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Assessing alternatives to the development of administrative-economic units applying the FARE-M Method

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Abstract: *The socio-economic development of economic-territorial units subordinate to administrative-management institutions appears as one of the main tasks. The values of alternative indicators reflecting socio-economic development may differ, which makes it difficult to unambiguously assess the importance of the indicators. The applied available methods are either too receptive or does not provide sufficient accuracy. The proposed FARE-M methodology for determining the importance of indicators is the prolongation of the technique for establishing the importance of FARE (Factor Relationship) weights already used for research purposes. The employed technique is based on the internal balance of system elements that is the essential systemic feature. This allows, unlike in the case of the AHP method, the weights of the indicators to be determined with reference to the first row of the data matrix only.*

Keywords: administrative-management institutions, socio-economic development of economic-territorial units, multi-criteria methods.

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Introduction

One of the most important operational functions of both national and local administrative-management institutions (AMIs) is the adoption of measures for the development of administrative territories and economic entities subordinate to administrative management institutions. The measures cover economic, social, ecological, etc. aspects. Under market economy conditions, it is common practice for several or more alternatives to the solutions to be developed in the first place (Androniceanu et al., 2021). This is not accidental, because the problem of socio-economic development is, by nature, complex, integrated, and therefore manifests

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itself in reality in a variety of respects. Upon the examination of possible alternatives to the above introduced problem, responsible persons must choose the one they consider most appropriate to achieve the goal. At present, such alternative is frequently selected in a purely intuitive way with reference solely on experience and intuition. Meanwhile, the values of the indicators reflecting one alternative may be higher compared to the analogous values of other alternatives, whereas the other values may be lower. In the event of a sufficient number of such indicators, an adequate picture of assessment is hardly possible when neglecting specific methods capable of considering the created complex situation. The situation may further encounter problems in the case indicators are multi-dimensional and change in opposite directions, i.e. an increase in some of the values of certain indicators improves the situation while other indicators may degrade, but most importantly, they are not equally relevant in terms of dealing with the problem. In order to perform an integrated assessment of alternatives, all above discussed indicators must be combined into a single aggregate. The possibility is provided employing multi-criteria methods gaining more and more application (MacCrimmon, 1968; Hwang & Yoon, 1981; Opricovic & Tzeng, 2004; Bathaei et al., 2019; Brans et al., 1984; Brauers et al., 2010; Srinivasan & Shocker, 1973; Brauers & Ginevičius, 2010).

By their nature, these methods are universal for several reasons. First, they can be applied to any kind of quantitative assessment of a SES's condition. Second, in case the situation under assessment changes, it is possible to freely change both a set of indicators representing a SES's condition and evaluations of the significance of these indicators. Namely because of these features, MCDMs are widely applied in engineering, social and humanitarian sciences, and other fields of research.

In addition to application of MCDMs, great attention is paid to their improvement, as evidenced by the growing number of the methods developed (SAW – MacCrimmon, 1968; TOPSIS – Hwang, Yoon, 1981; VIKOR – Opricovic, Tzeng, 2004; Bathaei et al., 2019; COPRAS – Kaklauskas et al., 2005; ELECTRE III and ELECTRE IV – Roy, 1968; Roy, 1996; PROMETHEE – Brans et al., 1984; LINMAP – Srinivasan, Shocker, 1973; MOORA and MULTIMOORA – Brauers, Ginevičius, 2010; Brauers et al., 2010, etc.).

This is because it is unanimously acknowledged that there can hardly be any ideal method. Hence, each of the existing and newly proposed methods has both strengths and weaknesses.

The philosophy of multi-criteria assessment is reflected in the classical SAW (Single Additive Weighting) method. Its core is summation of the values of weighted indicators. The word "weighted" means that the actions are performed with transformed values, i.e. normalized values of indicators are multiplied by their significance (Hwang & Yoon, 1981).

The product of indicator values and weights is employed in many multi-criteria assessment methods. This leads to a relevant scientific problem of how to adequately estimate indicator significance. At present, it is usually done through expert evaluations (Podvezko, 2007).

A method of evaluating indicator significance largely depends on the number of indicators. When this number is small, direct evaluation can be employed, i.e. significance of various indicators can be divided into unit parts. The problems related to social-economic development can only be adequately reflected by a number of indicators, which raises a dilemma: on one hand, an expert can adequately evaluate the significance of only a limited number of indicators (Ginevičius, 2009; Ginevičius & Podvezko, 2005); on the other hand, a significant reduction in the number of indicators will result in the loss of adequacy of the quantitative evaluation of a phenomenon under consideration. Therefore, in addition to simple methods, more complex ones, aimed at expanding the adequacy of expert evaluation, i.e. enabling experts to evaluate a larger number of indicators, were developed (Saaty, 2001). An in-depth analysis revealed not only the strengths, but also the weaknesses of these methods, making it relevant to continue research in this direction.

1. Literature review

The problem of evaluating the significance of multi-criteria assessment indicators was analysed by many scientists (Hwang & Yoon, 1981; Chu et al., 1979; Hwang & Lin, 1987; Sawaragi et al., 1987; Zavadskas & Kaklauskas, 1996; Podvezko, 2007; Pekelman & Sen, 1974; Rogers, 2000; Song et al., 2017; Prasuvic & Prasuvic, 2017; Turskis et al., 2017; Ramkumar & Samenta, 2018). It should be noted that indicator significance can be categorised as objective and subjective. Objective significance methods describe indicator dominance levels in an alternative under consideration, so they are most commonly applied in engineering, technological and similar sciences, and the main purpose of multi-criteria assessment in this case is to arrange the priority order of the alternatives of the objects under consideration (projects, engineering-technological solutions, etc.). Subjective significance methods indicate how significant particular indicators are in assessing the condition of a phenomenon in question not only in terms of individual indicators, but also with regard to comparing some of them. For this reason, subjective significance methods are widely spread in social sciences (Zavadskas et al., 1994; Kaklauskas et al., 2016; Brauers & Zavadskas, 2006; Cinelli et al., 2014; Baležentis et al., 2010; Zavadskas et al., 2014; Keshavarz et al., 2015; Slavinskaitė, 2017; Nugaras, 2014; Oželienė, 2019; Volkov, 2018). In order to evaluate the significance of objective indicators, the entropy method is commonly applied (Hwang, Yoon, 1981). Other methods, such as LINMAP (Linear Programming Techniques for Multidimensional analysis of Priviledged) (Srinivasan & Shocker, 1973), mathematical programming models (Pekelman & Sen, 1974), etc. are also employed. Nevertheless, subjective methods for evaluating indicator significance are more common (Saty, 1977; Chu et al., 1979; Hwang & Yoon, 1989; Zavadskas & Kaklauskas, 1987).

The following approaches to the determination of indicator weights can be distinguished: direct, ranking, assignment of coefficients, AHP (Tutygin & Korobov, 2010). A different approach was later proposed, which was named FARE (Ginevičius, 2009; Saaty, 2001).

Direct determination of indicator weights. In this case, the experts assign weights to the indicators immediately following the condition: $\sum_{i=1}^{n} \omega_i = 1$, where ω_I is the weight of the *i-th* indicator, $i = \overline{1n}$, where *n* is the number of indicators.

The disadvantage of this method is that the expert, when giving weight to an indicator, has to bear in mind the importance of all other indicators for the phenomenon in question. The complexity of evaluation increases geometrically as the number of indicators increases. There is a limit at which an expert can no longer adequately assess the weights of indicators.

Ranking of indicators. This method of determining indicator weights is easier than the first one because the expert does not need to control the total sum of the weighting factors, leaving the rankings in ascending or descending order, as can be seen in Figure 1 (Kendall and Gibbons, 1990).

Figure 1. Ranking of indicators

$$\left.\begin{matrix} R_{11} & R_{12} & \cdots & R_{1j} & \cdots & R_{1r} \\ R_{21} & R_{22} & \cdots & R_{2j} & \cdots & R_{2r} \\ \vdots & \vdots & & \vdots & & \vdots \\ R_{i1} & R_{i2} & \cdots & R_{ij} & \cdots & R_{ir} \\ \vdots & \vdots & & \vdots & & \vdots \\ R_{m1} & R_{m2} & \cdots & R_{mj} & \cdots & R_{mr} \end{matrix}\right\}, \qquad (1)$$

where R_{ij} is the estimate of the *i-th* indicator given by the *j-th* expert.

Experts can give the same rank to several or more indicators. In this case, the terminal values can be obtained as averages of the estimates. On the other hand, in this case, the expert must also bear in his mind the relationship between the importance of all the indicators.

Assignment of coefficients to indicators. In this case, the expert must assess the importance of each indicator individually in the range of the adopted scale, independently of the other indicators, as can be seen in Figure 2 (Tutygin and Korobov, 2010).

Figure 2. Assignment of coefficients to indicators

$$\left.\begin{matrix} Q_{11} & Q_{12} & \cdots & Q_{1j} & \cdots & Q_{1r} \\ Q_{21} & Q_{22} & \cdots & Q_{2j} & \cdots & Q_{2r} \\ \vdots & \vdots & & \vdots & & \vdots \\ Q_{i1} & Q_{i2} & \cdots & Q_{ij} & \cdots & Q_{ir} \\ \vdots & \vdots & & \vdots & & \vdots \\ Q_{m1} & Q_{m2} & \cdots & Q_{mj} & \cdots & Q_{mr} \end{matrix}\right\}, \qquad (2)$$

where Q_{ij} is the estimate of the *i*-th indicator on the accepted score scale given by the *j*-th expert.

In this case, the weight of indicator ***i***-th will be determined as follows:

$$\omega_i = \frac{\sum_{j=1}^{r} Q_{ij}}{\sum_{j=1}^{r} x_{ij} \sum_{i=1}^{m} Q_{ij}}, \qquad (3)$$

where ω_I is the weight of the ***i***-th indicator.

In this case, the expert must inevitably take into account the importance of estimates he will give to other indicators when assessing the indicator.

Determining the weight of indicators applying the FARE method (Ginevičius, 2011). It provides for a fundamentally different approach to this problem. In contrast to the AHP method, it relies on the interaction of indicators that are treated as elements of the same system. The method requires expert assessments by filling in only the first line of the basic matrix, which indicates the extent to which the indicators influencing the phenomenon in question depend on the most important indicator. All other rows of the matrix derive from the first row and are filled in by analytical calculations. This results in an ideally matched matrix that does not require a peer review of the consistency of the assessment. On the other hand, the practical application of the method has shown that it is expedient to improve the procedure for filling in the first row of the matrix.

Determining the weight of indicators applying the AHP method (Saaty, 2001). The Saaty pairwise comparison method expands the capacities of expert evaluation, i.e. it enables experts to simultaneously evaluate the significance of a larger number of indicators. At the time when it emerged, this method was a step forward in comparison to direct evaluation of indicator significance, when indicator weights are estimated immediately for unit parts, subject to the condition $\sum_{i=1}^{n} w_i = 1{,}0$; here w_i represents significance of the *i*th indicator, and n – the number of the indicators under consideration. The essence of the Saaty method is significance of a pair of indicators to a phenomenon in question. The result of such evaluation is a square matrix **P**, which is completed by each of the experts according to the evaluation scale proposed by T. Saaty (Saaty, 1980) (Figure 3).

Figure 3. The Saaty pairwise comparison matrix

$$\mathbf{P} = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & & p_{2n} \\ \cdots & \cdots & & \cdots \\ p_{n1} & p_{n2} & \cdots & p_{nn} \end{bmatrix} = \begin{bmatrix} \frac{\overline{q}_1}{\overline{q}_1} & \frac{\overline{q}_1}{\overline{q}_2} & \cdots & \frac{\overline{q}_1}{\overline{q}_i} & \cdots & \frac{\overline{q}_1}{\overline{q}_n} \\ \frac{\overline{q}_2}{\overline{q}_1} & \frac{\overline{q}_2}{\overline{q}_2} & & \frac{\overline{q}_2}{\overline{q}_i} & & \frac{\overline{q}_2}{\overline{q}_n} \\ \cdots & & & \cdots & & \cdots \\ \frac{\overline{q}_n}{\overline{q}_1} & \frac{\overline{q}_n}{\overline{q}_2} & \cdots & \frac{\overline{q}_n}{\overline{q}_i} & \cdots & \frac{\overline{q}_n}{\overline{q}_n} \end{bmatrix} \tag{4}$$

(*Source:* compiled by the author)

Figure 3 indicates that, in an ideal case, when the elements in matrix **P** are ratios of unknown weights, the matrix is inversely symmetric, i.e. $p_{ij} = 1/p_{ji}$. In fact, $p_{ij} = \frac{w_i}{w_j}$, and $p_{ji} = \frac{w_j}{w_i}$; here w_i, w_j represent the weights of the *i*th and *j*th indicators respectively. It follows that it is possible to fill the part of the matrix above or below the main diagonal.

The inverse symmetry of matrix **P** in an ideal case is interpreted as follows: for instance, if one object is three times heavier than another, then the latter is three times lighter or 1/3 times heavier than the former.

In this way, the corresponding elements of any two columns in the matrix will be proportional, which means that the ratios of the elements in the respective columns will be the same. For example, let us consider the ratio of the elements in the first and second columns:

$$\frac{p_{i1}}{p_{i2}} = \frac{\frac{w_i}{w_1}}{\frac{w_i}{w_2}} = \frac{w_2}{w_1}, \ (i = 1, ..., m). \tag{5}$$

This will be the case with any other elements in the rows of any matrix **P**. Based on its application practice, it makes sense to examine its pros and cons. This is discussed in some sources (Tutygin & Korobov, 2010).

Pair evaluation of the impact of indicators. Due to the impact of socio-economic conditions on the phenomenon in question, the number of indicators included in the system often changes. The AHP method allows no significant losses, as all that remains is to add or subtract columns and rows, i.e. to form a new matrix. Previous evaluation results remain unchanged and a full update of the evaluation form is not required. In other words, it is just an increase or decrease in the linear space of the matrix.

Presence of a verbal-digital scale. Conventional digital scales are not always convenient for comparing indicators because they are often multidimensional. This comparison is particularly difficult when some factors are quantitative and others are qualitative. The Saaty verbal-digital scale avoids this inconvenience.

The AHP approach integrates the peer review compatibility criterion. Various numerical indices are commonly used to determine compatibility. In the case of AHP, the free choice of the optimal criterion provides wider possibilities for this. As a result, the compatibility ratio is also convenient, especially in terms of the programming of the whole process and the automation of calculations.

The AHP approach to indicator weights raises the most doubts about the interpretation of the results and, in particular, concerns the quality control of the peer review. In particular, the question of the ideal expert remains open. Calculations show that in some cases, strict adherence to the principle of transitivity yields a result that contradicts logic (Tutygin & Korobov, 2010).

2. Methodology

When evaluating indicator weights by AHP method, experts fill all the rows of the pairwise comparison matrix (Figure 3). It means that if an expert, for instance, is evaluating 10 indicators, he/she needs to weigh the significance of 45 indicator pairs, i.e. $\frac{m(m-1)}{2}$ pair interactions (*m* – the number of interactions between indicators) (Ginevičius, 2009; Ginevičius, 2011), which is hardly possible.

The question then arises as to how reduce the number of evaluations. A solution to this problem was proposed based on FARE method (Ginevičius, 2011). The core of this method is the assumption that the essential feature of the evaluated set of indicators, as of a system, is stability provided by its initial elements, i.e. indicator equilibrium. This equilibrium can be achieved by balancing two parameters of an indicator system – direction and strength of the interaction. In accordance with this principle, an initial limited amount of information on the direction and strength of the interactions between one and the rest of indicators is sufficient to form the whole system. In this case, experts evaluate not $\frac{m(m-1)}{2}$, but $m - 1$ interactions, i.e. $\frac{m}{2}$ times fewer interactions. The direction and strength of the interactions between all other indicators derive from the system equilibrium requirements, thus they are obtained analytically, without participation of experts. At the same time, full consistency in the indicator significance evaluation matrix is achieved.

An important role in the FARE approach is played by the baseline potential of the indicator impact on or significance to a phenomenon under consideration, which is assumed the same for all indicators. An increase or decrease in this potential stems from differences in the significance of the indicators compared. The weight of an indicator is estimated as a ratio of its actual potential to the total baseline potential of all indicators in a system. The analysis of FARE application revealed that in order to raise its adequacy, it is appropriate to improve the method of obtaining initial expert information.

The basic matrix for evaluating the significance of multi-criteria assessment indicators by FARE-M method is depicted in Figure 4.

Figure 4. Basic matrix for evaluating the significance of multi-criteria assessment indicators by FARE-M method

$$\mathbf{F} = \begin{vmatrix} - & \Delta p_{12} & \Delta p_{13} & \dots & \Delta p_{1i} & \dots & \Delta p_{1m} \\ -\Delta p_{21} & - & \Delta p_{23} & \dots & \Delta p_{2i} & \dots & \Delta p_{2m} \\ -\Delta p_{31} & -\Delta p_{32} & - & \dots & \Delta p_{3i} & \dots & \Delta p_{3m} \\ \vdots & \vdots & \vdots & & \vdots & & \vdots \\ -\Delta p_{i1} & -\Delta p_{i2} & -\Delta p_{i3} & \dots & - & \dots & \Delta p_{im} \\ \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots \\ -\Delta p_{m1} & -\Delta p_{m2} & -\Delta p_{m3} & \dots & -\Delta p_{mi} & \dots & - \end{vmatrix} \qquad (6)$$

As it can be seen from Figure 4, the basic matrix **F** is inversely symmetric with respect to the diagonal. This can be explained as follows. The estimates over the diagonal of matrix **F** indicate the extent to which an indicator with a higher rank of significance raises the baseline potential of its impact on a phenomenon under consideration relative to an indicator with a lower rank of significance. The baseline potential of the impact of the latter indicator decreases by the same amount. For instance, if the baseline potential of the impact of indicator 2 increased by Δp_{23} relative to indicator 3, then the baseline potential of the impact of indicator 3 decreased by the same amount, i.e. by $-\Delta p_{32}$ (Figure 4).

According to their meaning, all rows (columns) in matrix **F** can be divided into two parts: first row (first column) and all remaining rows (columns). Values e_{1i} (first row) represent an increase in the baseline potential of the most significant indicator, obtained by ranking the significance of the impact of all indicators in this row on a phenomenon under consideration, due to its greatest significance in comparison to the significance of other indicators. These values are obtained through expert evaluation, for instance, on a 10-grade scale indicating the extent to which a particular indicator is less significant in comparison to most significant one.

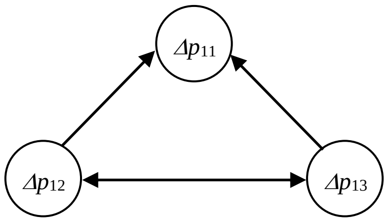
The other rows in the matrix (Figure 4) reflect an increase or a decrease in the baseline potential of the significance of all other indicators, depending on the level of their significance indicated in the first row of the matrix. Before performing these calculations, the first row of matrix **F** needs to be transformed so that an indicator with a higher rank of significance would raise its baseline potential by accordingly reducing the potential of an indicator with a lower rank of significance:

$$\Delta\tilde{p}_i = \Delta p_{11} - \Delta p_{1i}, \tag{7}$$

here $\Delta\tilde{p}_i$ – an increase in the baseline potential of the *i*th indicator; Δp_{11} – the impact of the most significant (highest-ranked) indicator on a phenomenon under consideration (highest score on the rating scale); Δp_i – the same, of the *i*th indicator.

Based on the first row of matrix **F**, an analytical method can be invoked to evaluate an increase in the baseline potential of all other indicators, depending on the ranks of their significance. An increase in the baseline potential of the first, most significant, indicator in relation to lower significance of the second and third indicators is already known. Based on that, an increase in the baseline potential of the second indicator in relation to the third indicator can be evaluated. This can be done on the basis of a triangle formed by considering the interactions between the three indicators (Figure 5):

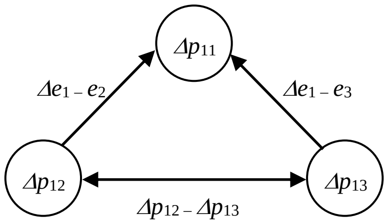
Figure 5. The initial graph of the impact of particular indicators on a phenomenon under consideration



(*Source:* compiled by the author)

So that the microsystem depicted in Figure 3 would keep its equilibrium, i.e. so that it would be stable, the direction and strength of the interactions between its elements need to be matched. The direction and strength of the interactions Δp_{11} Δp_{12} and Δp_{11} Δp_{13} are already known. Based on the transitivity properties of the quantities in question (Ginevičius & Podvezko, 2004), it follows that indicator Δp_{11} is more significant than indicator Δp_{12}; thus, indicator Δp_{12} is more significant than indicator Δp_{13} with a lower rank of significance. In this case, the graph depicted in Figure 3 will be transformed as follows (Figure 6).

Figure 6. The graph of the matched significance of the three indicators



(*Source:* compiled by the author)

Based on the principle depicted in Figure 6, the directions and strengths of the interactions between all indicators are matched.

Figure 4 indicates that in relation to its diagonal, the basic matrix has two symmetrical sides which carry opposite signs. The positive sign indicates an increase in the baseline potential of the impact of an indicator, while the negative sign marks a decrease in the baseline potential of the impact of an indicator by the same amount.

By summing the rows of matrix **F** filled in this way, the total increase or decrease in the baseline potential of the indicators is obtained. The actual potential P_i^f of the impact of the *i*th indicator is estimated as follows:

$$P_i^f = P + \sum_{i=1}^{m} \Delta p_i \,, \tag{8}$$

here: P – baseline potential of the impact of the indicators on a phenomenon under consideration; $\sum_{i=1}^{m} \Delta p_i$ – total increase (decrease) in the baseline potential of the *i*th indicator depending on its significance rank.

The baseline potential of the impact is estimated as follows:

$$P = \Delta p_{11}(m-1). \tag{9}$$

In order to estimate indicator significance weights, value P_i^f needs to be compared with the baseline potential of the entire indicator system, which is estimated as follows:

$$P^s = m \cdot P = \Delta p_{11} m(m-1), \quad (10)$$

here: P^s – baseline potential of the impact of the entire indicator system on a phenomenon under consideration.

Indicator weights are estimated as follows:

$$w_i = \frac{P_i^f}{P^s}, \quad (11)$$

here: w_i – weight of the ith indicator.

A deeper analysis of matrix **F** indicated that the matrix is characterised by certain regularities that allow all other rows to be filled quickly and easily based on the first row. This can be performed as follows:

$$\Delta p_{ij} = \Delta p_{1j} - \Delta p_{1i};\ i, j = 2, 3, ..., m,\ \Delta p_{ji} = -\Delta p_{ij};\ i \neq j;\ i \neq 1;\ j \neq 1, \quad (12)$$

here: Δp_{ij} – value of the element in the jth column of the ith row in matrix **F**; Δp_{1j}, Δp_{1i} – elements of the first row, respectively.

The actual total baseline potential P_i^f of the impact of the ith indicator can be estimated based on only the first row of matrix **F**, i.e. filling in all other rows becomes completely unnecessary. This can be performed as follows:

$$P_i^f = P_1^f - m \cdot \Delta p_{1i}. \quad (13)$$

Based on formula (10), weight of the ith indicator in its extensive form is expressed as follows:

$$w_i = \frac{P_i^f}{P^s} = \frac{P_1 - m\Delta p_{1i} + \Delta p_{11}(m-1)}{m\Delta p_{11}(m-1)}. \quad (14)$$

The methodology proposed for estimation of the weights of particular indicators by FARE-M method differs fundamentally from FARE method in terms of the order in which first (base) row of matrix **F** is filled. The former methodology is more understandable and adequate to real situations.

3. Empirical Research

Let us presume that a phenomenon under consideration is reflected by seven indicators. Experts awarded the following ranks of the indicator significance (Table 1).

Table 1. Significance ranks of the indicators representing a phenomenon under consideration

Indicators	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Significance ranks	2	6	3	7	1	5	4

(*Source:* compiled by the author)

Table 1 shows that indicator 5 is awarded the highest rank. Experts need to consider indicator significance ranks, and based on a selected 10-grade scale, need to indicate to which extent the impact of all other indicators on a phenomenon under consideration is smaller compared to the impact of the indicator with the highest rank (the impact of the indicator with the highest rank is awarded 10 points). Let us presume that expert evaluation provided the following results (Table 2):

Table 2. Evaluations of the impact of particular indicators on a phenomenon under consideration

Indicator	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Evaluation of the indicator impact on a phenomenon under consideration	9	3	7	1	10	4	6

(*Source:* compiled by the author)

The evaluations of the impact of particular indicators provided in Table 2 need to be transformed based on formula (6) (Table 3).

Table 3. Transformed values of the indicator significance

Indicators	1	2	3	4	5	6	7
Transformed values of the indicator significance	1	7	3	9		6	4

According to the above-describe procedure (Figures 5-6), all rows in matrix **F** are filled.

Figure 7. Aggregate matrix of the impact of particular indicators representing a phenomenon under consideration

Indicator	**5**	**1**	**3**	**7**	**6**	**2**	**4**	$\sum_{i=1}^{m} \Delta p_i$	P_i^f	w_i
5		1	3	4	6	7	9	30	90	0.214
1	–1		2	3	5	6	8	23	83	0.198
3	–3	–2		1	3	4	6	9	69	0.164
7	–4	–3	–1		2	3	5	2	62	0.148
6	–6	–5	–3	–2		1	3	–12	48	0.114
2	–7	–6	–4	–3	–1		2	–19	41	0.098
4	–9	–8	–6	–5	–3	–2		–33	27	0.064
Σ	–30	–23	–9	–2	12	19	29	0	420	1.000

(*Source:* compiled by the author)

Values P_i^f are estimated based on formula (12).

$P_1^F = 30 - 7 \cdot 1 = 23,$
$P_3^F = 30 - 7 \cdot 3 = 9,$
$P_7^F = 30 - 7 \cdot 4 = 2,$
$P_6^F = 30 - 7 \cdot 6 = -12,$
$P_2^F = 30 - 7 \cdot 7 = -19,$
$P_4^F = 30 - 7 \cdot 9 = -33.$

Based on formulas (10) and (13), indicator weights are estimated. The results are provided in Figure 7.

The methods FARE, and especially FARE-M, developed for estimation of the weights of multi-criteria assessment indicators are comparatively new, which raises the question of their validity. It is logical to assume that they could be treated as valid if the indicator weights, estimated based on these methods, correlate with the weights, estimated by applying the AHP method, which is widely used today.

4. Discussion

In order to justify the usefulness of the proposed FARE-M method, it is appropriate to compare it with perhaps the most widely used AHP method today.

For comparing AHP and FARE-M methods, an expression characterized by 12 indicators has been selected. The weights of the indicators determined applying both methods are provided in Table 4.

Table 4. The weights of the indicators of the investigated expression established applying AHP and FARE-M methods

No of the indicator	1	2	3	4	5	6	7	8	9	10	11	12
Weight of the indicator (AHP method)	0,195	0,150	0,099	0,071	0,035	0,104	0,061	0,090	0,071	0,087	0,018	0,019
Weight of the indicator (FARE-M method)	0,135	0,107	0,089	0,073	0,067	0,098	0,071	0,085	0,076	0,080	0,062	0,057

(*Source:* Ginevičius, 2011)

Table 4 shows that similar weights have been obtained in both cases. A close relationship between the obtained results is also confirmed by the value of the correlation coefficient. It was found that $r = 0.98$. In addition, a comparison of both methods and other weighting methods has disclosed that FARE rather than AHP method gives a more accurate result (Ginevičius, 2011). Thus, two conclusions can be drawn. First, the FARE-M method provides an adequate assessment of indicator weights; second, applying the FARE-M method requires a significantly smaller volume of calculations, is more understandable, eliminates the risk of inconsistency in the initial expert assessment and is therefore much more appropriate for practical calculations (Grondys et al. 2021).

5. Conclusions

The socio-economic development of economic-territorial units subordinate to administrative-management institutions emerges as one of the main functions, and therefore the reached strategically adequate decisions are of utmost importance. The intercomparison of possible alternatives commonly leads to making decisions. The values of the indicators reflecting alternatives may vary. Thus, the gained experience or intuition might be not enough to rank the alternatives conforming to their importance in terms of the objective pursued. For integrated assessment, all indicators need to be combined into a single aggregate employing multi-criteria methods. Establishing the weight of indicators plays a substantial role. The accuracy of the available proposals, including the widely used AHP method, depends largely on the number of indicators and is strongly biased or too receptive to calculations.

The proposed FARE-M method is the extension of the FARE approach already used in research and provides for a simpler and more comprehensible completion of the first line of the expert evaluation matrix. Similarly, to the FARE method, the suggested technique is based on internal balance that is one of the essential systemic features. Balance can be achieved if the direction and strength of the element interactions are matched to each other, which proposes that some limited information, e.g. the impact of an indicator with a lower significance rank on a phenomenon under consideration in relation to the impact of an indicator with highest significance rank, is sufficient to form a system.

All indicators, as elements of their system, have equal baseline impact potential. On the other hand, this potential can fluctuate, increase or decrease, depending on an indicator significance rank. Thus, actual potential of the impact is equal to the sum of the baseline potential and its increment, depending on an indicator significance rank. The total potential of the impact of an entire indicator system is equal to the sum of baseline potentials of all indicators. Indicator weights are estimated as a ratio of their actual baseline potential to baseline potential of the entire indicator system.

Filling in the matrix reflecting the baseline potential of the impact of the indicators representing a phenomenon under consideration revealed some regularities which allow to estimate indicator weights based on the first matrix row only.

The method FARE-M proposed for estimation of indicator weights is understandable, simple in calculations and allows to adequately evaluate a significantly higher number of indicators compared to AHP method, and can therefore be widely applied for multi-criteria assessment.

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