Choosing the best option out of the many available options is always the goal to be achieved in all areas. However, the parameters (criteria) in each alternative are not the same, sometimes contradictory. In this situation, choosing the best option is an extremely difficult decision for the decision maker. Multi-criteria decision making (MCDM) is the ranking of alternatives based on the criteria of each alternative. More than one hundred multi-criteria decision-making methods have been proposed by the inventors. They are being used in many different fields. However, for decision makers, choosing an appropriate method to use in each specific case is a difficult task. CURLI (Collaborative Unbiased Rank List Integration) is a multi-criteria decision making method that distinguishes it from all others. That difference is reflected in the fact that when applying this method, the decision maker does not need to normalize the data nor determine the weights for the criteria. However, it will take a long time for decision makers to apply this method, especially when the number of options to rank is large. This study carried out the development of a new MCDM method based on the CURLI method. This new method is named CURLI-2. Many different examples are presented to evaluate the effectiveness of the proposed method. In each example, the result of ranking the alternatives using the CURLI-2 method has been compared with those using other different MCDM methods. The best alternative determined when using the CURLI-2 method always coincides with the use of existing MCDM methods. Using CURLI-2 method to rank alternatives will be much faster and simpler than using CURLI method. This is the advantage of CURLI-2 method compared with CURLI method

Keywords: new multi criteria decision making method, CURLI-2 method, CURLI method

UDC 519
DOI: 10.15587/1729-4061.2023.279622

DEVELOPMENT OF A NEW MULTI-CRITERIA DECISION-MAKING METHOD

Tran Van Dua
Doctor of Mechanical Engineering
Department of Mechanical Engineering
Hanoi University of Industry
Cau Dien str., 298, Bac Tu Liem District,
Hanoi, Vietnam, 100000
E-mail: duatv@haui.edu.vn

Received date 17.03.2023
Accepted date 22.05.2023
Published date 30.06.2023

How to Cite: *Dua, T. V. (2023). Development of a new multi-criteria decision-making method. Eastern-European Journal of Enterprise Technologies, 3 (1 (123)), 33–38. doi: https://doi.org/10.15587/1729-4061.2023.279622*

1. Introduction

Currently, there are many different multi-criteria decision-making methods (MCDMs), and choosing which one to use is a challenge for decision makers. It can be said that because the ranking results of the alternatives may not be the same when using different MCDM methods. MCDM methods can be divided into four groups. The first group includes methods that both require normalization of the data and require the determination of weights for the criteria. The second group consists of methods that do not require normalization of the data but require the determination of weights for the criteria. The third group are methods that do not require weighting for the criteria but require normalization of the data. The remaining group (the fourth group) is composed of methods that do not require normalization of the data nor do they require the determination of weights for the criteria. Thus, it can be seen that when using the method of group four, the decision maker will eliminate the difficulties in data normalization as well as determining the weights for the criteria. In group four, there is only one method, the CURLI method. This method is gaining popularity in recent times. However, when using the CURLI method, it will be difficult to rank the alternatives if the number of options to be ranked is large. Thus, improving the CURLI method so that it can be easily used will assist decision makers in multi-criteria decision making. Therefore, research devoted to new MCDM method is relevant.

2. Literature review and problem statement

Many investigations have been carried out to determine the appropriateness of data normalization methods when combined with multi-criteria decision-making methods. In [1], the CODAS method was used to combine with five different data normalization methods in ranking smartphone categories. This study has shown that rank inversion occurs when different data normalization methods are used. In [2], the VIKOR method was combined with four different data normalization methods to rank the products of a supermarket. The results of this study show that only one of the four data normalization methods is suitable to combine with the VIKOR method. In [3], the SAW method was used in combination with four different data normalization methods to evaluate candidates for graduate study. This study showed that only one of the four data normalization methods used were found to be suitable for incorporation with the SAW method. In [4], three methods of data normalization have been used in conjunction with the PIV method in the financial ranking of firms. This study showed that only one of the three data normalization methods used were found to be suitable for incorporation with the PIV method. In [5], the ROV method was used to combine with eight different data normalization methods to rank the financial performance of companies. The results showed that only one of the eight methods of data normalization were determined to be suitable to be combined with the ROV method. In [6], the TOPSIS method was combined with six different metric normalization

methods to rank drone-landing options. This study has shown that only one out of six methods of data normalization were determined to be suitable to be combined with the TOPSIS method. In [7], the AHP method was used in combination with five different data normalization methods to rank smart parking locations. This study has shown that only one out of five data normalization methods is suitable to be combined with the AHP method. In [8], the WSPAS method was combined with six different data normalization methods to rank robots. This study concluded that only one of the six data normalization methods was determined to be suitable to be combined with the WSPAS method.

Thus it is possible to see the complexity of data normalization in multi-criteria decision making. Meanwhile, all MCDM methods mentioned above when applied need to standardize the data. Using a multi-criteria decision-making method without the need to normalize the data would eliminate this complexity. CURLI is the method that meets this requirement [9]. In addition, if it is necessary to determine the weight for the criteria when making a multi-criteria decision, it is also a difficulty for the decision maker. This is also considered a limitation of all the MCDM methods mentioned above. A wrong decision can be made if the selection of the weighting method is incorrect. These difficulties will also be eliminated if a decision-making method is used that does not require weighting of the criteria. CURLI is also the method to meet this requirement [9]. However, the application of the CURLI method will face certain difficulties if the number of options to be ranked is large. This is the impetus to develop the CURLI method into a new method so that it is more convenient to use.

3. The aim and objectives of the study

The aim of this study is to develop the CURLI method into a new multi-criteria decision making method.

To achieve this aim, the following objectives are accomplished:

– to discover the limitation of the CURLI method and propose a solution to overcome it;

– to rank alternatives using a new multi-criteria decision-making method.

4. Materials and methods

This study carried out the development of a new method based on the CURLI method. Therefore, it is necessary to have an overview of the CURLI method first. The steps for implementation of multi-criteria decision-making according to the CURLI method are as follows [9]:

Step 1. Build a decision matrix with m alternatives and n criteria (Table 1), where x_{ij} is the value of criterion C_j of alternative A_i, with $i=1\div m, j=1\div n$.

Table 1

Decision matrix

No.	C_1	C_2	C_i	C_n
A_1	x_{11}	x_{12}	x_{1j}	x_{1n}
A_2	x_{21}	x_{22}	x_{2j}	x_{2n}
A_i	x_{i1}	x_{i1}	x_{ij}	x_{im}
A_m	x_{m1}	x_{m2}	x_{mj}	x_{mn}

Step 2. Create n square matrix of level m as shown in Table 2. Microsoft Excel software is the tool used to perform this task. Each square matrix is the score of a criterion. The scoring rules are as follows, example for a certain criterion C_j:

– if in the cell corresponding to row 2 and column 1, x_{2j} is worse than x_{1j}, then that cell will score 1;

– if in the cell correspoding to row 1 and column 2, x_{1j} is better than x_{2j}, then that cell will score –1;

– if in the cell correspoding to row 2 and column m, x_{2j} equals x_{mj}, then that cell will score 0;

– in the cells where the number of rows matches the number of columns, score 0.

Let's call this matrix the scoring matrix for each criterion.

Table 2

Example of the scoring matrix for C_j criterion

No.	S_1^j	S_2^j	S_i^j	S_m^j
A_1	0	–1	...	...
A_2	1	0	...	0
A_i	...	...	0	...
A_m	...	...	...	0

Step 3. Combining all the scored square matrix for n criterion according to formula (1). This task was also performed using microsoft Excel software. There is a matrix called the process scoring matrix, denoted by PA the matrix. This is content that has been improved over its original version:

$$S_i = \sum_{j=1}^{n} S_i^j; i = 1 \div m. \quad (1)$$

Step 4. Rank the alternatives according to the principle that the best solution is the one with the smallest value of S_i, and vice versa. This is also the difference in the performance rating of the alternatives of the proposed method (CURLI-2 method) compared to the original version (CURLI method).

5. Results of the development of a multi-criteria decision-making method

5. 1. Limitations of the CURLI method and how to overcome it

The implementation of step 4 of CURLI method is a very difficult task, take the decision makers a lot of effort. This task is even more difficult if the number of alternatives that need to be ranked is large. This is also a confirmation of a recently published study [10]. A recent study had to create a complex computer program in Java language when applying this method [11]. This work is clearly complicated and sometimes it causes difficulties for the decision makers who are not good at information technology. It further shows the inadequacy of decision-making in urgent cases. This is considered the first limitation of the CURLI method.

To remove these limitations of CURLI method, a method is proposed and named CURLI-2. The steps for implementation of multi-criteria decision-making according to CURLI-2 method include:

– the first three steps are the same as CURLI method;

– Step 4. Add the cells in each row of PA matrix according to (2). The alternative with the lowest score (S) is the best alternative, and vice versa:

$$S = \sum_{i=1}^{m} S_i;\ i = 1 \div m. \quad (2)$$

Obiviously, it is much more convenient to add up the scores of cells of each alternative to rank the alternatives according to the scores than rearrange the rows and columns as in step 4 of CURLI method.

5. 2. Multi-criteria decision making using the proposed method

5. 2. 1. Example 1

In this example, five material types to create car protective cover are ranked. Each type of material is evaluated by six criteria (Table 3). The meaning of each criterion is presented in the top row of Table 3.

Table 3

Material types to create car protective cover [12–14]

No.	Compressive strength	Bending modulus	Hardness	Charpy impact toughness	Elongation	Cost
	$C1$	$C2$	$C3$	$C4$	$C5$	$C6$
A_1	20	700	92	1	500	78
A_2	40	1500	92	1	100	84
A_3	65	2500	105	2.18	30	114
A_4	130	3100	93	3	50	153
A_5	70	2500	90	0.6	7	1300

Where, four criteria $C1$–$C4$ are the larger the better. In contrast, $C5$ and $C6$ are the smaller the better [12–14]. Choosing an alternative which simutaneously ensures all the criteria $C1$–$C4$ are considered the largest and $C5$, $C6$ are considered the smallest is the task for multi-criteria decision-making. Some MCDM methods were used to complete this task include CURLI [12], PROMETHEE [13], and EDAS [14]. The result of ranking the alternative done by these method will be used to compare to the ranking result done by CURLI-2 method.

Ranking the alternatives according to CURLI-2 method is done as follows:

Step 1. Build a multi-criteria decision-making matrix. This matrix is the data of the material types (Table 3).

Step 2. Scoring six criteria, let's obtain the results Tables 4–9.

Table 4

Scoring matrix for criterion $C1$ (example 1)

No.	S_i^1				
	S_1^1	S_2^1	S_3^1	S_4^1	S_5^1
A_1	0	1	1	1	1
A_2	–1	0	1	1	1
A_3	–1	–1	0	1	1
A_4	–1	–1	–1	0	–1
A_5	–1	–1	–1	1	0

Table 5

Scoring matrix for criterion $C2$ (example 1)

No.	S_i^2				
	S_1^2	S_2^2	S_2^2	S_4^2	S_5^2
A_1	0	1	1	1	1
A_2	–1	0	1	1	1
A_3	–1	–1	0	1	0
A_4	–1	–1	–1	0	–1
A_5	–1	–1	0	1	0

Table 6

Scoring matrix for criterion $C3$ (example 1)

No.	S_i^3				
	S_1^3	S_2^3	S_2^3	S_4^3	S_5^3
A_1	0	0	1	1	–1
A_2	0	0	1	1	–1
A_3	–1	–1	0	–1	–1
A_4	–1	–1	1	0	–1
A_5	1	1	1	1	0

Table 7

Scoring matrix for criterion $C4$ (example 1)

No.	S_i^4				
	S_1^4	S_2^4	S_3^4	S_4^4	S_5^4
A_1	0	0	1	1	–1
A_2	0	0	1	1	–1
A_3	–1	–1	0	1	–1
A_4	–1	–1	–1	0	–1
A_5	1	1	1	1	0

Table 8

Scoring matrix for criterion $C5$ (example 1)

No.	S_i^5				
	S_1^5	S_2^5	S_3^5	S_4^5	S_5^5
A_1	0	1	1	1	1
A_2	–1	0	1	1	1
A_3	–1	–1	0	–1	1
A_4	–1	–1	1	0	1
A_5	–1	–1	–1	–1	0

Table 9

Scoring matrix for criterion $C6$ (example 1)

No.	S_i^6				
	S_1^6	S_2^6	S_3^6	S_4^6	S_5^6
A_1	0	–1	–1	–1	–1
A_2	1	0	–1	–1	–1
A_3	1	1	0	–1	–1
A_4	1	1	1	0	–1
A_5	1	1	1	1	0

Step 3. Add the scoring matrix for each criterion (from Tables 4–9) according to formula (1) let's obtain *PA* matrix as in Table 10.

Table 10

PA Matrix (example 1)

No.	S_i				
	S_1	S_2	S_3	S_4	S_5
A_1	0	2	4	4	0
A_2	–2	0	4	4	0
A_3	–4	–4	0	0	–1
A_4	–4	–4	0	0	–4
A_5	0	0	1	4	0

Step 4. The score S of each alternative is calculated according to (2), the results are presented in Table 11. The results of ranking the alternatives according to score S are also summarized in Table 11. Besides, the ranking results of CURLI method, *PROMETHEE* method and *EDAS* method are also summarized in Table 11.

Table 11

Ranking the alternatives according to different MCDM methods (example 1)

No.	CURLI-2 (Proposed method)		CURLI [12]	PROMETHEE [13]	EDAS [14]
	S	Rank			
A_1	10	5	5	5	5
A_2	6	4	3	3	3
A_3	–9	2	2	2	2
A_4	–12	1	1	1	1
A_5	5	3	4	4	4

It can be seen from the data in Table 11 that the result of ranking the alternatives according to CURLI-2 method is not the same as the ranking results according to other methods. Howerver, all the methods show that A_4 is the best alternative, which means the task of finding the best alternative is equivalent using all four different methods. Besides, the second-ranked alternative (alternative A_3) and the fifth-ranked alternative (alternative A_1) are exactly the same when using these four methods. In other words, in this example, using CURLI-2 method gives the same effectiveness compared to other *MCDM* methods.

5. 2. 2. Example 2

In this example, nine material types to create gear are ranked. Five criteria have been used to evaluate for each alternative (Table 12) [12, 14–16].

Where $C1$ is the smaller the better, the other four criteria are the larger the better. Finding out an alternative which simultaneously ensures that $C1$ is considered to be the smallest and the other four criteria are considered the largest is the task for multi-criteria decision-making. This task is also done when using different methods, include CURLI [12], EDAS [14], TOPSIS [15], and EXPROM2 [16]. The results of ranking the alternatives done by using these MCDM methods will also be used to compare to the ranking result done by using CURLI-2 method.

Table 12

Material types to create gear [12, 14–16]

No.	Core hardness	Strength	Fatigue strength	Bending strength	Tensile strength
	$C1$	$C2$	$C3$	$C4$	$C5$
A_1	200	200	330	100	380
A_2	220	220	460	360	880
A_3	240	240	550	340	845
A_4	270	270	630	435	590
A_5	270	270	670	540	1190
A_6	240	585	1160	680	1580
A_7	315	700	1500	920	2300
A_8	315	750	1250	760	1250
A_9	185	500	430	430	625

Ranking the alternatives using CURLI-2 method according to the steps in example 1. The result of ranking the alternatives using CURLI-2 method has been summarized in Table 13. In addition, the ranking results using the other MCDM methods are also summarized in Table 13.

Table 13

Ranking the alternatives using different MCDM methods (example 2)

No.	CURLI-2 (Proposed method)	CURLI [12]	EDAS [14]	TOPSIS [15]	EXPROM2 [15]
A_1	9	9	9	9	9
A_2	7	8	8	8	8
A_3	8	7	7	6	6
A_4	6	5	5	5	5
A_5	4	4	4	4	4
A_6	2	3	3	3	3
A_7	1	1	1	1	1
A_8	3	2	2	2	2
A_9	5	6	6	7	7

The data in Table 13 have shown that the results of ranking the alternatives are not the same when using different methods. However, all five used methods have showed that A_7 is the best alternative and A_1 is the worst alternaitve. In other words, the task to find out the best alternative (A_7) has been successfully completed when using five different MCDM methods. Which means, in this example, using CURLI-2 method is equally as effective as using other MCDM methods.

5. 2. 3. Example 3

In this example, seven different types of robot are ranked. Each robot type is described by five criteria (Table 14) [17, 18].

Where, criteria *C*1, *C*2, *C*4 and *C*5 are the larger the better. In contrast, *C*3 is the smaller the better. The task of multi-criteria decision-making is to find out an alternative, which simultaneously ensures that C3 is the smallest, and the other criteria are the largest. *R* and CURLI methods [17], CODAS method [18] are used to complete this task.

Table 14

Different robot types [17, 18]

No.	Load capacity	Maximum tip speed	Repeatability	Memory capacity	Manipulator reach
	*C*1	*C*2	*C*3	*C*4	*C*5
A_1	60	0.4	2540	500	990
A_2	6.35	0.15	1016	3000	1041
A_3	6.8	0.1	1727.2	1500	1676
A_4	10	0.2	1000	2000	965
A_5	2.5	0.1	560	500	915
A_6	4.5	0.08	1016	350	508
A_7	3	0.1	1778	1000	920

Ranking the alternatives using CURLI-2 is done in the same way as in example 1. Table 15 showed the results of ranking the alternatives using different methods.

Table 15

Ranking the alternatives using different MCDM methods (example 3)

No.	CURLI-2 (Proposed method)	R [17]	CURLI [17]	CODAS [8]
A_1	4	2	2	3
A_2	1	1	1	1
A_3	3	4	4	2
A_4	2	3	3	5
A_5	5	5	5	7
A_6	7	7	7	6
A_7	6	6	6	4

The data in Table 15 has showed that the result of ranking the alternatives using CURLI-2 has a high degree of similarity compared to when using other MCDM methods. The fifth, sixth and seventh-ranked alternatives are exactly the same when using three methods CURLI-2, *R* and CURLI. Specially, all four used methods showed that A_2 is the best alternative. In other words, CURLI-2 method has successfully completed its role when it is used to make multi-criteria decision in this example.

6. Discussion of the results of multi-criteria decision making using the CURLI-2 method

From the data in Tables 11, 13, 15, it is shown that the best solution determined using the CURLI-2 method always coincides with the best alternative determined using other MCDM methods. That shows that the proposed method (CURLI-2 method) is completely reliable when used for multi-criteria decision making. It means that it is correct to detect the limitation in step 4 of the CURLI method as well as to suggest a solution to overcome it. The difference between the CURLI-2 method and the CURLI method is in the way step 4 is performed. Although the implementation is different when using these two methods, they always show the same best solution when ranking alternatives.

The procedure in step number four is the difference between the CURLI-2 method and the CURLI method. Despite this difference, in all the examples performed, both methods identified the same best alternative (in Tables 11, 13, 14).

The limitation of the proposed method (CURLI-2 method) is that the scoring for options is based on dry numbers only. For a given criterion, if the difference in its value among the alternatives is very large, which scoring seems difficult to interpret.

The disadvantage of the CURLI-2 method is that it does not consider the weight of the criteria. That means the decision maker's opinion on the priority of the criteria against each other will not be taken into account. This is also the disadvantage of the CURLI method.

The work to be done in the future is applying CURLI-2 method to rank the alternatives when the number of alternatives changes, which means after ranking the alternatives, there will be alternatives added or removed from the list of alternatives. Thereby, it is possible to make necessary improvements (if necessary) to further improve the CURLI-2 method.

7. Conclusions

1. The development of the CURLI method has developed a new MCDM method. The new method is called CURLI-2. Using the CURLI-2 method will be simpler than using the current MCDM methods.

2. In all cases examined, the best alternative determined using the CURLI-2 method was consistent with that of the other MCDM methods.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

The study was performed without financial support.

Data availability

The manuscript has data included as electronic supplementary material.

Acknowledgements

This work was supported by the Hanoi University of Industry (Vietnam).

References

1. Biswas, S., Pamucar, D. (2021). Combinative distance based assessment (CODAS) framework using logarithmic normalization for multi-criteria decision making. Serbian Journal of Management, 16 (2), 321–340. doi: https://doi.org/10.5937/sjm16-27758
2. Alrababah, S. A. A., Atyeh, A. J. (2019). Effect of Normalization Techniques in VIKOR Approach for Mining Product Aspects in Customer Reviews. International Journal of Computer Science and Network Security, 19 (12), 112–118. Available at: http://paper.ijcsns.org/07_book/201912/20191216.pdf
3. Vafaei, N., Ribeiro, R. A., Camarinha-Matos, L. M. (2022). Assessing Normalization Techniques for Simple Additive Weighting Method. Procedia Computer Science, 199, 1229–1236. doi: https://doi.org/10.1016/j.procs.2022.01.156
4. Ersoy, N. (2021). Application of the PIV method in the presence of negative data: an empirical example from a real-world case. Hitit Sosyal Bilimler Dergisi, 14 (2), 318–337. doi: https://doi.org/10.17218/hititsbd.974522
5. Ersoy, N. (2021). Selecting the Best Normalization Technique for ROV Method: Towards a Real Life Application. Gazi University Journal of Science, 34 (2), 592–609. doi: https://doi.org/10.35378/gujs.767525
6. Stanujkić, D., Đorđević, B., Đorđević, M. (2013). Comparative analysis of some prominent MCDM methods: A case of ranking Serbian banks. Serbian Journal of Management, 8 (2), 213–241. doi: https://doi.org/10.5937/sjm8-3774
7. Vafaei, N., Ribeiro, R. A., Camarinha-Matos, L. M. (2016). Normalization Techniques for Multi-Criteria Decision Making: Analytical Hierarchy Process Case Study. IFIP Advances in Information and Communication Technology, 261–269. doi: https://doi.org/10.1007/978-3-319-31165-4_26
8. Mathew, M., Sahu, S., Upadhyay, A. K. (2017). Effect Of Normalization Techniques In Robot Selection Using Weighted Aggregated Sum Product Assessment. International Journal of Innovative Research and Advanced Studies, 4 (2), 59–63. Available at: http://www.ijiras.com/2017/Vol_4-Issue_2/paper_12.pdf
9. Duc Trung, D. (2022). Multi-criteria decision making of turning operation based on PEG, PSI and CURLI methods. Manufacturing Review, 9, 9. doi: https://doi.org/10.1051/mfreview/2022007
10. Trung, D. D. (2022). Development of data normalization methods for multi-criteria decision making: applying for MARCOS method. Manufacturing Review, 9, 22. doi: https://doi.org/10.1051/mfreview/2022019
11. Trung, D., Ba, N., Tien, D. (2022). Application of the Curli method for multi-critical decision of grinding process. Journal of Applied Engineering Science, 20 (3), 634–643. doi: https://doi.org/10.5937/jaes0-35088
12. Tran, D. V. (2022). Application of the Collaborative Unbiased Rank List Integration Method to Select the Materials. Applied Engineering Letters : Journal of Engineering and Applied Sciences, 7 (4), 133–142. doi: https://doi.org/10.18485/aeletters.2022.7.4.1
13. Ilangkumaran, M., Avenash, A., Balakrishnan, V., Kumar, S. B., Raja, M. B. (2013). Material selection using hybrid MCDM approach for automobile bumper. International Journal of Industrial and Systems Engineering, 14 (1), 20. doi: https://doi.org/10.1504/ijise.2013.052919
14. Prasenjit, C., Arnab, B., Supraksh, M., Soumava, B., Shankar, C. (2018). Development of a Hybrid Meta-Model for Material Selection Using Design of Experiments and EDAS Method. Engineering Transactions, 66 (2), 187–207. Available at: https://et.ippt.gov.pl/index.php/et/article/view/812/
15. Milani, A. S., Shanian, A., Madoliat, R., Nemes, J. A. (2004). The effect of normalization norms in multiple attribute decision making models: a case study in gear material selection. Structural and Multidisciplinary Optimization, 29 (4), 312–318. doi: https://doi.org/10.1007/s00158-004-0473-1
16. Chatterjee, P., Chakraborty, S. (2012). Material selection using preferential ranking methods. Materials & Design, 35, 384–393. doi: https://doi.org/10.1016/j.matdes.2011.09.027
17. Trung, D. D. (2022). Comparison r and curli methods for multi-criteria decision making. Advanced Engineering Letters, 1 (2), 46–56. doi: https://doi.org/10.46793/adeletters.2022.1.2.3
18. Ghorabaee, M. K., Zavadskas, E. K., Turskis, Z., Antucheviciene, J. (2016). A new combinative distance-based assessment (CODAS) method for multi-criteria decision-making. Economic Computation and Economic Cybernetics Studies and Research, 50 (3), 25–44. Available at: https://www.researchgate.net/publication/308697546_A_new_combinative_distance-based_assessment_CODAS_method_for_multi-criteria_decision-making