Assessment of the Consistency of Expert Opinions in Ranking the Importance of Indicators

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Abstract
The state of socio-economic phenomena is usually reflected by a large number of indicators of various importance. In order to quantitatively assess the state of such phenomena, it is necessary to know both the values of the indicators and the weights. When there are many indicators, adequate determination of weights becomes complicated, since experts can no longer mentally weigh the mutual relations of importance of all indicators. The solution of the problem is facilitated by determining the weights in two stages. In the first, the importance ranks of the indicators are obtained, and in the second, based on these ranks, the weights. Both the importance ranks and the weights are determined by experts, therefore it is necessary to check the consistency of their opinions. Today, methods have been developed to determine the consistency of expert assessment of indicator weights, and there is almost no talk about checking the consistency of expert assessment of importance ranks. Methods for determining the consistency of expert assessment of indicator weights are not suitable here, since the expert determines the weights quantitatively, i.e. in numbers, and the importance – qualitatively - indicates which of the two indicators is more important. The proposed methodology, named DeA (definition of agreement), is based on the ratio of the difference in the sums of indicators estimated with identical estimates to the total number of estimates. The compatibility criterion obtained in this way shows the minimum number of identical estimates that must be present in order for the experts' opinions to be consistent.

Keywords: Indicator; rankings; expert assessment consistency

JEL Classification: C44; C02

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1. Introduction

We live in a world of socio-economic systems (SES) of various types and levels, i.e. social systems that integrate various material and technical resources (Kuzior et al., 2026; Vasylieva et al., 2026). Such systems are characterized by several essential circumstances. First, their functioning, even existence, is possible only through their constant development; second, in reality they manifest themselves in a large number of aspects of the most diverse nature. These circumstances are interrelated, condition each other. In order for the development of SES to be purposeful in such a context, it is necessary to have the opportunity to quantitatively assess it at the desired point in time. This allows us to compare the scale of development changes with the costs involved, to highlight the reasons for the unsatisfactory situation and, on this basis, to make decisions on effective development management.

In order to quantitatively assess the state of development at a given point in time, aspects of SES manifestation need to be formalized, i.e. expressed in indicators and their values combined

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into one generalizing quantity, index. The solution of this problem is complicated by the fact that indicators can be expressed in different dimensions; change in different directions, i.e. an increase in one of their values can improve the state of development, while another can worsen it. In addition, they may be of different importance for the development of SES. In recent decades, multi-criteria methods have been widely used to solve such complex problems (Keshavarz Ghorabaee et al., 2015; Brans & De Smet, 2016; Kaya & Kahraman, 2011; Saaty et al., 2003; Wu et al., 2009; Azizi & Ramezanzadeh, 2016; Łopatka et al., 2023). The essence of almost all of them is that in an appropriate way, the weighted transformed dimensionless values of indicators are combined into a single size, an index. This means that by combining them, their directions of change are unified, i.e. all indicators are converted into either maximizing or minimizing ones; their weights are determined, and they are also converted into dimensionless ones, i.e. mutually comparable. Of all these tasks, the most complicated is the determination of indicator weights, since it requires expert assessment. The situation becomes even more complicated when the number of indicators is large. This is because experts can only adequately determine the importance of a limited number of indicators.

Ways have been proposed to solve this problem. There are two main ones. In the first case, the process of determining the weights of indicators is divided into two stages (Podvezko & Podviezko, 2009, 2015; Reiff et al., 2016; Wątróbski et al., 2016). First, the importance ranks of the indicators are determined and second, the weights, based on the results of the first stage. This facilitates the expert assessment procedure and increases its adequacy. This is because the expert will not give a greater weight to an indicator with a lower importance rank. The assessment procedure becomes simpler because the expert does not need to indicate the weight of the indicator in tenths or even hundredths of a unit, but only to indicate whether the indicator under consideration is more important than the one being compared.

The most well-known and widely used method of pairwise comparison of the importance of indicators is still based on Saaty AHP method (Saaty, 1980). Along with its advantages, the literature also indicates its disadvantages (Tutygin & Korobov, 2010). In the context of the problem under consideration, one more can be attributed to them. The AHP method provides that the consistency of expert opinions is checked only at the end of the complex and lengthy calculations for determining the weights of indicators. If it turns out that the opinions are not consistent, the procedure for determining the weights of indicators is started anew, i.e. the opinions of those experts whose assessments differed the most are adjusted by consensus. This makes the AHP method complex and sensitive.

All this can be avoided if, in both cases, the compatibility of the importance assessment of each pair of indicators is carried out immediately, at the very beginning. This implies the need to propose a methodology for assessing the compatibility of expert pairwise comparisons of the importance of indicators.

The aim of the article is to propose a methodology for assessing the compatibility of expert pairwise comparisons of the importance of indicators and to validate it with a specific example.

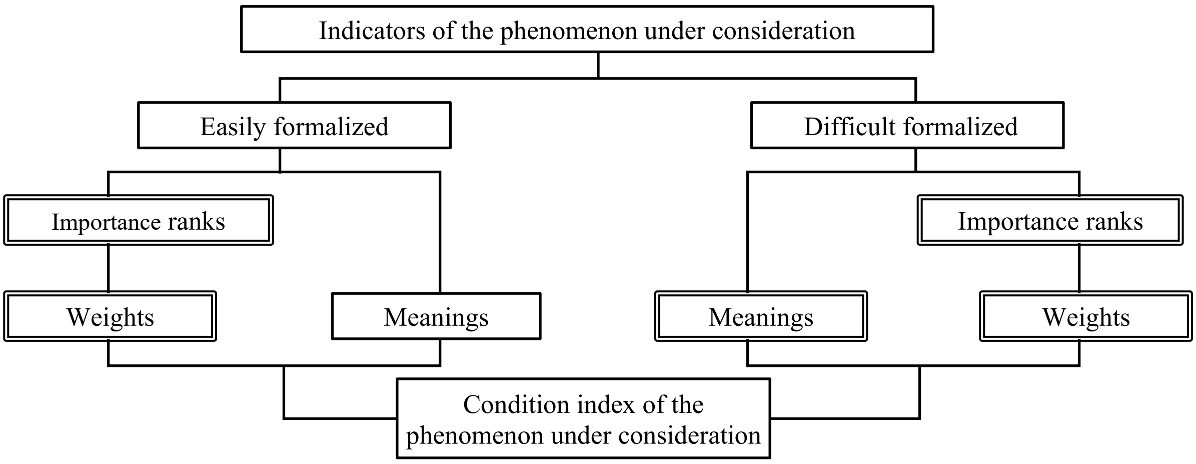
2. Literature Review

The main goal of the analysis of complex phenomena is the assessment of the state. In engineering and technological sciences, this helps to organize the options under consideration (Morkūnaitė, 2020; Barvidas, 2010), in social sciences, it helps to purposefully manage their development (Gedvilaitė, 2019). In reality, they manifest themselves in many different aspects. Their formalized expression is indicators. In order to comprehensively quantitatively assess such a state of phenomena, the values of the indicators need to be combined into one generalizing value, an index. In order to have such an opportunity, first of all, two fundamental problems need to be solved. First, the values of the indicators need to be transformed in such a way that they become comparable; second, their importance in relation to the phenomenon under consideration needs to be adequately determined (Hwang & Yoon, 1981; Ginevičius et al., 2018, 2023).

Some indicators, which are formalizable, can be easily determined, while others, which are difficult to formalize, are more complicated to determine. In the first case, they can be obtained from various sources – statistical databases, regulatory documents, reports, literature sources, etc. In the second case, they are obtained through expert assessments. Indicators can be expressed in different dimensions, so they need to be unified (Podvezko, 2008). In addition, they can change in different directions, i.e. an increase in one of their values improves the situation, while the other worsens it. Therefore, it is necessary to unify their directions of change to transform them either into maximizing or minimizing ones (Podvezko, 2008).

A comprehensive assessment of the state of complex phenomena is practically impossible without the participation of experts in this process. They provide not only the values of indicators that are difficult to formalize, but also the importance of both them and easily formalized indicators in relation to the phenomenon under study, which is determined by experts (Figure 1).

Figure 1. Simplified scheme for assessing the state of the phenomenon under consideration



Source: Compiled by the author

Expert assessments are always subjective, so their adequacy depends on many circumstances – the number of assessed indicators, the competence of experts, the nature of the assessed phenomenon, etc. Therefore, an integral part of them is checking the consistency of opinions. Only if the opinions of experts are agreed, the assessment results can be used as a basis for further calculations. It is no coincidence that this problem has been studied for many years (Fishburn, 1971; Kendall, 1975; Keeney & Raiffa, 1976; Arditi & Gunaydin, 1999; Roy, 1996; Egerová et al., 2021). When assessing its importance, it is appropriate to take a deeper look at the current situation. The “time” of the analysis and the position in it are reflected in Table 1.

Table 1. Objects and methods of checking the compatibility of expert assessments

Indicators	Objects of expert assessment		
	Indicator values	Indicator importance rankings	Indicator weights
Easily formalized	No need	Practically none	Many different methods
Difficult to formalize	Practically none	Practically none	Many different methods

Source: Compiled by the author

A methodology has been proposed to determine the consistency of expert assessment of indicator values that are difficult to formalize (Ginevičius et al., 2022). It is based on the statement that, unlike the determination of weights, the estimate of the value of an individually taken indicator does not depend on the estimates of the value of all other indicators in the system.

Many different methods have been proposed for checking the consistency of expert assessment of indicator weights. They can be divided into groups. The first group includes those on the basis of which the consistency of expert assessment of the importance of a small number of indicators is determined. The most well-known and widely used are the Kendall concordance coefficient and the Pearson criterion (Kendall, 1975). The methods of the second group are applied when the number of indicators to be assessed is large. In this case, the methods of the first group are not suitable, since the expert can only adequately enter the importance of a limited number of indicators due to the fact that he cannot mentally encompass the mutual relationships of the importance of all indicators. Without greater evidence, it is stated in literary sources that this number cannot exceed 10-12 indicators (Podvezko, 2005). A deeper analysis shows that the Kendall methodology can give not only an approximate, but even the opposite result. This is because it is based not on the initial estimates of the importance of indicators, but on ranks. In searching for a solution to this problem, the aim was to reduce the volume of expert assessment. This is how the methods of pairwise comparison of the importance of indicators emerged. Today, the most widely used is the Saaty pairwise comparison AHP method (Saaty et al., 2003). Perhaps this is why many sources of literature examine both its advantages and disadvantages. In any case, it can be argued that the main reason for its popularity is that there are no adequate alternatives or they are little known.

The main advantage of the AHP method is that it allows for the comparison of a large number of indicators (Jakučionis & Ustinovičius, 2000; Podvezko, 2008; Tutygin & Korobov, 2010; Mubarak et al., 2024). On the other hand, a number of its shortcomings are indicated, especially from the standpoint of expert assessment compatibility. The most important ones are the following:

1. Experts rarely manage to fill in a consistent pairwise comparison matrix, especially when the number of pairs of indicators being compared is large. As the number increases, the consistency decreases.
2. The methodology provides that only the consistency of the matrix completed by each expert is checked; it does not specify how to check it for the entire group of experts.
3. It is doubtful whether experts will be able to adequately indicate the differences between two adjacent importance ratings, let alone intermediate ratings, such as "slightly greater importance" (third value on the scale) and "greater importance" (fifth value on the scale).
4. The method is essentially focused on determining the compatibility of indicator weights rather than their expert assessment, therefore little attention is paid to it.

5. A rather complex and sensitive path is envisaged for determining indicator weights, including compatibility - if the opinions of experts are not coordinated, a second stage is organized, during which the initial expert assessments are adjusted by consensus.
6. The applicability of the method is limited by the fact that the importance estimates of some pairs of indicators are related to the importance estimates of all other such pairs.
7. The consistency of expert assessment becomes apparent only after all the long and complex calculations for determining indicator weights have been performed. This increases the cost of the assessment and reduces its adequacy.

Table 1 shows that there is practically no methodology for determining the consistency of expert assessment of the importance of indicators. Meanwhile, as indicated in the literature, this is a very important condition for the quantitative assessment of the state of the complex phenomena under consideration. It is viewed as the first stage of analysis and assessment, which significantly increases the adequacy of determining the weights of indicators (Podvezko, 2008; Šarka, 2000; Yakymova et al., 2022). This is because the expert will not give more weight to an indicator assessed with a lower importance rank. Despite this, no suggestions have been found in the literature on how to determine the consistency of expert assessment of the importance ranks of indicators. This problem is quite complicated, especially when the number of indicators to be assessed is large. In this case, the expert must mentally "weigh" the mutual relations of importance of all other indicators of the system.

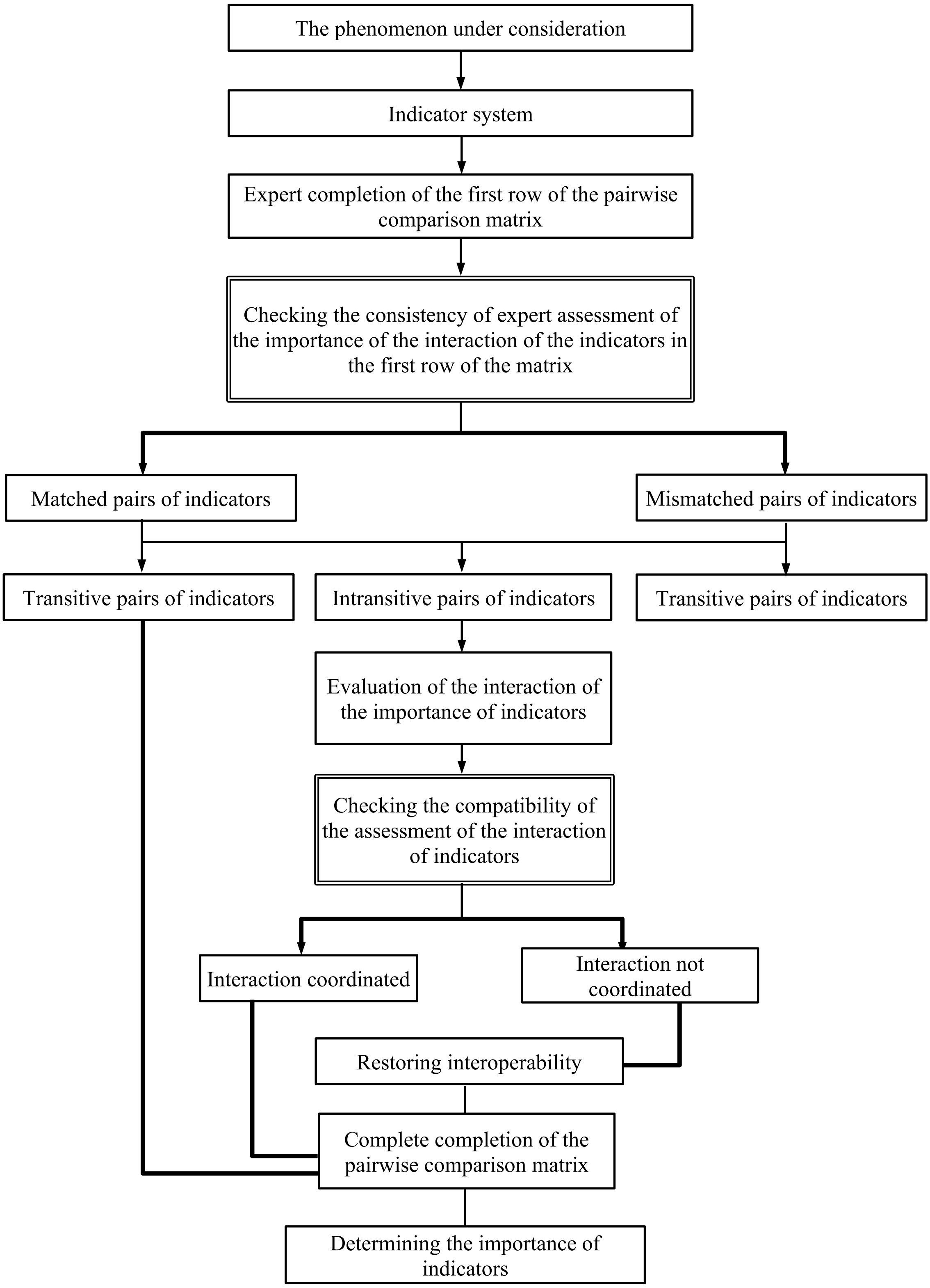
3. Research Methodology

Figure 1 shows that the adequacy of determining weights largely depends on the knowledge of the importance ranks of indicators. They are given by experts, therefore it is necessary to check the compatibility of their opinions. As the number of indicators to be assessed increases, this need increases, since the adequacy of the assessment decreases. Here again, we encounter a similar situation as in the case of determining indicator weights. When the number of indicators is small, experts can indicate the importance of indicators quite accurately. When there are many of them, such possibilities decrease and again it is possible to rely on pairwise comparison methods. The essential difference between the assessment of indicator weights and importance ranks will be that in the first case, experts assess the weights quantitatively, in numbers, so the weight of each indicator can be reflected in ten estimates. In the second case, experts have only one answer option - whether indicator X is more important than indicator Y or not, so the assessment is qualitative. In such a situation, a completely different approach to checking the compatibility of expert opinions is required.

The possibilities of determining the importance ranks of indicators can be significantly expanded by relying on their transitivity property (Figure 2). A corresponding methodology has been proposed, the essential advantages of which are the following (Ginevičius et al., 2023; Hogeforster & Ginevičius, 2024):

1) allows for the assessment of an unlimited number of indicators, since the ratio of indicators in one pair does not depend on the importance ratios of other pairs;
2) significantly reduces the scope of expert assessment, since the ranking of the importance of indicators is also based on analytical calculations;
3) addresses the fundamental shortcoming of all expert assessment methods – it determines the importance ranks of indicators not directly but based on their interaction as elements of the system.

Figure 2. The place of expert assessment compatibility in the ranking of indicator importance



Source: own research

This methodology provides that experts fill in only the first row of the pairwise comparison matrix, as well as the importance ratios of the pairs of intransitive indicators that emerged in it (Table 2).

Table 2. Indicator importance ranking matrix

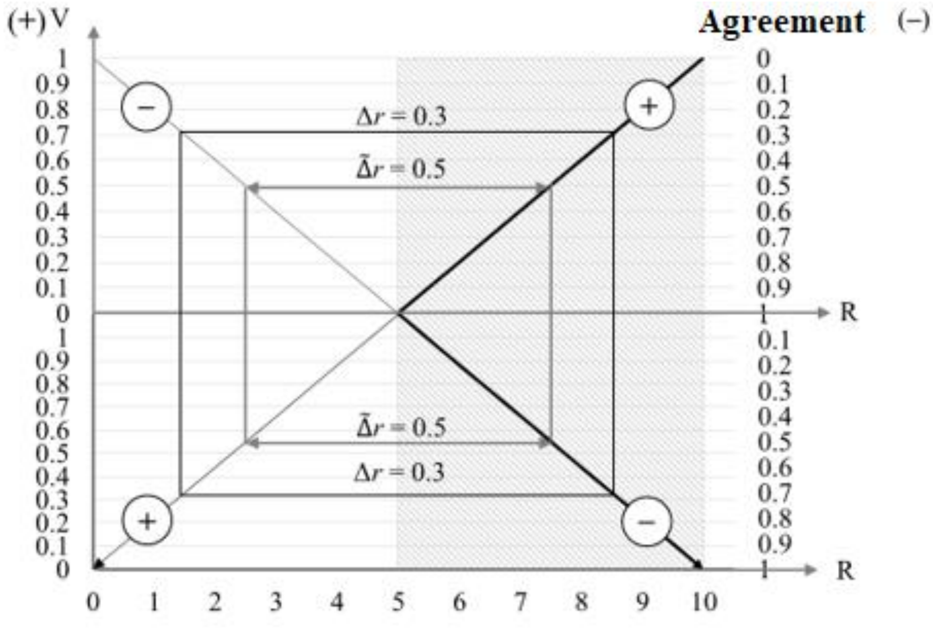
Indicators	Indicators								
	1	2	3	...	*i* - 1	*i*	...	*r*- 1	*r*
1		+	-	...	+	-	...	-	+
2	-								
3	+								
⋮	⋮								
i - 1	-								
i	+								
⋮	⋮								
r- 1	+								
r	-								

Source: own research

The half of the matrix below the diagonal is filled in by mirroring the corresponding cell above the diagonal. As can be seen from Table 2, experts fill only about half of all cells. The rest are filled in based on analytical calculations. From filling in the first row of the matrix, it becomes clear that the following pairs of indicators are intransitive: 2 – (*i* – 1); 2 – *r ;* 3 – *i* ; 3 – (*r* – 1); (*i* – 1) – (*r* – 1); *i* – (*r* – 1). The importance ratio of indicators can be indicated not only as "+" – " –", but also "1" – "0"; "yes" – "no" and so on.

The fact that the importance ratio of one pair of indicators does not depend on the importance ratios of other pairs of indicators forms the conditions on which the compatibility of expert opinions and the procedure for determining it depend. The essential point is that it must be assessed for each pair of indicators separately. Another important point is that the value of the compatibility criterion must depend on the number of identical estimates. For example, if all experts indicated that indicator X is more important than indicator Y, then the value of the criterion must be equal to 1 and vice versa; if the experts' estimates are divided in half, then the value of the criterion must be equal to 0. It follows that the threshold value of the criterion must be at least 0.5. All this can be represented graphically in the following way (Figure 3).

Figure 3. Model for determining the compatibility of expert assessment of indicator importance ranks



Source: own research

In the matrix filled in by experts (Table 2), estimates with the "+" and "–" signs are summed up for each indicator. Based on this, a summary matrix is created (Table 3).

Table 3. Summary table of ranking the importance of indicators

Indicators	Experts															
	1		2		3		…		j		…		r		$R_i^{\max}$	R_i^{min}
	+	-	+	-	+	-	…	…	+	-	…	…	+	-		
1	r_{11}	r_{11}	r_{12}	r_{12}	r_{13}	r_{13}	…	…	r_{1j}	r_{1j}	…	…	r_{1r}	r_{1r}	$r_1^{\max}$	$r_1^{\min}$
2	r_{21}	r_{21}	r_{22}	r_{22}	r_{23}	r_{23}	…	…	r_{2j}	r_{2j}	…	…	r_{2r}	r_{2r}	r_2^{max}	$r_2^{\min}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	…	…	⋮	⋮	…	…	⋮	⋮	⋮	⋮
i	r_{i1}	r_{i1}	r_{i2}	r_{i2}	r_{i3}	r_{i3}	…	…	r_{ij}	r_{ij}	…	…	r_{ir}	r_{ir}	$r_i^{\max}$	$r_i^{\min}$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	…	…	⋮	⋮	…	…	⋮	⋮	⋮	⋮
n	r_{n1}	r_{n1}	r_{n2}	r_{n2}	r_{n3}	r_{n3}	…	…	r_{nj}	r_{nj}	…	…	r_{nr}	r_{nr}	$r_n^{\max}$	$r_n^{\min}$

Source: own research

Below, for each indicator, the higher and lower estimates given by all experts are summed up separately, regardless of their sign (Table 3):

$$R_i^{\max} = \sum_{k=1}^{r} r_{ik}^{\max}; \tag{1}$$

$$R_i^{\min} = \sum_{k=1}^{r} r_{ik}^{\min}, \tag{2}$$

where $R_i^{\max}$– the sum of the estimates of the higher values of the i - th indicator (regardless of their sign); $R_i^{\min}$– the same, for the lower estimates; $r_i^{\max}$– the higher values of the *i*- th indicator regardless of the sign; $r_i^{\min}$– the same, for the lower values.

Based on formulas (1) and (2), it is possible to determine the level of expert assessment compatibility for each indicator Δr_i:

$$\Delta r_i = \frac{R_i^{\max} - R_i^{\min}}{r(n-1)} \tag{3}$$

where *n* is the number of indicators; *r* is the number of experts.

Depending on the nature of the phenomenon under study, a value of the compatibility criterion lower than 0.5 may be assumed. For example, it can be assumed that opinions will be consistent if the ratio of the number of assessments with opposite signs is close to two. In this case, Δr the value of the criterion would be close to 0.3 (Figure 3).

4. Empirical study

Comparable problems of weighting and ranking indicators for assessing countries' development have been addressed, for example, in the construction of composite indices for industry digital transformation (Yakymova et al., 2022) and in comparative assessments of waste management performance in the Baltic States (Štreimikienė, 2023).

The methodology was approved based on the main indicators reflecting the economic development of countries specified in literature (Table 4).

Table 4. Economic development indicators of countries

#	**Indicators of economic development of the country**
1	Change in gross domestic product
2	Annual growth of industrial production
3	Average monthly salary
4	Unemployment
5	Export/import ratio

Source: own research

Eight experts (responsible employees of the Ministry of Economy, Economic Development Agency) were provided with the indicator importance ranking matrix with a request to fill in its first row, as well as the interaction ratio of pairs of intransitive indicators. Responses were received from eight experts. An example of one such completed questionnaire is given in Table 5.

Table 5. Pairwise comparison matrix of the importance of country economic development indicators

Indicators	Indicators				
	Average monthly salary	Change in gross domestic product	Annual growth of industrial production	Unemployment	Export/import ratio
Average monthly salary		–	–	+	–
Change in gross domestic product	+		+	+	+
Annual growth of industrial production	+	–		+	–
Unemployment	–	–	–		–
Export/import ratio	+	–	+	+	

Source: own research

Next, a summary table of expert assessments was compiled (Table 6).

Table 6. Results of pairwise ranking of the importance of country economic development indicators

Indicators	Experts																R^{max}	R^{min}	Difference	Δr
	1		2		3		4		5		6		7		8					
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-				
Average monthly salary	1	3	2	2	1	3	2	2	0	4	1	3	2	2	3	1	22	10	12	0.375
Change in gross domestic product	4	0	3	1	4	0	2	2	1	3	1	3	2	2	3	1	24	8	16	0.500
Annual growth of industrial production	2	2	1	3	3	1	3	1	2	2	1	3	0	4	0	4	24	8	16	0.500
Unemployment	0	4	1	3	3	1	1	3	2	2	2	2	1	3	2	2	22	10	12	0.375
Export/import ratio	3	1	3	1	4	0	4	0	3	1	4	0	2	2	2	2	25	7	18	0.563

Source: own research

Table 6 shows that the estimates of all indicators are consistent. Based on the results obtained, it is possible to calculate the economic development ranks of countries in order to adequately determine their weights. They are necessary for a multi-criteria assessment of the state of economic development.

5. Conclusions

For quantitative assessment of the state of development of socio-economic systems, it is necessary to know the values and weights of the indicators reflecting it. The latter are determined by experts. When there are many indicators due to the limited capabilities of experts (they can adequately assess the weights of only a limited number of indicators), determining their weights becomes problematic. This problem can be simplified by carrying out the assessment in two stages. In the first, the importance ranks of the indicators are determined, in the second, based on these ranks - weights, i.e. specific importance estimates expressed in numbers are given. The adequacy of expert assessment in this case increases due to the fact that it is easier for experts to indicate which of the two indicators is more important than to immediately assess this ratio quantitatively, in numbers. Once the ranks are known, of course, a greater weight will be given to the indicator with a higher rank, i.e. the expert will need to mentally assess the importance ratio of all other indicators.

As in the case of determining weights, it is necessary to check the compatibility of expert assessments of the importance ranks of indicators. This is complicated when there are many indicators. Compatibility methods for determining weights are not suitable, since in this case the weights are determined quantitatively, in numbers, and the importance ranks are determined qualitatively, i.e. by unambiguously indicating which of the two indicators is more important. In this case, it is possible to determine how many identical estimates were in their total number, and therefore the sums of the opposite estimates. Compatibility will be reflected by the ratio of the difference of these sums to the total number of estimates. Based on this, it is possible to determine the minimum value of the compatibility criterion, as well as the number of identical estimates reflecting it.

The proposed methodology for determining the compatibility of expert assessment of the importance ranks of indicators is universal. It can be applied not only in the process of determining the weights of indicators in multi-criteria assessment, but also in determining the order of implementation of measures of any type of development plans. It is necessary to know this, since due to different importance and financial capabilities, it is impossible to implement all of them simultaneously. In addition, the order is determined by their interdependence.

The effective application of the proposed methodology may be limited by the large parameters of the pairwise comparison matrix of the importance of indicators, therefore, in further developing the research, calculations should be performed in an automated manner.

References

Arditi, D., Gunaydin, H.M. (1999). Perceptions of Process Quality in Building Projects. *Journal of Management in Engineering*, 15 (2), 43-53. https://doi.org/10.1061/(ASCE)0742-597X(1999)15:2(43)

Azizi, M., Ramezanzadeh, M. (2016). Location selection of agricultural-residuals particleboard industry through group decision: The case study of northern Iran. *Economics, Management and Sustainability*, 1(1), 14-22. https://doi.org/10.14254/jems.2016.1-1.2

Barvidas, A. (2010). Construction Management Mode Selection to Ensure more Efficiency and Quality. Doctoral dissertation. Vilnius: Technika.

Brans, J.P., De Smet, Y. (2016). PROMETHEE Methods. In: Greco, S., Ehrgott, M., Figueira, J. (eds) Multiple Criteria Decision Analysis. International Series in Operations Research & Management Science, vol 233. Springer, New York, NY. https://doi.org/10.1007/978-1-4939-3094-4_6

Egerová, D., Kutlák, J., Eger, L. (2021). Millennial job seekers' expectations: How do companies respond? *Economics & Sociology*, 14(1), 46-60. https://doi.org/10.14254/2071-789X.2021/14-1/3

Fishburn, P.C. (1971). A comparative analysis of group decision methods. *Behavioral Science*, 16(6), 538–544. https://doi.org/10.1002/bs.3830160604

Gedvilaitė, D. (2019). The assessment of sustainable development of a country's regions. Doctoral dissertation. Vilnius: Technika.

Ginevičius, R., Gedvilaitė, D., Stasiukynas, A., Čepel, M. (2018). Integrated assessment of the socioeconomic systems' development. *Economics & Sociology*, 11(1), 11-21. https://doi.org/10.14254/2071-789X.2018/11-1/1

Ginevičius, R., Gedvilaitė, D., Stasiukynas, A., Suhajda, K. (2022). Complex Expert Assessment of the State of Business Enterprises. *Acta Polytechnica Hungarica*, 19(2), 135–150. https://doi.org/10.12700/APH.19.2.2022.2.8

Ginevičius, R., Nazarko, J., Gedvilaite, D., Petraskevicius, V. (2023). Ranking the importance of multi-criteria evaluation indicators based on their transitivity. *Economics & Sociology*, 16 (4), 309-320. https://doi.org/10.14254/2071-789X.2023/16-4/15

Hogeforster, M., & Ginevičius, R. (2024). Implementation of the work-based learning model in SMEs: Ranking the indicators of feasibility based on transitivity. *Economics & Sociology*, 17(3), 291-302. https://doi.org/10.14254/2071-789X.2024/17-3/15

Hwang, C.L., & Yoon, K. (1981). Multiple Attribute Decision Making. Methods and Application a State-of-the-Art Survey. Lecture Notes in Economics and Mathematical Systems 186. Berlin, Heidelberg: Springer.

Jakučionis, S., & Ustinovičius, L. (2000). Multicriteria analysis of the variants of the old town building renovation in the marketing aspect. *Statyba - Civil Engineering*, 6(6), 469–475. https://doi.org/10.1080/13921525.2000.10531633

Kaya, T., Kahraman, C. (2011). A fuzzy approach to e-banking website quality assessment based on an integrated AHP-ELECTRE method. *Technological and Economic Development of Economy*, 17 (2), 313-334. https://doi.org/10.3846/20294913.2011.583727

Keeney, R.L., Raiffa, H. (1976). *Decisions with multiple objectives: Preferences and value tradeoffs* (Wiley series in probability and mathematical statistics). John Wiley & Sons.

Kendall, M.G. (1975). *Rank Correlation Methods* (4th ed.). London: Charles Griffin.

Keshavarz Ghorabaee, M., Zavadskas, E. K., Olfat, L., & Turskis, Z. (2015). Multi-criteria inventory classification using a new method of evaluation based on distance from average solution (EDAS). *Informatica*, 26(3), 435-451. https://doi.org/10.15388/Informatica.2015.57

Kuzior, A., Hrytsenko, L., Trojanek, M., & Oláh, J. (2026). GovTech as a "technological-institutional–human" system: Non-linear effects on social progress and human well-being. *Human Technology*, 22(1), 198-218. https://doi.org/10.14254/1795-6889.2026.22-1.10

Łopatka, P., Tłuczak, A., Jadach, R. (2023). Multi-criteria decision support methods for the selection of the optimum contractor: A case study of a passenger transfer centre. *Journal of Sustainable Development of Transport and Logistics*, 8(2), 219-228. https://doi.org/10.14254/jsdtl.2023.8-2.16

Morkūnaitė, Ž. (2020). Multiple Criteria Model for Reconstruction Decisions Selection of Cultural Heritage Buildings. Doctoral dissertation. Vilnius: Technika.

Mubarak, E.M., Zuhair Ridha, A., Abdullah, Z.T. (2024). Multi-criteria assessment methodology for remanufacturing conventional grinding machines into CNC machine tools. *Economics, Management and Sustainability*, 9(2), 29-43. https://doi.org/10.14254/jems.2024.9-2.3

Podvezko, V. (2005). Agreement of expert estimates. Technological and economic development of economy, 11(2), 101–107. https://doi.org/10.3846/13928619.2005.9637688

Podvezko, V. (2008). Comprehensive evaluation of complex quantities. *Business: Theory and Practice*, 9 (3), 160-168. https://doi.org/10.3846/1648-0627.2008.9.160-168

Podvezko, V., & Podviezko, A. (2009). PROMETHEE I method application for identification of the best alternative. Business: Theory and Practice, 10(2), 84-92. https://doi.org/10.3846/1648-0627.2009.10.84-92

Podvezko, V., & Podviezko, A. (2015). Eliciting opinions of experts using uncertainty. *Lietuvos Matematikos Rinkinys*, 56, 78-83. https://doi.org/10.15388/LMR.A.2015.14

Reiff, M., Surmanová, K., Balcerzak, A. P., Pietrzak, M.B. (2016). Multiple criteria analysis of European Union agriculture. *Journal of International Studies*, 9(3), 62-74. https://doi.org/10.14254/2071-8330.2016/9-3/5

Roy, B. (1996). *Multicriteria Methodology for Decision Aiding*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Saaty, T.L. (1980). *The Analytic Hierarchy Process*. New York: McGraw-Hill.

Saaty, T.L., Vargas, L.G., & Dellmann, K. (2003). The allocation of intangible resources: the analytical hierarchy process and linear programming. *Socio-Economic Planning Sciences*, 37 (3), 169–184. https://doi.org/10.1016/S0038-0121(02)00039-3

Šarka, V. (2000). Synthesis of multi-criteria solutions when selecting rational technological-organizational options for buildings. Vilnius: Technika.

Štreimikienė, D. (2023). Waste management in Baltic States: Comparative assessment. Journal of International Studies, 16(4), 39-51. https://doi.org/10.14254/2071-8330.2023/16-4/3

Tutygin, A. & Korobov, V. (2010). Advantages and disadvantages of the analytical hierarchy process [Преимущества и недостатки метода анализа иерархий]. *Natural and Exact Sciences* [Естественные и точные науки], (122), 108–115.

Vasylieva, T., Krawczyk, D., Rącka, I., Fenyves, V. (2026). Digital government and quality of life: Unpacking the human-centred mechanisms of e-government development. *Human Technology*, 22(1), 178-197. https://doi.org/10.14254/1795-6889.2026.22-1.9

Wątróbski, J., Jankowski, J., Ziemba, P. (2016). Multistage performance modelling in digital marketing management. *Economics & Sociology*, 9(2), 101-125. https://doi.org/10.14254/2071-789X.2016/9-2/7

Wu, H.Y., Tzeng, G.H., Chen, Y.H. (2009). A fuzzy MCDM approach for evaluating banking performance based on Balanced Scorecard. *Expert Systems with Applications*, 36, 10135–10147. https://doi.org/10.1016/j.eswa.2009.01.005

Yakymova, L., Novotná, A., Kuz, V., Tamándl, L. (2022). Measuring industry digital transformation with a composite indicator: A case study of the utility industry. *Journal of International Studies*, 15(1), 165-186. https://doi.org/10.14254/2071-8330.2022/15-1/11