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Analysis of MCDM method and approach LNYP – CODAS method for decision making

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Abstract:

Multi – Criteria Decision Making (MCDM) methods is a one of the subfields of operation research. Applying a MCDM problem and getting an optimization result based on ranking type, it is easy to make a perfect decision. A decision maker considers many numbers of input criteria in particular area. In this paper, study of the LNYP (average weighting) method to evaluate the weighting for input criteria and considering the weighting as equal for present criteria. Applying the LNYP- Combinative Distance-based Assessment (CODAS) method to select a truck for company. Finally, decision maker got a better decision for selecting the best truck for business.

Keywords: Decision making, Multi- Criteria Decision Making, LNYP method, Average Weighting, CODAS method.

Introduction:

The Combinative distance-based Assessment (CODAS) method was introduced by Ghorabaee, Zavadskas(2016). This methodology is an efficient and updated decision – making. It is a distance-based approach that used Euclidean and Hamming measures. The Euclidean distances as the primary comparison measure. If Euclidean distances of two alternatives are very close to each other, then corresponding Hamming distance are used for comparison. In this method, the desirability of alternatives is determined by using two measures. The main and primary measure are related to the Euclidean distance of alternatives from the negative – ideal solution. The Secondary measures is the Hamming distance, which

related to norm – indifference space. Clearly, alternatives which has greater distances from the negative - ideal solution is more desirable. Although the norm – difference space is preferred in the CODAS, two types of indifference space could be considered in this process.

Although the LNYP method is applied for evaluate the weight for each criterion. The main purpose of method is giving an equal preference for the given criteria. Based on Max-Min for compensatory method of criteria (LNYP) is proposed to determine the criteria weights in multi-criteria decision-making problem. The category of this method related to the objective weighting methods for obtaining criteria weights. Already mentioned, the LNYP uses each criterion's Max-Min on the performance of alternatives to determine criteria weights. The weights of criteria are considering as equal weight. In this study, compensatory method of Max-Min measure is help to calculate the average weight for alternatives performance. In the decision matrix two types of criteria are obtained. They are beneficial criteria and non- beneficial criteria. For beneficial criteria consider the maximum value of the criteria performance. For non- beneficial criteria consider the minimum value of the criteria performance.

Now the illustration problem derived the selection of trucks for transporting a material from the companies. The decision maker chosen Nine different types Truck and six different of features related to the Truck. Some important specifications of the Trucks are Power in hp, (Gross Vehicle Weight) GVW in Kg, Number of Tyre, Engine in cc, Fuel tank capacity litres, Price in lakhs. From the specification they divided into beneficial and non- beneficial criteria. The beneficial criteria are power, GVW, Number of tyres, fuel tank capacity, engine and the non – beneficial criteria are Price of the tyre. From data, the decision maker gets a better decision for running our company.

Literature Review:

In Year 2021, "Combinative Distance Based Assessment (CODAS) Framework Using Logarithmic Normalization for Multi- Criteria decision making", the purpose of the paper extended the CODAS frame work using Logarithmic (LN) Scheme to derived the normalized decision matrix. And Entropy performance to calculated the weight for present criteria. This framework performance based on ranking the smartphones in India.

In year 2020, "CODAS Method for multiple attribute group decision making under 2-tuple linguistic neutrosophic environment", the study of the paper, fuzzy CODAS based on they present a 2- tuple linguistic neutrosophic CODAS model. And Fuzzy weighted (hamming distance and Euclidean distance) based on weight has been calculated for given criteria. The numerical example for new model is safety assessment of construction project.

In year 2017, "Integrated Fuzzy AHP-CODAS framework for maintenance decision in urea fertilizer industry", performance of the work under fuzzy AHP has develop a weight for different criteria and sub- criteria were computed using Geometric mean (GM) method. These weights are included in fuzzy CODAS model and approach the final ranking for the considering alternatives.

In year 2017, "Supplier Selection using Combinative Distance-Based Assessment (CODAS) Method for Multi – Criteria Decision-Making", in this paper, the CODAS method handles the MCDM problems for a steelmaking company in Libya. This paper shows the concept of the CODAS method and weight has determined by AHP Process.

In year 2021, "A new Integrated FUCOM-CODAS framework with Fermatean fuzzy Information for Multi-Criteria Group Decision – Making", in this paper the hybrid full consistency (FUCOM) method and CODAS method based on the MAGDM in the domain for smartphone brand selection.

In year 2021, "The application of probabilistic linguistic CODAS method based on new score function in multi-criteria decision-making", the study paper about CODAS method as extended as probabilistic linguistic environment. By apply the PL-CODAS method the investors choosing emerging companies. And also, they compared PL-TOPSIS method, PL-TODIM method and PL-MABAC method to verify its applicability and effectiveness.

In year 2021, "An extension of the CODAS method on interval rough numbers for multi-criteria group decision making", Performance of the work to develop a new interval Rough of Combinative Distance – based Assessment (IR CODAS) method. A real- life case study handling multiple Criteria group decision making Problems using Lingusitic terms.

Methodology:

LNYP (Average weighting) Method:

In this new method based on Max- Min for compensatory method of criteria, (LNYP) is proposed to determine the criteria equal weights in multi-criteria decision-making problem.

Steps in LNYP (Average Weighting) Method:

Step1:

Compute a y_P with R condition of Max and Min:

a) When, $R < q$, we apply the below formula:

In given data the beneficial attributes mean the formula given below:

$$y_P = \frac{1}{(q_{(max)} - R)}$$

In given data the non-beneficial attributes mean the formula given below:

$$y_P = \frac{1}{(q_{(min)} - R)}$$

b) When, $R > q$, we apply the below formula:

In given data the beneficial attributes mean the formula given below:

$$y_P = \frac{1}{(R - q_{(max)})}$$

In given data the non-beneficial attributes mean the formula given below:

$$y_P = \frac{1}{(R - q_{(min)})}$$

c) When, $R = q$ then the formula:

In given data the beneficial attributes mean the formula given below:

$$y_P = \frac{1}{(R^2 q_{(max,)} - R)}$$

In given data the non-beneficial attributes mean the formula given below:

$$y_P = \frac{1}{(R^2 q_{(min)} - R)}$$

Here $q_{(max)}$ – The maximum values in beneficial attribute are denote as $q_{(max)}$

$q_{(min)}$ - The minimum values in non-beneficial is denote as $q_{(min)}$

R= Sum of beneficial attributes+ Sum of Non- beneficial attributes

Step2:

Estimate the Assessment value of r_k :

$r_k = \sum_{p=1}^{c} y_P$

Step3:

Determining the Weighting based on Max and Min W_j:

$W_j = \frac{y_P}{r_k}$, $\sum_{j=1}^{n} W_j = 1$

Step4:

Calculation of Average Weighting A. W:

A. W= $\frac{\sum_{j=1}^{n} W_j}{R}$

Average Weight is considering as equal weight for all criteria. This process is help to calculate the equal weight for given all criteria is known as LNYP Method.

CODAS method:

In this Section, (CODAS) is introduced to deal with multi- criteria decision-making problems. The norm indifference space is preferred in the CODAS, two types of indifference space could be considered in its process. Based on the assumption that alternatives and criteria are available, the steps of the proposed method can then be presented as follows:

Step1: Construct the decision - making matrix as follows:

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{bmatrix}$$

Where x_{ij} denotes the performance value of i^{th} alternative on j^{th}criterion $(i = 1,2,3 \ldots . n)$ and $(j = 1,2,3,4, \ldots . m)$

Step2: Calculate the normalized decision matrix:

$$n_{ij} = \begin{cases} \frac{x_{ij}}{max_i x_{ij}}, if\ j \in N_b \\ \frac{min_i x_{ij}}{x_{ij}}, if\ j \in N_c \end{cases}$$

Where $N_b\ and\ N_c$ represent the sets of benefit and non- benefit criteria respectively.

Step3: Calculate the weighted normalized decision matrix:

$r_{ij} = w_j n_{ij}$

Step4: Determine the negative – ideal solution (point) as given in equation

$ns = min_i r_{ij}$

Step5: Calculate the Euclidean and Taxicab distances of alternatives from the negative – ideal solution

$E_i = \sqrt{\sum_{j=1}^{m} (r_{ij} - ns_j)^2}$

$T_i = \sum_{j=1}^{m} |r_{ij} - ns_j|$

Step6: Construct the relative assessment matrix

$h_{ij} = (E_i - E_k) + \psi(E_i - E_k) \times (T_i - T_k)$

Where k∈ $\{1,2, \ldots . n\}\ and\ \psi$ denotes a threshold function to recognize the equality Euclidean.

Step7: Calculate the assessment score of each alternative

$H_i = \sum_{k=1}^{n} h_{ik}$

Step8: Ranking alternatives

According to the decreasing values of assessment score (H). the alternative with highest H is best choice among the alternatives

Illustration:

Now illustration problem calculating the decision with help of LNYP method and TOPSIS method and it considering the highest ranking is the best alternative.

There are two types of attributes one is beneficial attributes and another one is non-beneficial attributes. In the given data the beneficial attributes are number of tyre, power, Gross Vehicle Weight (GVW), Engine, Fuel Tank and the non- beneficial attributes are Price.

Alternatives	Number of tyre	Power	GVW	Engine	Fuel Tank	Price
Truck1	6	186	39500	5600	365	31.21
Truck2	6	200	18500	5660	220	30.13
Truck3	10	276	28000	7200	260	41.24
Truck4	6	200	18500	5660	375	24.88
Truck5	6	83	9600	3783	300	20.97
Truck6	6	160	14052	3800	425	22.45
Truck7	6	241	18500	7200	215	37.89
Truck8	6	147	14500	3900	200	25.81
Truck9	6	177	16020	5005	160	25.89

Calculate LNYP (Average Weight):

Step1:

Yp	0.25	0.0037	0.00002532	0.00014	0.00239	0.0668

Step2:

r_k	0.32305

Step3:

Wj	0.77386	0.01146	0.000078377	0.00043	0.00739	0.20678

Step4:

AW	0.16667

By the above process, we determine the Average weight is 0.16667 and it consider as equal weight for all given criteria.

CODAS method:

Step1: Normalized decision matrix:

Truck1	0.6	0.673913	1	0.777778	0.858824	0.671900032
Truck2	0.6	0.724638	0.468354	0.786111	0.517647	0.695984069
Truck3	1	1	0.708861	1	0.611765	0.508486906
Truck4	0.6	0.724638	0.468354	0.786111	0.882353	0.842845659

Truck5	0.6	0.300725	0.243038	0.525417	0.705882	1
Truck6	0.6	0.57971	0.355747	0.527778	1	0.934075724
Truck7	0.6	0.873188	0.468354	1	0.505882	0.553444181
Truck8	0.6	0.532609	0.367089	0.541667	0.470588	0.812475785
Truck9	0.6	0.641304	0.40557	0.695139	0.376471	0.809965238

Step2: Weighted normalize decision matrix:

Truck1	0.1	0.112319	0.166667	0.12963	0.143137	0.111983339
Truck2	0.1	0.120773	0.078059	0.131019	0.086275	0.115997345
Truck3	0.166667	0.166667	0.118143	0.166667	0.101961	0.084747818
Truck4	0.1	0.120773	0.078059	0.131019	0.147059	0.140474277
Truck5	0.1	0.050121	0.040506	0.087569	0.117647	0.166666667
Truck6	0.1	0.096618	0.059291	0.087963	0.166667	0.155679287
Truck7	0.1	0.145531	0.078059	0.166667	0.084314	0.092240697
Truck8	0.1	0.088768	0.061181	0.090278	0.078431	0.135412631
Truck9	0.1	0.106884	0.067595	0.115856	0.062745	0.134994206

Step3: Determined the negative ideal solution:

Ns	0.1	0.050121	0.040506	0.087569	0.062745	0.084747818

Step4:

Ei
0.169584
0.26219
0.338924
0.298671
0.251873
0.287405
0.28402
0.23294
0.248146

Ti
0.338046
0.206433
0.379163
0.291694
0.136821
0.240529
0.241122
0.128382
0.162385

Step5: Assessment matrix h_{ij}:

Truck1	0	-0.092	-0.169	-0.12921	-0.08262	-0.11805	-0.11466	-0.06362	-0.07884
Truck2	0.0923	0	-0.076	-0.03642	0.010332	-0.0252	-0.02181	0.029296	0.014057
Truck3	0.1694	0.0769	0	0.040323	0.087473	0.051661	0.055055	0.106515	0.091172
Truck4	0.1289	0.0365	-0.040	0	0.046943	0.011277	0.014666	0.065946	0.050656

Truck5	0.0819	-0.010	-0.086	-0.04665	0	-0.03546	-0.03208	0.018936	0.003725
Truck6	0.1175	0.0252	-0.051	-0.01125	0.035606	0	0.003385	0.054587	0.039321
Truck7	0.1142	0.0218	-0.054	-0.01464	0.032215	-0.00339	0	0.051195	0.035931
Truck8	0.0630	-0.029	-0.105	-0.06552	-0.01893	-0.05434	-0.05097	0	-0.0152
Truck9	0.0782	-0.014	-0.090	-0.05039	-0.00373	-0.0392	-0.03582	0.015216	0

Step6: Assessment Score:

	Hi
Truck1	-0.84905
Truck2	-0.01385
Truck3	0.678677
Truck4	0.314817
Truck5	-0.10651
Truck6	0.213093
Truck7	0.182627
Truck8	-0.27652
Truck9	-0.14005

Step7:

Ranking of alternatives

Truck1	9
Truck2	5
Truck3	1
Truck4	2
Truck5	6
Truck6	3
Truck7	4
Truck8	8
Truck9	7

Above table shows the ranking of the alternatives. The highest - ranking take place in truck3. Therefore, decision maker can choose a truck3.

Conclusion:

In the MCDM problem, LNYP- CODAS method is very helpful to make a decision for decision maker. This model does not require specialized expensive software to integrate the alternatives. The model can be applied using the spreadsheet, such as Excel, which is a component of Microsoft Office. It is present in most companies in computer equipment, so that the software is more available to users. In the spreadsheet, the procedure is made just to

evaluate the weighting process with LNYP, and also compare the alternatives with CODAS method. The LNYP and CODAS Method are very easy to understand and appliance, so the time spent conducting is minimal, allowing managers and customers to carry out other activities. In future, LNYP (average weight) method can applied for complex decision - making problems in our environment.

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