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NOVEL EDAS++ METHOD: INTERVAL TYPE CRITERIA AND EXTENSION TO EDAS+

Abstract: *Multicriteria problems belong to poorly structured decision-making problems as they take place in conditions of stochasticity (indeterminacy). This primarily refers to the number of criteria and the complexity of their mutual relations between which there may be complete opposition, as well as to the methodologically diverse space for determining preferences or weighting factors which significantly affect the decision-making results.*

The paper focuses on the introduction of new types of criteria: 1 - 4 interval type criteria and its implementation in EDAS + method of multicriteria analysis.

Keywords: criteria, interval type criteria, EDAS, EDAS +, weighting factor, optimization

1. Introduction

One of the newer methods of multicriteria analysis is the EDAS method (Evaluation based on Distance from Average Solution) which is based on aggregating the values obtained as a positive distance from the average value and the values obtained as a negative distance from the average value. The method was developed by Ghorabee et al. in 2015 - (Ghorabaee et al., 2015). Another, extended variant of the EDAS method is presented here. The first extended EDAS + variant was published in a 2019 scientific paper (Štilić et al., 2019). New extension is made by introducing new types of criteria: type 1, type 2, type 3 and type 4 interval criteria.

The criteria by which ranking will be done in the classical EDAS and EDAS+ methods are benefit and the criterion function should be maximized based on them, or non-benefit when the criterion function should be minimized.

In the EDAS ++ method, new ways of evaluating alternatives have been introduced, based on the given criteria, where the emphasis is on the interval within which all values of the criterion function are identically valued, i.e. invariant. There is also a difference between benefit and non-benefit criteria and method of optimization, type 1 and 2 criterion intervals .

The next group of interval criteria, types 3 and 4, are those on the basis of which the values are grouped into the desired interval, while values above and below the lower and upper limits of the interval are viewed as a maximization and minimization subjects, respectively. With the fourth group, values in the interval are invariant, values above the upper and below interval limit are observed are minimization and maximization subjects, respectively. Here, the unambiguous quality of the criteria as benefit or not is abandoned, and the calculation is done by both modes.

Introduction of interval criteria or criteria by which alternatives have optimal value given by the interval does not exclude the existence of classical criteria / criteria functions. As in the EDAS method, calculations are done by each individual criterion, the introduction of the interval criterion and the method of calculation do not change the essence of the EDAS method itself, since all the specifics are solved in step 3 of the mathematical model by special mapping for each type of interval criteria.

In the case of type-1 interval criteria (benefit criterion function) the values within the interval are invariant (have the same relevance), which is achieved by assigning values of the upper interval limit to each attribute from the interval, while other values below or above this interval are treated as with beneficial criteria (should be maximized). In order for the desired interval to be favored, attribute values above the interval are mapped to the mean of the interval.

In the case of type-2 interval criteria (non-benefit criterion function), everything is the same as with type-1 interval criteria except that the values within the interval are assigned the value below lower interval limit, and attributes with values below the lower limit get the value of the interval mean, so in fact minimization refers only to values above the (upper) interval limit.

For type 3 interval criteria, the values within the interval are invariant (have the same relevance), values above this interval are treated as in the case of benefit criteria (should be maximized), and values below this interval are treated as with non-benefit criteria (should be minimized). This is achieved in the phase of basic decision-making matrix mapping, when arguments that are within the given interval are assigned the mean value of the interval limits, arguments with value greater than the upper interval limit remain unchanged, and arguments with value below the lower limit of the given interval are replaced by the inverse value.

With type 4 interval criteria, values within the interval are invariant (have the same relevance), values above this interval are treated as with non-benefit criteria (should be minimized), and values below this interval are treated as with benefit criteria (should be maximized). This is achieved in the phase of basic decision-making matrix mapping, when arguments that are within the given interval are assigned the mean value of the interval limits, arguments with value greater than the upper interval limit are replaced by the inverse value, and arguments with value below the lower limit of the given interval remain unchanged.

The introduction of inverse values in interval criteria 3 and 4 solves the two-way optimization and they are further treated as benefit, since the process of minimization is carried out in the manner described.

2. Mathematical model

2.1. Step 1

Defining key criteria, weighting factors for criteria and alternatives to solving the problem of multicriteria analysis.

2.2. Step 2

Forming a decision-making matrix X = $\left[X_{ij}\right]_{nxm} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \dots & x_{1m} \\ x_{21} & x_{22} & x_{23} & \dots & x_{2m} \\ x_{31} & x_{32} & x_{33} & \dots & x_{3m} \\ \dots & \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & x_{n3} & \dots & x_{nm} \end{bmatrix}$

2.3. Step 3

Mapping matrix X to matrix Q is done depending on the type of criteria.

With classical benefit and non-benefit criteria, as well as with especially unspecified conditions of criteria intervals, mapping is done as follows: the value of the attribute $x_{i,j} \rightarrow q_{i,j}$ so that

$q_{i,j} = x_{i,j}$. (1)

For all interval criteria (types 1 - 4), mapping is done as follows: first, the endpoints of the optimal interval [a, b] are observed, which is determined by two real numbers a, b, a ≤ b, , and which make up all $x_{i,j} \in$ R to which a ≤ $x_{i,j}$ ≤ b, ie. [a, b] = {$x_{i,j} \in$ R | a ≤ $x_{i,j}$ ≤ b} applies, then the mean value of the interval is calculated, m = $\frac{a+b}{2}$. (2)

The following are the specifics of mapping:

For type 1 interval criteria – for $x_{i,j} \in$ [a, b] → $q_{i,j} = b$, for $x_{i,j} >$ b → $q_{i,j} =$ m . (3)

For type 2 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = a$, for $x_{i,j} < a \rightarrow q_{i,j} = m$. (4)

For type 3 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = m$, for $x_{i,j} < a \rightarrow q_{i,j} = \frac{1}{x_{i,j}}$. (5)

For type 4 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = m$, for $x_{i,j} > b \rightarrow q_{i,j} = \frac{1}{x_{i,j}}$. (6)

Criteria functions are benefit and non-benefit in classical criteria as well as in type 1 and 2 criterion intervals and optimization is done in further steps of the procedure. Criterion intervals 3 and 4 have elements of both benefit and non-benefit functions, so the processes of maximization and minimization occur during the mapping itself and in the further procedures, these types of interval criteria are treated as benefit criterion functions.

2.4. Step 4

The presented procedure is the basis for extending the original EDAS method to EDAS +. It implies normalization of the decision-making matrix by applying the 'Correct mapping' method (Puška, A. 2013) using only the form that refers to the 'benefit' type criteria:

$$r_{ij} = \frac{x_{ij} - x_j^-}{x_j^+ - x_j^-} \quad i = 1, 2... m; \ j = 1, 2... n \tag{7}$$

as the original EDAS method in the further steps has built-in elements of optimization in terms of maximizing 'income' type functions and minimizing 'expenditure' type functions. In this way, a normalized decision matrix is obtained based on the initial matrix.

$$R = \left[R_{ij}\right]_{nxm} = \begin{bmatrix} r_{11}\ r_{12}\ r_{13} \dots r_{1m} \\ r_{21}\ r_{22}\ r_{23} \dots r_{2m} \\ r_{31}\ r_{32}\ r_{33} \dots r_{3m} \\ \dots\ \dots\ \dots\ \dots\ \dots \\ r_{n1}\ r_{n2}\ r_{n3} \dots r_{nm} \end{bmatrix} \quad (8)$$

2.5. Step 5

Determining the average solution for each criterion separately

$$AV = \left[AV_j\right]_{1xm} = \left[\frac{\sum_{i=1}^{n} x_{i1}}{n}\ \frac{\sum_{i=1}^{n} x_{i2}}{n} \dots \frac{\sum_{i=1}^{n} x_{im}}{n}\right] = [x_1^*, x_2^*, \dots, x_m^*] \quad (9)$$

2.6. Step 6

Forming a matrix $\left[PDA_{ij}\right]_{nxm}$ where the matrix elements represent a positive distance from $\left[AV_j\right]_{1xm}$ (let's denote the element of that matrix by d_{ij}^{+}) and matrix $\left[NDA_{ij}\right]_{nxm}$ where the matrix elements represent a negative distance from $\left[AV_j\right]_{1xm}$ (let's denote the element of that matrix by a d_{ij}^{-}). The elements of matrices $\left[PDA_{ij}\right]_{nxm}$ i $\left[NDA_{ij}\right]_{nxm}$ are calculated depending on whether the criteria are benefit, 'income' or 'expenditure', as follows:

$$d_{ij}^{+} = \begin{cases} \frac{max\left(0,\left(x_{ij}-x_j^*\right)\right)}{x_j^*} & ;\ j \in \Omega_{max} \\ \frac{max\left(0,\left(x_j^*-x_{ij}\right)\right)}{x_j^*} & ;\ j \in \Omega_{min} \end{cases} \quad (10)$$

where Ω_{max} is a group of 'income' criteria and Ω_{min} is a group of 'expenditure' criteria

$$d_{ij}^{-} = \begin{cases} \frac{max\left(0,\left(x_j^{*}-x_{ij}\right)\right)}{x_j^{*}} & ; \text{j} \in \Omega_{max} \\ \frac{max\left(0,\left(x_{ij}-x_j^{*}\right)\right)}{x_j^{*}} & ; \text{j} \in \Omega_{min} \end{cases} \tag{11}$$

2.7. Step 7

Forming one-dimensional matrices of weighted sums $[SP_i]_{n\text{x}1}$ and $[SN_i]_{n\text{x}1}$ in which elements are the result of multiplication of matrices $\left[PDA_{ij}\right]_{nxm}$ and $\left[NDA_{ij}\right]_{nxm}$ with a vector (one-dimensional matrix) of weighting factors $[W]_{m\text{x}1}$

2.8. Step 8

Normalization of one-dimensional matrices $[SP_i]_{n\text{x}1}$ and $[SN_i]_{n\text{x}1}$ is done as follows:

Normalized $[SP_i]_{n\text{x}1}$ is denoted as $[NSP_i]_{n\text{x}1}$

$$[NSP_i]_{n\text{x}1} = \frac{[\text{SP}_i]_{\text{nx1}}}{(\max[\text{SP}_i]_{\text{nx1}})} = \frac{1}{(\max[\text{SP}_i]_{\text{nx1}})} * [SP_i]_{n\text{x}1} \tag{12}$$

Normalized $[SN_i]_{n\text{x}1}$ is denoted as $[NSN_i]_{n\text{x}1}$

$$[NSN_i]_{n\text{x}1} = 1 - \frac{[\text{SN}_i]_{\text{nx1}}}{(\max[\text{SP}_i]_{\text{nx1}})} = 1 - \frac{1}{(\max[\text{SP}_i]_{\text{nx1}})} * [\text{SN}_i]_{\text{nx1}} \tag{13}$$

2.9. Step 9

Forming a vector (one-dimensional matrix) of calculating assessment $[AS_i]_{nx1}$ the elements of which are obtained using the following formula:

$$as_i = \frac{1}{2}(nsp_i + nsn_i) \tag{14}$$

where: as_i the elements of $[AS_i]_{nx1}$, nsp_i are the elements of $[NSP_i]_{nx1}$, and nsn_i are the elements of $[NSN_i]_{nx1}$.

2.10. Step 10

This is the final step in which as many AS_i assessment calculations are obtained as there are alternatives (n), where $0 \leq AS_i \leq 1$. The alternative with the highest AS_i is the best ranked alternative.

3. Application of the EDAS ++ method in ranking candidates for work in tourism industry

This paper presents the application of the EDAS method to the ranking of six graduates (selected by random procedure from the student database). The same example with the same numerical values as in the paper was used (Štilić, A. et. al, 2019) so that a comparative overview of ranking results without and with the use of some of the types of interval criteria presented in this paper could be made.

3.1. Step 1 - Defining criteria and weighting factors

The seven criteria on the basis of which students are ranked in this paper are GPA (‘income’ criterion), length of studies (‘expenditure’ criterion) and five criteria that result from the personality test, under the name Big 5. The Big 5 test is also known as OCEAN after the initial letters of the traits being tested: Openness, Conscientiousness, Extroversion, Agreeableness and Neuroticism. Of these five criteria, the first four obviously belong to the 'income' criteria, and the last - neuroticism – to 'expenditure' criteria.

For these seven criteria, the following weighting factors were retained: w_1 = 0,4, w_2 = 0,1, w_3 = 0,05, w_4 = 0,1, w_5 = 0,05, w_6 = 0,2 i w_7 = 0,1 (Štilić A., Njeguš A., 2019.).

Unlike in the previous work, the following interval criteria were introduced:

Type 1 interval criterion, for the GPA is [8,5 , 10] ,

type 2 interval criterion, for the length of studies is [36 , 40],

type 3 not applicable in this example and

type 4 interval criterion, for the neuroticism is [30 , 60].

3.2. Step 2 - Forming a decision-making matrix

Table 1: Decision-making table

	GPA ↑ w_1=0,4	Length of studies (months) ↓ w_1=0,1	O Openness ↑ w_1=0,05	C Conscientiousness ↑ w_1=0,1	E Extroversion ↑ w_1=0,05	A Agreeableness ↑ w_1=0,2	N Neuroticism ↓ w_1=0,1
S1	8,6	40	32	85	70	15	42
S2	9,4	44	75	60	42	60	15
S3	8,2	36	40	15	90	75	60
S4	9,2	38	84	26	62	68	38
S5	9,5	36	58	38	83	1	76
S6	7,8	48	94	29	26	89	93

$$X = \left[X_{ij}\right]_{nxm} = \begin{bmatrix} x_{11}\ x_{12}\ x_{13} \dots x_{1m} \\ x_{21}\ x_{22}\ x_{23} \dots x_{2m} \\ x_{31}\ x_{32}\ x_{33} \dots x_{3m} \\ \dots\ \dots\ \dots\ \dots\ \dots \\ x_{n1}\ x_{n2}\ x_{n3} \dots x_{nm} \end{bmatrix} = \begin{bmatrix} 8{,}6\ 40\ 32\ 85\ 70\ 15\ 42 \\ 9{,}4\ 44\ 75\ 60\ 42\ 60\ 15 \\ 8{,}2\ 36\ 40\ 15\ 90\ 75\ 60 \\ 9{,}2\ 38\ 84\ 26\ 62\ 68\ 38 \\ 9{,}5\ 36\ 58\ 38\ 83\ 1\ 76 \\ 7{,}8\ 48\ 94\ 29\ 26\ 89\ 93 \end{bmatrix}$$

3.3. Step 3 – Mapping

Mapping matrix X to matrix Q:

For type 1 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = b$, for $x_{i,j} > b \rightarrow q_{i,j} = m$. (3)

For type 2 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = a$, for $x_{i,j} < a \rightarrow q_{i,j} = m$. (4)

For type 3 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = m$, for $x_{i,j} < a \rightarrow q_{i,j} = \frac{1}{x_{i,j}}$. (5)

For type 4 interval criteria – for $x_{i,j} \in [a, b] \rightarrow q_{i,j} = m$, for $x_{i,j} > b \rightarrow q_{i,j} = \frac{1}{x_{i,j}}$. (6)

In other cases: $x_{i,j} \rightarrow q_{i,j}$ or $q_{i,j} = x_{i,j}$ (1)

$$\begin{bmatrix} 8{,}6\ 40\ 32\ 85\ 70\ 15\ 42 \\ 9{,}4\ 44\ 75\ 60\ 42\ 60\ 15 \\ 8{,}2\ 36\ 40\ 15\ 90\ 75\ 60 \\ 9{,}2\ 38\ 84\ 26\ 62\ 68\ 38 \\ 9{,}5\ 36\ 58\ 38\ 83\ 1\ 76 \\ 7{,}8\ 48\ 94\ 29\ 26\ 89\ 93 \end{bmatrix} \rightarrow \begin{bmatrix} 10\ 36\ 32\ 85\ 70\ 15\ \ 45 \\ 10\ 44\ 75\ 60\ 42\ 60\ \ 15 \\ 8{,}2\ 36\ 40\ 15\ 90\ 75\ \ 45 \\ 10\ 36\ 84\ 26\ 62\ 68\ \ 45 \\ 10\ 36\ 58\ 38\ 83\ 1\ \ 0{,}013 \\ 7{,}8\ 48\ 94\ 29\ 26\ 89\ 0{,}011 \end{bmatrix}$$

3.4. Step 4 – Normalization

$$Q \rightarrow R;\ r_{ij} = \frac{q_{ij} - q_j^-}{q_j^+ - q_j^-} \quad i = 1, 2 \dots m;\ j = 1, 2 \dots n \qquad (15)$$

$$\begin{bmatrix} 10 & 36 & 32 & 85 & 70 & 15 & 45 \\ 10 & 44 & 75 & 60 & 42 & 60 & 15 \\ 8{,}2 & 36 & 40 & 15 & 90 & 75 & 45 \\ 10 & 36 & 84 & 26 & 62 & 68 & 45 \\ 10 & 36 & 58 & 38 & 83 & 1 & 0{,}013 \\ 7{,}8 & 48 & 94 & 29 & 26 & 89 & 0{,}011 \end{bmatrix} \rightarrow$$

Table 2: Normalized decision matrix, presented in form of table

1	0	0	1	0,688	0,159	1
1	0,667	0,694	0,643	0,250	0,670	0,333
0,182	0	0,129	0,000	1	0,841	1
1	0	0,871	0,157	0,563	0,761	1
1	0	0,419	0,329	0,891	0	0,000
0	1	1,000	0,200	0	1	0

3.5. Step 5

From this step, the procedure continues according to the established steps of the classical EDAS method.

Table 3: Expanded Table 2 by the average solution for each criterion separately

	GPA ↑ w_1=0,4	Length of studies (months) ↓ w_1=0,1	O Openness ↑ w_1=0,05	C Conscientiousness ↑ w_1=0,1	E Extroversion ↑ w_1=0,05	A Agreeableness ↑ w_1=0,2	N Neuroticism ↓ w_1=0,1
S1	1	0	0	1	0,688	0,159	1
S2	1	0,667	0,694	0,643	0,250	0,670	0,333
S3	0,182	0	0,129	0,000	1	0,841	1
S4	1	0	0,871	0,157	0,563	0,761	1
S5	1	0	0,419	0,329	0,891	0	0,000
S6	0	1	1,000	0,200	0	1	0
$\sum_{i=1}^{n} x$	4,182	1,667	3,113	2,329	3,391	3,432	3,333
x_m^*	0,69697	0,277778	0,518817	0,388095	0,565104	0,57197	0,555538

3.6. Step 6

Forming a matrix $[PDA_{ij}]_{nxm}$ where the matrix elements represent a positive distance from $[AV_j]_{1xm}$ (let's denote the element of that matrix by d_{ij}^{+}) and matrix $[NDA_{ij}]_{nxm}$ where the matrix elements represent a negative distance from $[AV_j]_{1xm}$ (let's denote the element of that matrix by a d_{ij}^{-}). The elements of matrices $[PDA_{ij}]_{nxm}$i $[NDA_{ij}]_{nxm}$ are calculated depending on whether the criteria are benefit, 'income' or 'expenditure'.

Table 4: PDA

d_{ij}^{+}	GPA ↑ w_1=0,4	Length of studies (months) ↓ w_1=0,1	O Openness ↑ w_1=0,05	C Conscientiousness ↑ w_1=0,1	E Extroversion ↑ w_1=0,05	A Agreeableness ↑ w_1=0,2	N Neuroticism ↓ w_1=0,1
S1	0,435	1	0	1,577	0,217	0	0,800
S2	0,435	0	0,337	0,656	0	0,172	0
S3	0	1	0	0	0,770	0,470	0,800
S4	0,435	1	0,679	0	0	0,331	0,800
S5	0,435	1	0	0	0,576	0	0
S6	0	0	0,927	0	0	0,748	0

Table 5: NDA

d_{ij}^{-}	GPA ↑ w_1=0,4	Length of studies (months) ↓ w_1=0,1	O Openness ↑ w_1=0,05	C Conscientiousness ↑ w_1=0,1	E Extroversion ↑ w_1=0,05	A Agreeableness ↑ w_1=0,2	N Neuroticism ↓ w_1=0,1
S1	0	0	1	0	0	0,722	0
S2	0	1,400	0	0	0,558	0	0,400
S3	0,739	0	0,751	1	0	0	0
S4	0	0	0	0,595	0,005	0	0
S5	0	0	0,192	0,153	0	1	1
S6	1	2,600	0	0,485	1	0	1

3.7. Step 7

Forming one-dimensional matrices of weighted sums $[SP_i]_{nx1}$ and $[SN_i]_{nx1}$ in which elements are the result of multiplication of matrices $\left[PDA_{ij}\right]_{nxm}$ and $\left[NDA_{ij}\right]_{nxm}$ with a vector (one-dimensional matrix) of weighting factors $[W]_{mx1}$

$$[SP_i]_{nx1} = \left[PDA_{ij}\right]_{nxm} \text{ x } [W]_{mx1} = \begin{bmatrix} 0{,}522417 \\ 0{,}290834 \\ 0{,}312525 \\ 0{,}454082 \\ 0{,}302715 \\ 0{,}196042 \end{bmatrix}$$

$$[SN_i]_{nx1} = \left[NDA_{ij}\right]_{nxm} \text{ x } [W]_{mx1} = \begin{bmatrix} 0{,}194371 \\ 0{,}207907 \\ 0{,}433217 \\ 0{,}059740 \\ 0{,}324913 \\ 0{,}858466 \end{bmatrix}$$

3.8. Step 8

$$\text{Normalized } [SP_i]_{nx1} = [NSP_i]_{nx1} = \frac{[\mathrm{SP}]_{1xn}}{(\max[\mathrm{SP_i}]_{1xn})} = \tag{12}$$

$$= \frac{1}{(\max[\mathrm{SP_i}]_{1xn})} * \begin{bmatrix} 0{,}522417 \\ 0{,}290834 \\ 0{,}312525 \\ 0{,}454082 \\ 0{,}302715 \\ 0{,}196042 \end{bmatrix} = \begin{bmatrix} 1 \\ 0{,}556708 \\ 0{,}598228 \\ 0{,}869194 \\ 0{,}579451 \\ 0{,}37526 \end{bmatrix}$$

Normalized $[SN_i]_{nx1} = [NSN_i]_{nx1} = 1 - \frac{[SN_i]_{nx1}}{(\max[SN_i]_{nx1})} =$ (13)

$$= \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} - \frac{1}{(\max[SN_i]_{nx1})} \begin{bmatrix} 0,194371 \\ 0,207907 \\ 0,433217 \\ 0,059740 \\ 0,324913 \\ 0,858466 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} 0,226416 \\ 0,242184 \\ 0,504641 \\ 0,069589 \\ 0,378481 \\ 1 \end{bmatrix} = \begin{bmatrix} 0,773584 \\ 0,657262 \\ 0,546794 \\ 0,899803 \\ 0,600485 \\ 0,187630 \end{bmatrix}$$

3.9. Step 9 and 10

Table 6: Results of EDAS++ (after implementing interval criteria)

	nsp_i	nsn_i	$as_i = \frac{1}{2}\ (nsp_i + nsn_i)$	Rank
S1	1	0,773584	0,886792	2
S2	0,556708	0,757816	0,657262	3
S3	0,598228	0,495359	0,546794	5
S4	0,869194	0,930411	0,899803	1
S5	0,579451	0,621519	0,600485	4
S6	0,37526	0	0,187630	6

Table 7: Results of EDAS+ (without implementing interval criteria)

	nsp_i	nsn_i	$as_i = \frac{1}{2}\ (nsp_i + nsn_i)$	Rank
S1	0,442441	0,653146	0,547793	4
S2	1	0,854917	0,927459	1
S3	0,497082	0,496721	0,496901	5
S4	0,779289	0,922955	0,851122	2
S5	0,89858	0,637172	0,767876	3
S6	0,419101	0	0,209550	6

4. Conclusion

The paper focuses on the introduction of new types of criteria: type 1 - 4 interval criteria and their implementation in EDAS + method of multicriteria analysis.

Interval criteria provide more accurate ranking in conditions where some of criteria has an optimal interval of attribute values that are equally relevant, and therefore invariant to the decision. The paper presents the innovated multicriteria analysis using interval criteria called EDAS ++ through a mathematical model and example.

In the following papers, the interval criteria that in certain conditions make the decision making process more precise and simpler will be implemented in methods: TOPSIS, COPRAS, ARAS, CODAS...

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