the RAS
Khabarovsk, Russian Federation*
[b]*Computing Center of Far Eastern Branch of RAS
Khabarovsk, Russian Federation*

Received 04.06.2024, received in revised form 08.11.2024, accepted 18.11.2024

**Abstract**. The purpose of the study is to develop a method for calculating the integral estimates of the rationality of integrated logistics systems in the mining industry by expert methods. The calculation of integral estimates of the levels of social rationality of the studied logistics systems of a particular branch of the regional economy is very difficult. Since there is a practical difficulty in strictly formalizing and taking into account all the factors and processes that reflect the specifics of their formation and functioning. The article presents a procedure for the step-by-step calculation of the integral assessment of social rationality. As a result, it is possible to choose the optimal drugs related to one or several sectors of the economy of the federal district and the country as a whole.

The methodology for an integral (generalized) assessment of logistics systems involves the following stages: 1) formulation of the research problem; 2) selection of evaluation features; 3) selection of significant criteria for assessing the levels of rationality of logistics systems for each criterion; 4) determination of assessments of the levels of rationality of logistics systems for each selected criterion within each attribute; 5) determination of generalized (integral) estimates according to their various classifications; 6) determination of the integral assessment for each logistics system under study; 7) interpretation of the results. The proposed expert assessment methodology in combination with other mathematical methods can become an important tool for designing national and international logistics systems in various sectors of the economy.

**Keywords**: integrated logistics systems, effective functioning, socio-economic development.

Research area: Social Structure, Social Institutions and Processes; Economics.

Citation: Arkhipova Yu. A., Leontiev R. G. Assessment of the rationality of integrated logistics systems. In: *J. Sib. Fed. Univ. Humanit. soc. sci*., 2024, 17(12), 2494–2503. EDN: VFYQRY


* Corresponding author E-mail address: yuliya_arhipovas@mail.ru
ORCID: 0000-0002-9297-6056 (Arkhipova); 0000-0003-4664-3768 (Leontiev)

# Оценка рациональности интегрированных логистических систем

**Ю.А. Архипова[а], Р.Г. Леонтьев[б]**
[а]*Институт горного дела ДВО РАН*
*Российская Федерация, Хабаровск*
[б]*Вычислительный центр ДВО РАН*
*Российская Федерация, Хабаровск*

**Аннотация**. Целью исследования является разработка методики расчета интегральной оценки рациональности интегрированных логистических систем в горнодобывающей отрасли экспертными методами. Расчет интегральных оценок уровней общественной рациональности исследуемых логистических систем той или иной отрасли экономики региона представляет большую сложность вследствие практической невозможности строгой формализации и учета всех факторов и процессов, отображающих специфику их формирования и функционирования. В статье представлена процедура поэтапного расчета интегральной оценки общественной рациональности, на основе которой возможен выбор оптимальных логистических систем, относящихся к одной или нескольким отраслям экономики федерального региона и страны в целом.
Методика интегральной (обобщенной) оценки логистических систем предполагает следующие этапы: 1) постановка задачи исследования; 2) выбор оценочных признаков; 3) выбор значимых критериев оценки уровней рациональности логистических систем по каждому признаку; 4) определение оценок уровней рациональности логистических систем по каждому отобранному критерию внутри каждого признака; 5) определение обобщенных (интегральных) оценок по их различным классификациям; 6) определение интегральной оценки для каждой исследуемой логистической системы; 7) интерпретация результатов.
Предложенная методика экспертной оценки в сочетании с другими математическими методами может стать важным инструментом проектирования национальных и международных логистических систем в различных отраслях экономики.

**Ключевые слова:** интегрированные логистические системы, эффективное функционирование, социально-экономическое развитие.

Научная специальность: 5.4.4. Социальная структура, социальные институты и процессы (социологические науки); 5.2.3. Региональная и отраслевая экономика.

Цитирование: Архипова Ю. А., Леонтьев Р. Г. Оценка рациональности интегрированных логистических систем. *Журн. Сиб. федер. ун-та. Гуманитарные науки*, 2024, 17(12), 2494–2503. EDN: VFYQRY

## Introduction

The economy of the Far East of the Russian Federation as a resource-type problematic region (Leontiev, 2021) not only implements production relations and the exchange of goods between individual territories, but also acts as a factor organizing the world economic space and ensures the further implementation of the geographical division of labor (Baklanov, 2018). The logistics systems (LS) of mining and other sectors of the region's economy are a leading factor in its international economic integration, primarily with the countries of Northeast Asia and the Asia-Pacific region.

In accordance with the approved Decree of the Government of the Russian Federation dated September 24, 2020 No. 2464-r "The National Program for the Socio-Economic Development of the Far East for the period up to 2024 and for the future up to 2035", one of the key competitive advantages of the Far Eastern Federal District is the presence of the largest world reserves of natural resources, which can become the basis for new large-scale production. According to this program, in order to accelerate economic growth, export-oriented sectors of the economy will be developed in the Russian Far East, which can, among other things, ensure an influx of investments, in particular, logistics and mining. At the same time, the natural competitive advantages of the Russian Far East in the field of mining industry development will increase (Arkhipova, 2020, Sklyarova, 2020). Improving the efficiency of functioning and development of the mining complex of the Russian Far East is the most important aspect. It is necessary to solve the problems of formation and functioning of rational integrated logistics systems of the mining industry (ILSMI) in this region.

## 1. About the integral assessment of the rationality of logistics systems

The assessment of the level of social rationality (or irrationality) of the activities of a mining enterprise or any other sector of the economy has practically not been considered in the literature (at least in the domestic one). Moreover, such prerequisites and procedures were not covered in any way in relation to the corresponding sectoral mining logistics systems (LSMI) and ILSMI. Nevertheless, the terms "product quality" and "rationality of LSMI and ILSMI" are similar in content, which allows them to be used to assess the level of social rationality (or irrationality) of a particular logistics system. And also to modify known methods that are used for a generalized assessment of product quality.

Calculation of integral estimates of the levels of social rationality of the studied LSMI in the region is very difficult due to the practical impossibility of strict formalization and taking into account all the factors and processes that reflect the specifics of their (LS) formation and functioning. The procedure for the integral assessment of the ILSMI should include the following steps (Fig. 1):

1) statement of the research problem;

2) selection of evaluative features that are adequate to the studied ILSMI;

3) selection of significant criteria for assessing the levels of rationality of the ILSMI for each feature;

4) determination of estimates of the levels of rationality of ILSMI for each selected criterion within each feature;

5) determination of generalized (integral) estimates of the rationality of the ILSMI according to their various classifications;

6) determination of the integral assessment for each investigated ILSMI:

– or interpretation of the results (conclusions) for the first version of the study (6. A);

– or comparison of the results of the ILSMI assessment according to the second version of the study (6. B);

– or the choice of the optimal ILSMI according to the third option (6. C);

7) interpretation of the results (conclusions) for the second and third options of the study.

Thus, there is a need to calculate the integral (generalized) assessment of the rationality of the studied ILSMI by expert methods. The estimate can be used in practice, depending on the variant of the problem statement and the required calculation accuracy.

## 2. Integrated assessment procedure

**Stage 1. Selection of generalized estimates**. For research and practical calculations of integral assessments of the levels of social rationality of any logistics systems of economic sectors, several classifications are distinguished, each of which has a certain set of features and their categories. So, for ILSMI it is necessary to distinguish the following classifications (Leontiev, 2021):

1) production and technological;

2) state-legal;

3) on economic relations and functional stages;

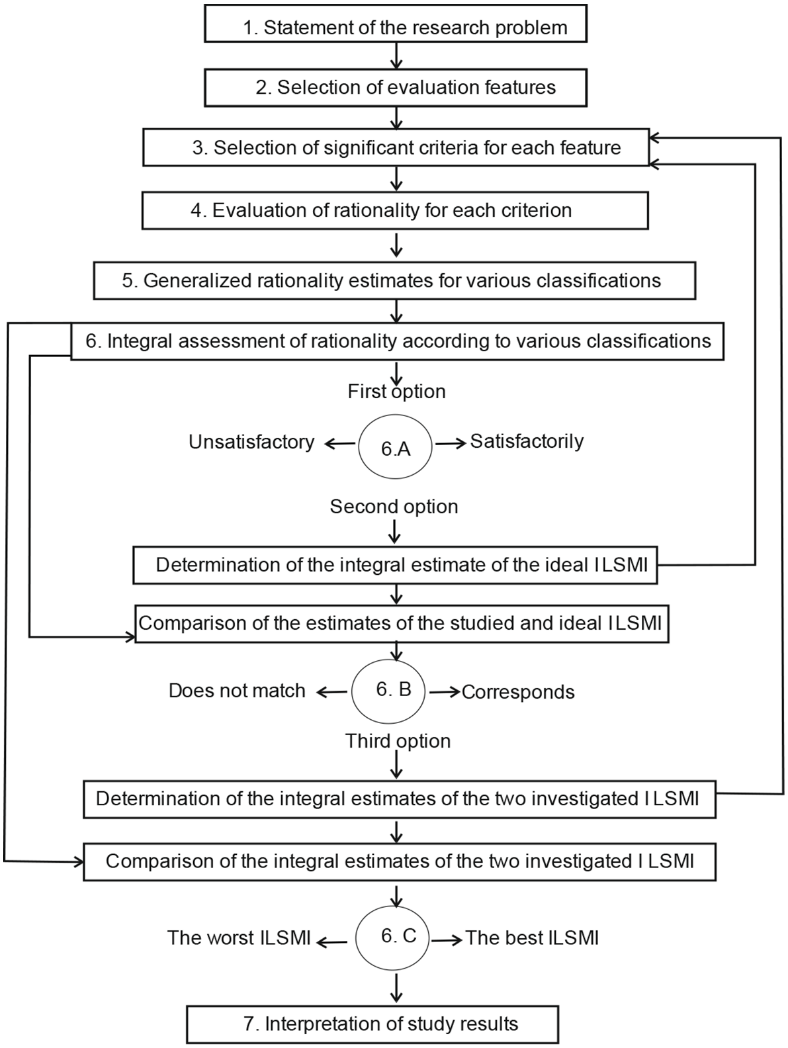


Fig. 1. Scheme of integrated assessment of the rationality of ILSMI

4) according to the spatial (territorial) location of associated industries;

5) by types of transport and cargo provision.

In practice, the selection of generalized estimates of the level of social rationality for each classification feature of the studied ILSMI and the determination of the degree of their influence on the level of the integral assessment of this system can be carried out by laborious enumeration of the corresponding possible combinations subjectively established by each researcher or designer. The problem of this complexity is often solved by experts (subjects of assessment) to a certain extent formally, without a sufficiently prepared justification. In order to objectively determine the integral assessment of the level of social rationality of the studied logistics system, it is necessary to take into account the points of view of many scientists and experts in other such industries.

After the preliminary selection of generalized assessments of the level of social rationality for each classification feature of the studied LS, it is necessary to clarify their composition and the degree of influence on the level of the integral assessment. These generalized assessments are of a different nature and have different relative importance. Therefore, it is not enough to make only a preliminary selection of generalized estimates by specialists belonging to the same industry as the studied LS. It is also necessary, with the help of specialists from other sectors of the economy, various state and public organizations, to clarify the composition of the relevant generalized (integral) assessments and to carry out a hierarchical weighting of these assessments.

The process of selection and weighting of generalized assessments formally proceeds as follows:

1. Specialists of a certain branch of the economy establish a temporary experimental series of generalized assessments of the level of social rationality for each classification feature of the studied LS of the same branch.

2. Experts (specialists from other sectors of the economy and government organizations) study and modify this series until the modified series is agreed with all experts.

3. Next, the generalized assessments are weighted by the ranking and evaluation method.

4. Weighing results are analyzed.

5. Each expert has the opportunity to re-evaluate the initial weighting at the next iteration.

So, the process of weighing generalized (integral) estimates begins with their ranking.

**Stage 2. Ranking of generalized estimates.** The ranking method assumes the equality of importance intervals between generalized estimates. Each expert is invited to give the generalized assessments the order of importance and assign natural numbers to each of them – ranks. In this case, the most important generalized estimate receives rank 1, and the last rank n – the least important one. After that, a rank matrix is compiled (Table 1).

In this table, the following designations are entered: $r_{ij}$ – the rank of the j-th criterion assigned by the i-th expert; m – number of experts; n is the number of criteria.

If the expert cannot distinguish the degree of importance of some generalized assessments, then he is forced to assign them the same rank, as a result of which the number of ranks n is not equal to the number of ranked criteria. In such cases, so-called standardized (linked) ranks are assigned to generalized assessments. To this end, the total number of standardized ranks is assumed to be n, and criteria having the same ranks are assigned a standardized rank, the value of which is the average of the sum of the places divided by the number of generalized ratings with the same ranks.

For example, if rank 3 is assigned to the 3rd, 4th and 5th generalized estimates by the i-th expert, then their ranks in the summary matrix of ranks are: (3+4+5)/3 = 4, that is, $r_{i3} = r_{i4} = r_{i5} = 4$. If the following 6th and 7th generalized estimates are assigned ranks equal to 4 and 5 by the i-th expert, then in the summary matrix their ranks will be respectively designated as 6 and 7, that is, $r_{i6} = 6$ и $r_{i7} = 7$. This is how the ranks change. Sometimes fractional ranks may appear in the summary matrix. For example, if the i-th expert 8 and the 9th generalized assessments are assigned a rank of 8, then in the summary matrix their rank will be 8.5.

Thus, the sum of ranks given by each i-th expert for all generalized estimates must be equal to the checksum, which is the sum of the numbers of the natural series (1):

Table 1. Matrix of the ranks assigned by the experts of the generalized assessments

| Ratings / Experts | 1 | 2 | … | j | … | n | The sum of the ranks of the i-th expert |
|---|---|---|---|---|---|---|---|
| 1 | $r_{11}$ | $r_{12}$ | … | $r_{1j}$ | … | $r_{1n}$ | |
| 2 | $r_{21}$ | $r_{22}$ | … | $r_{2j}$ | … | $r_{2n}$ | |
| … | … | … | … | … | … | … | |
| i | $r_{i1}$ | $r_{i2}$ | … | $r_{ij}$ | … | $r_{in}$ | |
| … | … | … | … | … | … | … | |
| m | $r_{m1}$ | $r_{m2}$ | … | $r_{mj}$ | … | $r_{mn}$ | |
| The sum of all $r_{ij}$ according to the j-th estimate | | | | | | | |

$$\mathbf{1 + 2 + \cdots + \mathit{i} + \cdots + \mathit{n} = (\mathit{n} + 1) * \mathit{n}/2}, \quad (1)$$

Next, the actual sums of all strings are calculated, which must be equal to each other and at the same time to the checksum. After checking the correctness of the compilation of the rank matrix, they proceed to clarify the degree of importance of the generalized assessments from the point of view of experts. To do this, in Table 1, the sums of all individual columns are calculated. In this case, of course, the total sum of all sums of the ranks of the j-th assessment (the sum of the matrix columns) must be equal to the total sum of all the sums of the ranks assigned to the i-th experts (the sum of the rows of the matrix).

The generalized assessment, which has the greatest degree of importance for determining the integral assessment of the level of social rationality of some studied LS, has the smallest sum of ranks, and the generalized assessment, which has the weakest influence, has the largest sum of ranks.

The stated method of ranking by order of assignment of ranks causes difficulty in application when the question is raised about assigning a "weight" to each generalized assessment, starting with the most important of them. The greater the numerical value of the degree of importance of the generalized assessment, the greater should be its weight. This peculiar complexity can be overcome by inverting the rank formed by each expert (2):

$$\boldsymbol{R_{ij} = n - r_{ij}}, \quad (2)$$

where $R_{ij}$ is the inverted rank of the j-th generalized assessment, established by the i-th expert; n is the number of ranked generalized estimates.

Therefore, the first most important generalized score will receive a reversed rank of n – 1, the next most important generalized score will receive a reversed rank of n – 2, and so on. And the last most important generalized score will receive a reversed rank of 0.

The resulting rank for each generalized assessment is determined by summing the reversed ranks of experts (3):

$$\boldsymbol{R_i = r_{1j} + r_{2j} + \cdots + r_{ij} + \cdots + r_{mj}}, \quad (3)$$

where $\mathbf{R}_j$ is the resulting rank of the j-th criterion; m – number of experts.

Next, the resulting importance ranks are normalized. To this end, the ranks for all generalized assessments are summed up, and then each of them is divided by the resulting amount.

Thus, the reversed resulting rank is normalized as follows (4):

$$\boldsymbol{s_j = R_j/(R_{1i} + R_{2i} + \cdots + R_{ji} + \cdots + R_{in})}, \quad (4)$$

where $s_j$ is the reversed complex weighted rank of the j-th criterion. The sum of all $s_j$ (for j = 1, 2…, n) must naturally be equal to one.

The accuracy and reliability of the ranking method largely depends on the number of pooled scores. The fewer such estimates, the higher their "distinguishability" from the expert's point of view. And, therefore, the more accurately and reliably it is possible to establish the resulting (complex weighted) rank of each generalized assessment. As a rule, the number of ranked generalized assessments should not exceed 20. This procedure is most reliable when n < 10. For example, in (Shlyakhovoy, 2002), 15 indicators were initially chosen, and later only 10 were left.

The ranking method cannot always be used in its purest form. Most often, it should be combined with other methods that provide a more accurate assessment of the degree of importance or usefulness of generalized (integral) estimates. In particular, in the process of calculating the integral assessment of the level of social rationality of any studied LS, the method of direct scoring can be used (Shlyakhovoy, 2002).

**Stage 3. Direct assignment of points.** The method of direct assessment consists in the fact that the range of change in the degree of importance or usefulness of the generalized assessment is divided into several intervals. Each interval is assigned a certain number of points, for example, from 0 to 10. The task of the assessor is to assign a certain number of points to each assessment in accordance with the degree of importance or usefulness of this assessment. It should be noted that each expert is allowed to give the same number of points to two (or several) different generalized assessments.

The assignment of points to generalized assessments with n = 10 and the maximum number of points equal to 10 is made on a scale from 0 to 100 units. A value of zero indicates that there is no useful value for this summary score. And the hundredth value of the scale indicates the highest degree of utility assigned to this generalized assessment.

The resulting assessment of the utility of some generalized assessment $V_j$ is determined by summing the points assigned by all experts to this generalized assessment (5):

$$\boldsymbol{V_j = v_{1j} + v_{2j} + \cdots + v_{ij} + \cdots + v_{mj}}, \quad (5)$$

where $v_{ij}$ – is the individual number of points assigned to the j-th generalized (integral) assessment by the i-th expert.

The resulting utility scores (as well as the resulting importance ranks) are normalized. For this purpose, the scores for all generalized assessments are summed up, and then the number of points individual for each generalized assessment is divided by the amount received.

And then the complex degree of utility of the j-th generalized estimate is equal to

$$\boldsymbol{w_j = V_j \,/\, (V_{1i} + V_{2i} + \cdots + V_{ji} + \cdots + V_{ni})}, \quad (6)$$

The sum of all $w_j$ (for j = 1, 2…, n) must also be equal to one.

For the 2nd and 3rd stages of the process of calculating the integral assessment of the level of social rationality of any studied LS, information is entered into a general table. The table indicates: the priority and evaluation of each criterion, the results of ranking and scoring, the average "vector of utility".

**Stage 4. Calculation of the effectiveness of integral assessment options for each generalized assessment.** The next section (stage) in the general process of calculating the integral assessment of the level of social rationality of the studied LS is the determination of the efficiency value of possible options for an integral assessment of this kind, which differ in the composition of generalized assessments.

After a preliminary determination of possible options for an integral assessment, each expert participating in the selection procedure visits a firm (enterprise) or corporation (complex of enterprises) where one or another LS of a particular sector of the economy is formed or operates. He gets acquainted on the spot with the situation and carefully studies the information received as a result of familiarization for each generalized assessment.

During this period, experts can simultaneously consider only one generalized assessment. Each expert determines his personal performance indicator for each of the integral assessment options, based on the specifics of this assessment. The performance indicator determined by the expert can be expressed as values in the range from 0 to 1. An indicator equal to 1 is given when the integral assessment option satisfies the given generalized assessment of the LS qualification as much as possible. A zero score corresponds to an almost complete lack of satisfaction of the relevant requirements. The value of 0.5 indicates that some version of the integral assessment of the rationality of some studied LS has neither special advantages nor disadvantages with respect to the considered generalized assessment.

For each j-th generalized assessment, a separate matrix of individual efficiency values is compiled (Table 2). It consists of estimates $c_{iik}$ given to each k-th version of the integral estimate (k = 1, 2, …, p) by each i-th expert (i = 1, 2, …, m).

Next, the efficiency values $c_{kcp}$ of k-x variants of the integral assessment are calculated according to the given j-th generalized assessment (7):

$$\boldsymbol{c_{kcp} = \frac{(c_{1k} + c_{2k} + \cdots + c_{ik} + \cdots + c_{mk})}{m}}, \quad (7)$$

After obtaining individual estimates $c_{ik}$ and average values of efficiency $c_{kcp}$ for any one j-th generalized assessment, the experts sequentially proceed to other generalized assessments. The total number of matrices of individual efficiency values (Table 3) is equal to the number of criteria n. Accordingly, for each j-th generalized assessment, its own value $c_{kcp}$, is obtained, which can be denoted as $e_{kj}$ ($e_{kj}$ is the average efficiency value related to the k-th version of the integral assessment according to the j-th generalized assessment).

From the average efficiency values, an efficiency matrix is compiled, in which each component $e_{kj}$ is the arithmetic mean of the individ-

Table 2. Matrix of efficiency values individual for each variant of the integral assessment (according to the j-th generalized assessment)

| Ratings / Experts | 1 | 2 | … | k | … | p |
|---|---|---|---|---|---|---|
| 1 | $c_{11}$ | $c_{12}$ | … | $c_{1k}$ | … | $c_{1p}$ |
| 2 | $c_{21}$ | $c_{22}$ | … | $c_{2k}$ | … | $c_{2p}$ |
| … | … | … | … | … | … | … |
| i | $c_{i1}$ | $c_{i2}$ | … | $c_{ik}$ | … | $c_{ip}$ |
| … | … | … | … | … | … | … |
| m | $c_{m1}$ | $c_{m2}$ | … | $c_{mk}$ | … | $c_{mp}$ |
| Sum of all $c_{ik}$ by k-th estimate $c_{kcp}$ | | | | | | |

Table 3. Efficiency matrix of integrated assessment options for all generalized assessments

| Generalized estimate / Integral estimate (option) | 1 | 2 | … | j | … | n |
|---|---|---|---|---|---|---|
| 1 | $e_{11}$ | $e_{12}$ | … | $e_{1j}$ | … | $e_{1n}$ |
| 2 | $e_{21}$ | $e_{22}$ | … | $e_{2j}$ | … | $e_{2n}$ |
| … | … | … | … | … | … | … |
| k | $e_{1k}$ | $e_{k2}$ | … | $e_{kj}$ | … | $e_{kn}$ |
| … | … | … | … | … | … | … |
| p | $e_{p1}$ | $e_{p2}$ | … | $e_{pj}$ | … | $e_{pn}$ |

ual efficiency values of all experts according to one generalized assessment.

**Stage 5. Calculation of the overall effectiveness of the integrated assessment options.** Further, the overall efficiency of the integral assessment option can be obtained as the product of the efficiency matrix (Table 3) by the generalized assessment utility criterion vector (generalized complex degree of utility of the j-th generalized assessment) $z_j$. This product is a composite utility vector $U_k$, which displays all the presented advantages of the integrated assessment options, expressed by experts individually in the order indicated above (8).

$$\boldsymbol{U_k} = \left(\boldsymbol{e_{1j}} + \boldsymbol{e_{2j}} + \cdots + \boldsymbol{e_{kj}} + \cdots + \boldsymbol{e_{pj}}\right) * \boldsymbol{z_j}, \quad (8)$$

where $U_k$ is the overall efficiency of the k-th variant of the integral assessment; $e_{kj}$ is the averaged efficiency of the k-th version of the integral estimate, which satisfies the j-th generalized estimate; $z_j$ – utility value of the j-th generalized evaluation ($z_j$ can be equal to either $s_j$, or $w_j$, or ($s_j + w_j$): 2).

Since the sum of $z_j$, by must be equal to 1 and the maximum value of $e_{kj}$ is also equal to 1, the maximum value for an arbitrary $U_k$ must be equal to 1. Thus, the "unconditional" choice of the variant of the integral estimate corresponds to the value $U_k = 1$, and the completely "unreasonable" variant of the integral estimate corresponds to the zero value $U_k$. It is obvious that most options for the integral assessment will have a value greater than 0 and less than 1, probably in the range of 0.2–0.7 (Shlyakhovoy, 2002). The most appropriate option can be considered the one with the maximum efficiency $U_k$.

Some methods for checking the consistency and reliability of expert assessments are outlined in many works.

In the article (Gudkov, 2021), for example, the proposed approach is to improve the accuracy of the valuation of expert decisions. It consists in the formalization of sub-criteria assessments using T. Saaty's hierarchical analysis based on paired comparisons. At the same time, computerization of the study is necessary, which makes it possible to visualize the results, improve the accuracy of estimates and predetermine the unexpected development of events.

The authors of (Korablev, 2005) consider the use of the eigenvector method to determine the degree of consistency of expert assessments presented in the form of a matrix of pairwise comparisons of factors. And they offer a way to correct expert estimates, which improves their agreement and allows you to set clearer priorities for factors. Mathematical and statistical methods of evaluation, including methods of simple ranking, weight coefficients, sequential and paired comparisons, are considered in detail in (Divina, 2019).

**Stage 6. Areas of applicability of the procedure.** Each of the calculation algorithms outlined above can be independently applied in practice, depending on the variant of the problem statement and the required accuracy of calculations.

This calculation process can also be used in the development and evaluation of options for locating production (processing of raw materials) LS of some sector of the economy (Omelchenko, 2013). The use of such a procedure is quite possible in the practical activities of various research and design organizations in research related to the problems of expanding existing and building new supply, transport and trade facilities. A similar procedure can be implemented to determine the optimal strategy for designing the development of integrated industries (Shindina, 2014) within one or more LS, which belong to one or more sectors of the economy in conditions of limited investment.

It should be noted that in the modern practice of designing LS in various sectors of the national and international economy, mathematical and statistical methods of expert assessments are still rarely used. For the successful use of these methods, it is necessary, in particular: to improve the system for selecting experts, to increase the efficiency of characterizing group opinions, to develop methods for checking the validity of estimates, to study implicit causes (for example, the presence of corruption schemes (Okonov, 2014), etc.

However, there is no doubt that in the near future, expert assessments in combination with other mathematical methods can become an important tool for designing national and international LS of various sectors of the economy of the regions (federal districts) of the Russian Federation and the country as a whole, including the ILSMI of the second and third orders.

**Stage 7. Interpretation of the results**. The content of the operations of the final stage of the generalized (integral) assessment of the social rationality of logistics systems is entirely determined by the formulation of the problem of a particular study and consists in the interpretation of the results obtained at the previous stages.

**Conclusions**

For the state, the population and society as a whole (as subjects of the LS assessment), only the quality level of a product purchased by someone cannot reflect the generalized rationality (value, utility) of the functioning of a certain ILSMI.

Because for them, such rationality is associated primarily with other estimates:

– what are the costs of the operation of these drugs associated with nature management, state support for production,

– what is its contribution to the socio-economic development of the region and the Russian Federation as a whole (tax and customs, revenues to the budgets of all levels, the number of jobs, etc.).

ILSMI, which does not meet the interests of at least one group of subjects of assessment, in principle, is irrational for society, and ILSMI, which satisfies the interests of the entire set of groups of this kind, is considered socially rational.

The development of an optimal plan for the development and placement of associated industries in the ILSMI should consist of a number of successive stages:

– determination of the boundaries of the region in which the existing, developing (reconstructed) and potential (scheduled for construction) suppliers of products are located;

– preparation of data: 1) on the need for relevant types of products and resources, 2) on possible options for the reconstruction of existing and construction of new production facilities, 3) on economic indicators for each of these options, 4) on transport costs along the transportation routes included in the region under consideration;

– choice of planning period;

– mathematical formalization of the problem;

– the solution of the problem.

**References**

Arkhipova Yu. A., Bardal A.B. The Minerals Potential of Far Eastern Region and Transport Limitations of Their Development. In: *Geography and Natural Resource*, 2020, 41, 406–414. Available at: https://doi.org/10.1134/S 1875372841040125

Baklanov P. Ya. O soderzhanii i «smyslaKH» sotsialno-ekonomicheskogo rayonirovaniya [On the content and "meanings" of socio-economic zoning]. In: *Geograficheskiy vestnik [Geographical Bulletin]*, 2018, 3 (46), 24–30. DOI: 10.17072/2079–7877–2018–3–24–30

Divina T.V., Petrakova E.A., Vishnevsky M.S. Osnovnyye metody analiza ekspertnykh otsenok [Basic methods of analysis of expert assessments]. In: *Ekonomika i biznes: teoriya i praktika [Economics and business: theory and practice],* 2019, 7, 42–44. DOI:10.24411/2411–0450–2019–11072

Gudkov P.G., Guseva A.I. Accuracy of Expert Assessments in Evaluating Innovative Projects. In: *Procedia Computer Science*, 2019, 190, 284–291. Available at: https://doi.org/10.1016/j.procs.2021.06.038

Korablev N.M., Udovenko S.G., Alzin Firas. Soglasovaniye i korrektsiya ekspertnykh otsenok v sistemakh podderzhki prinyatiya resheniy v usloviyakh nechetkoy iskhodnoy informatsii [Coordination and correction of expert assessments in decision support systems in conditions of fuzzy initial information]. In: *Radioelektronika. Informatika. Upravleniye. [Radioelectronics Informatics. Management]*, 2005, 2, 116–120.

Leontiev R.G., Arkhipova Yu.A. *Logistika gornogo dela (integrirovannyye sistemy) [In Mining logistics (integrated systems)].* Vladivostok, Dalnevostochnyy federalnyy universitet, 2021, 200.

Okonov B.A., Lidzhi-Goryayeva S.E. Ekspertnyy opros kak metod vyyavleniya korruptsionnykh riskov [Expert survey as a method for identifying corruption risks]. In: *Vestnik Instituta kompleksnykh issledovaniy aridnykh territoriy* [*Bulletin of the Institute for Complex Research of Arid Territories*], 2014, 2(29), 98–101.

Omelchenko I.N., Eliseeva E.V. Logisticheskaya model organizatsii proizvodstva na osnove kontseptsii resursosberezheniya [Logistic model of production organization based on the concept of resource saving]. In: *Gumanitarnyy vestnik [Humanitarian Bulletin]*, 2013, 10, 1–12. DOI 10.18698/2306–8477–2013–10.

Shindina T.A., Salimonenko E.N. Integrirovannaya logistika v organizatsiyakh [Integrated logistics in organizations]. In: *Vestnik Yuzhno-Uralskogo gosudarstvennogo universiteta. Seriya: Ekonomika i menedzhment [Bulletin of the South Ural State University. Series: Economics and Management]*, 2014, 8(4), 195–198.

Shlyakhovoy A.Z., Leontiev R.G. *Problemnyy region resursnogo tipa v Severo-Vostochnoy Azii: logistika, rybnaya promyshlennost Dalnego Vostoka RF [In Problematic region of resource type in Northeast Asia: logistics, fishing industry of the Far East of the Russian Federation]*. Moscow, VINITI RAN, 2002, 634.

Sklyarova G.F., Arkhipova Yu.A. *Mineralno-syryevoy potentsial Dalnevostochnogo regiona (v kolichestvennom i kachestvennom aspektakh po subyektam Federatsii Dalnevostochnogo federalnogo okruga) [In Mineral and resource potential of the Far Eastern region (in quantitative and qualitative aspects by the subjects of the Federation of the Far Eastern Federal District)].* Khabarovsk, Amurprint, 2020, 244.