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PRIORITIZING THE ALTERNATIVE BY PERFORMING FUZZY-TOPSIS APPROACH

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Abstract

This paper presents the idea to select best refrigerator among the various choices which is a complex decision-making problem involves many multiple conflicting criteria. Fuzzy Technique for Order Performance by Similarity to Ideal Solution (FTOPSIS) is an appropriate tool to inspect the best decision from multiple decision involved in the real world issues. The interdependencies between criteria are considered. In the present study, the results reveals that the FTOPSIS is remarkably successful in determining the best quality refrigerator among the various brands available in market and ranking given according to the different criteria's weights. The purposed work will assist in examining the product in the view of quality and helps to find the best ranking among the alternatives of various brands of refrigerators. Finally, conclusion shows that refrigerator B seems to be best choice for the customer with closeness coefficient of 0.905.

Keywords: Fuzzy TOPSIS, Criteria, Closeness coefficient.

1. Introduction

Multi-Attribute deciding is that the most documented branch of deciding. It is a branch of a general category of Operations Research models that wear down call problems underneath the presence of variety of call criteria. This super category of models is incredibly typically known as multi-criteria decision making (MCDM). The Multi criterion Decision Making (MCDM) area unit gaining importance as potential tools for analyzing advanced real issues because of their inherent ability to gauge completely different alternatives (Choice, strategy, policy, state of affairs also can be used synonymously) on varied criteria for attainable choice of the best/suitable different. These alternatives could also be any explored in-depth for his or her final implementation. Multi-Criteria Decision Making (MCDM) strategies have increased a lot of enthusiasm from scientists and professionals in surveying, assessing, and positioning options across assorted ventures [4]. There are various MCDM techniques created to take care of certifiable choice issues, anyway Technique for Request Preference by Similarity to Ideal Solution (TOPSIS) is at present one of the most famous strategies and worked sufficiently in different application zones (e.g., [1], [3], [5]). Fuzzy TOPSIS methodology explained to solve the decision making problem [2]. The details about fuzzy logic can refer [6], [7], [8], [9].

Fridges are significant on the grounds that they keep our food cold. Without them we wouldn't have frozen yogurt or smoothies, or even chilly, delicious apples. You would need to go to the supermarket day by day only for cold food. Without keeping your food chilly, your food would spoil. So, Fridges are a significant part in the public eye. They keep food cold and they help keep a few people from getting sick. They keep medication cold, which is essential to numerous individuals. Choosing the good quality of fridge is a tedious task, since one has to examine the quality using various factors such as Cost price, Consumption of electricity, storage volume. In this, paper, the quality of refrigerator was assessed by the technique of Fuzzy TOPSIS.

The remainder of the paper is expressed as follows: In Section 2, briefly, explains the step-by-step procedure of Fuzzy TOPSIS method. The problem is clearly defined and analysed in Section 3. Section 4 reveals the execution of Fuzzy TOPSIS approach to the purposed problem. Section 5, offer a final result and renders the idea for future research.

2. Methodology- Fuzzy TOPSIS

Chen [8] has presented the fuzzy TOPSIS technique in order to pick out the best alternative. Let i = 1, …, m be alternatives; j = 1, …, n be criteria and k = 1, …, t be number of Decision makers $\left(D_{i,j}\right)$. The steps for applying Fuzzy TOPSIS process are explained as follows:

Step 1: Approaching the problem and analysing the various criteria for the involved problem.

Step 2: Frame the ratings of alternative according to the decision makers. Weightage of each criterion are to rate in the view of quality of refrigerator.

Table 1. Rating of alternative and weightage of each criteria

Fuzzy number	Rating of alternatives	Rating of weightage
(1, 1, 3)	Very low importance (VI)	Extremely Low acceptable (ELA)
(1, 3, 5)	Low importance (LI)	Low acceptable (LA)
(3, 5, 7)	Medium importance (MI)	Moderately acceptable (MA)
(5, 7, 9)	High Importance (HI)	High acceptable (HA)
(7, 9, 9)	Very high Importance (VHI)	Extremely high acceptable (EHA)

Step 3: Evaluate the weightage of criteria according to the importance of criteria in the view of quality.

Step 4 : Evaluate the combined decision matrix using formula $\widetilde{D_{ij}} = (a_{ij}, b_{ij}, c_{ij})$,

$$\text{Where} \quad a_{ij} = \min\left(a_{ij}^{k}\right),\ b_{ij} = 1/k\ [\textstyle\sum_{k=1}^{n} b_{ij}^{k}]\ \ c_{ij} = \max\left(c_{ij}^{k}\right).$$

Step 5 : We have to identify the beneficial and non-beneficial criteria and use formula to frame the normalized matrix. $\widetilde{M} = \widetilde{m_{ij}}$

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$$\widetilde{m_{ij}} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad \text{where } c_j^* = max\ c_{ij} \quad \text{for beneficial criteria}$$

$$\widetilde{m_{ij}} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \quad \text{where } a_j^- = min\ c_{ij} \quad \text{for beneficial criteria.}$$

Step 6. Frame the weighted normalized matrix. Supposed that $\widetilde{U_J} = (\widetilde{u_1}, \widetilde{u_2}, \ldots . \widetilde{u_n})$ is the weight importance of decision maker and $\sum \widetilde{U_J}$ = 1, j=1, 2, . . ., n.

$\widetilde{N_{ij}}$=[$\widetilde{n_{ij}}$] $_{m\times n}$ is the weighted normalized matrix where i = 1,2, … , m and = 1,2, … , n and it can be found by using the formula,$\widetilde{N_{ij}} = \widetilde{m_{ij}} X \widetilde{U_J}$.

Step 7. Construct the Fuzzy Positive (FIPS) and Fuzzy Negative Ideal Solution (FNIS) using the formulae as follows:

$$T^* = \left(\tilde{n}_{1,}^* \tilde{n}_{2,\ldots\ldots}^* \quad \tilde{n}_j^*\right) \quad \text{where} \quad j = 1,2, \ldots, n$$

$$T^- = \left(\tilde{n}_{1,}^- \tilde{n}_{2,\ldots\ldots}^- \quad \tilde{n}_j^-\right) \quad \text{where} \quad j = 1,2, \ldots, n$$

Compute the distance of each weighted alternatives from FPIS and FNIS by using the following equations:

$$R_i^* = \sum_{j=1}^{n} d(\widetilde{n_{ij}}, \widetilde{n}_{j,}^*) \quad \text{where} \quad j = 1,2, \ldots, n$$

$$R_i^- = \sum_{j=1}^{n} d(\widetilde{n_{ij}}, \widetilde{n}_{j,}^-) \quad \text{where} \quad i = 1,2, \ldots, n$$

Step 8. Calculating each alternative closeness coefficient (CCi *). Closeness Coefficient (CCi *) represents the similarity to ideal solution and it can be determined as follows:

$CCi^* = \frac{R_i^-}{R_i^* + R_i^-}$. Rank each alternative, and prioritise the alternatives on the basis of Fuzzy positive ideal solution and fuzzy negative ideal solution.

3. Proposed problem

The aim is to choose best refrigerator on the basis of criteria:

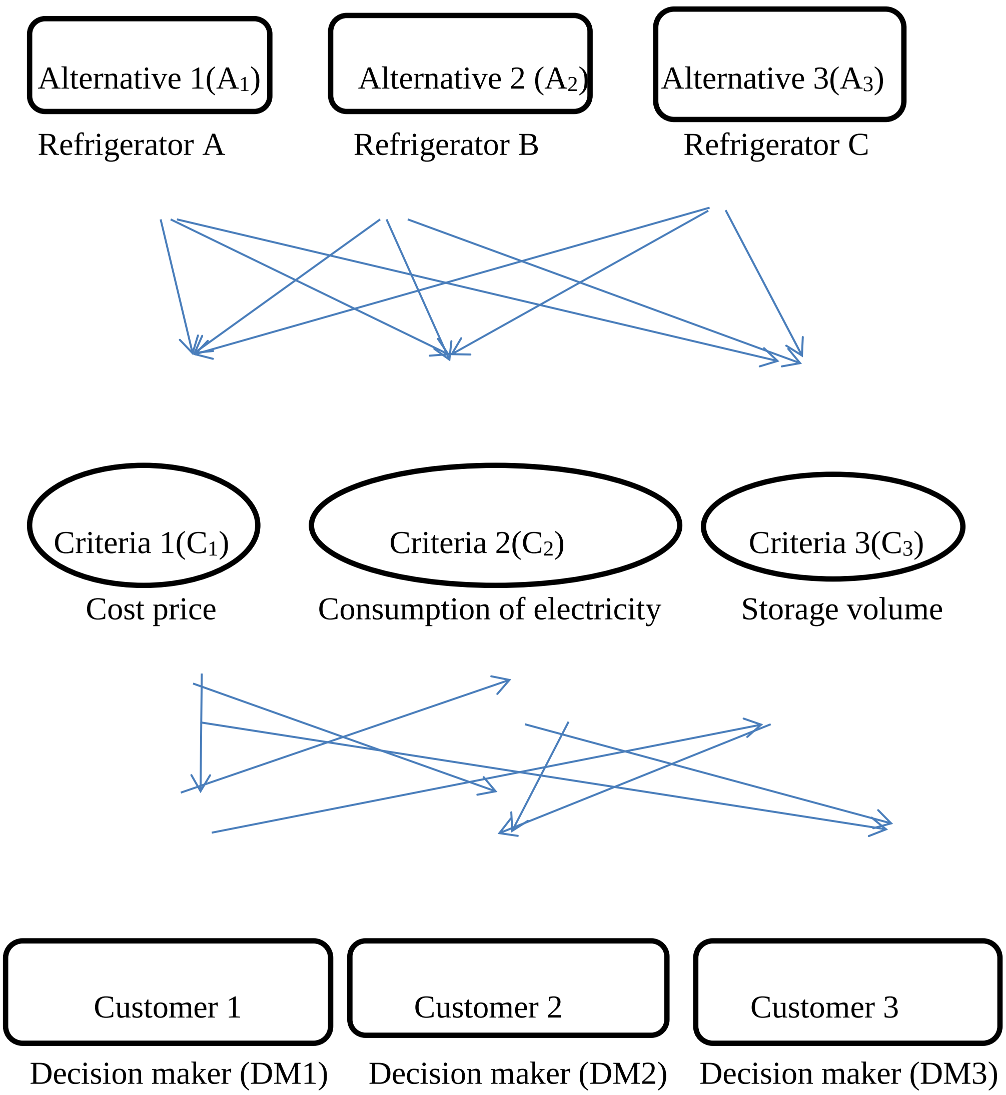

Fig 1. Shows the overall view of the purposed problem

On the basis of market survey data, it was found that the customer will often choice particular brand of refrigerator by analyzing and assessing the main criteria's such as Cost price, Consumption of electricity, Storage volume. In this purposed model, we have taken three brands of refrigerators such as Refrigerator A, Refrigerator B, Refrigerator C which has be fully examined with the criteria's such as Cost price, Consumption of electricity, Storage volume . This examination is carried out briefly by means of Fuzzy Topsis approach in the following section.

For analyzing the criteria, the data's which is collected in the survey from the set of three popular shops were considered. This paper will help the customer to choose his best alternatives available, that can be done with fuzzy TOPSIS technique. Also, we have to identify beneficial criteria and non-beneficial criteria according to the significance of criteria involved. While choosing a best quality refrigerator, the cost(C_1), consumption of electricity (C_2) should be minimal, therefore it is assumed to be non-beneficial criteria, while storage volume (C_3) of fridge should be maximal, and thus it is considered to beneficial criteria. The following flowchart which depicts the various steps involved in fuzzy TOPSIS as follows:

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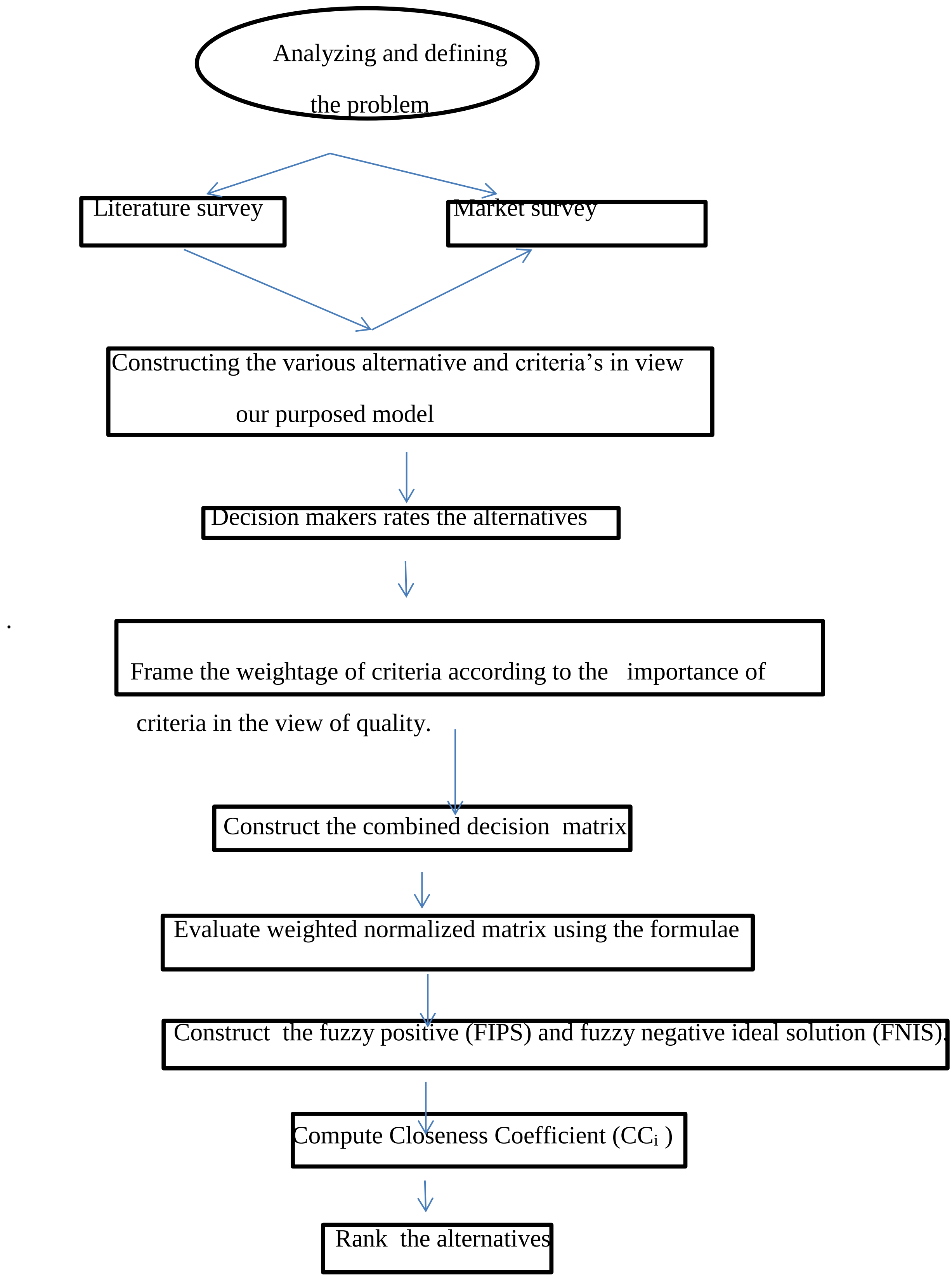

Fig 2. Shows the Fuzzy TOPSIS approach

4. Ranking the alternatives on basis of Fuzzy TOPSIS technique to the purposed problem

Implementation of Fuzzy TOPSIS approach to our problem in a sequential order are as follows:

Step 1: The aim is to select the best quality refrigerator on the basis of satisfactions of criteria.

Step 2: The decision makers used linguistic variable to evaluate the weights of criteria and the ratings of alternatives.

Tables 2. Linguistic variables for rating of alternative

	Alternative A_1		Alternative A_2		Alternative A_3	
Criteria's	Decision maker 1 (DM1)	Decision maker 2 (DM2)	Decision maker 1 (DM1)	Decision maker 2 (DM2)	Decision maker 1 (DM1)	Decision maker 2 (DM2)
C_1	(3,5,7)	(5,7,9)	(5,7,9)	(1,1,3)	(1,3,5)	(1,1,3)
C_2	(7,9,9)	(5,7,9)	(5,7,9)	(1,3,5)	(3,5,7)	(5,7,9)
C_3	(1,3,5)	(1,3,5)	(1,35)	(1,5,3)	(3,5,7)	(1,3,5)

Tables 3. Rating of weightage of each criteria

	Fuzzy number	
Criteria's	Decision maker 1 (DM1)	Decision maker 2(DM2)
C_1	(5,7,9)	(1,1,3)
C_2	(7,9,9)	(1,3,5)
C_3	(1,1,3)	(5,7,9)

Step 4 : Evaluate the combined decision matrix using formula $\widetilde{D_{ij}} = (a_{ij}, b_{ij}, c_{ij})$ where

$a_{ij} = \min\left(a_{ij}^k\right)$, $b_{ij} = 1/k\ [\sum_{k=1}^{n} b_{ij}^k]$ $c_{ij} = \max\left(c_{ij}^k\right)$.

Table 4. Combined decision matrix for criteria versus alternatives.

Weightage	(1,4,9)		(1,6,9)		(1,4,9)	
	Alternative A_1		Alternative A_2		Alternative A_3	
Criteria's	Decision maker 1 (DM1)	Decision maker 2(DM2)	Decision maker 1(DM1)	Decision maker 2 (DM2)	Decision maker 1 (DM1)	Decision maker 2 (DM2)
C_1	(3,5,7)	(5,7,9)	(5,7,9)	(1,1,3)	(1,3,5)	(1,1,3)
C_2	(7,9,9)	(5,7,9)	(5,7,9)	(1,3,5)	(3,5,7)	(5,7,9)
C_3	(1,3,5)	(1,3,5)	(1,35)	(1,5,3)	(3,5,7)	(1,3,5)

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Table 5. Combined Weightage for Decision makers

Alternatives	weightage for Decision maker
C_1	(1,4,9)
C_2	(1,6,9)
C_3	(1,4,9)

Step 5: We have to identify the beneficial and non -beneficial criteria and use formula to frame the normalized matrix. $\widetilde{M} = \widetilde{m_{\iota J}}$

$$\widetilde{m_{\iota J}} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad \text{where } c_j^* = max\ c_{ij} \quad \text{for beneficial criteria}$$

$$\widetilde{m_{\iota J}} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \quad \text{where } a_j^- = min\ c_{ij} \quad \text{for beneficial criteria}$$

Table 6. Normalized Matrix

Alternatives	Criteria 1 C_1	Criteria 2 C_2	Criteria 3 C_3
A_1	(0.143,0.2, 0.333)	(0.111, 0.111, 0.143)	(0.111, 0.4444, 0.777)
A_2	(0.111, 0.25, 1)	(0.111, 0.2, 1)	(0.111, 0.4444, 1)
A_3	(0.2 ,0.5, 1)	(0.111, 0.167, 0.333)	(0.111,0.444,0.777)

Step 6: Frame the weighted normalized matrix using the formulae $\widetilde{N_{\iota J}} = \widetilde{m_{\iota J}} X \widetilde{U_J}$.

Table 7. Weighted Normalized Matrix

Alternatives	Criteria 1 C_1	Criteria 2 C_2	Criteria 3 C_3
A_1	(0.143,0.8, 3)	(0.111,0.667,1.285)	(1,1.77,7)
A_2	(0.111,1,9)	(0.111,1.2,9)	(0.111,1.777,9)
A_3	(0.2,2,9)	(0.111,1,3)	(0.111,1.77,7)

Step 7. Construct the fuzzy positive and fuzzy negative ideal solution as

$$T^* = \left(\tilde{n}_{1,}^* \tilde{n}_{2,\ldots\ldots}^* \quad \tilde{n}_j^*\right) \quad \text{where} \quad j = 1,2, \ldots, n$$

$$T^- = \left(\tilde{n}_{1,}^- \tilde{n}_{2,\ldots\ldots}^- \quad \tilde{n}_j^-\right) \quad \text{where} \quad j = 1,2, \ldots, n$$

Table 8. FPIS and FNIS for alternatives

Alternatives	Criteria 1 C_1	Criteria 2 C_2	Criteria 3 C_3
A_1	(0.143,0.8, 3)	(0.111,0.667,1.285)	(1,1.77,7)
A_2	(0.111,1,9)	(0.111,1.2,9)	(0.111,1.777,9)
A_3	(0.2,2,9)	(0.111,1,3)	(0.111,1.77,7)
FIPS (T^*)	(0.2,2,9)	(0.111,1,2.9)	(0.111,1.777,9)
FNIS (T^-)	(0.111,1,9)	(0.111,0.667,1.285)	(0.111,17777,7)

Step 8. Calculating the distance of each weighted alternatives from fuzzy positive and fuzzy negative ideal solution

Compute $R_i^* = \sum_{j=1}^{n} d(\widetilde{n_{ij}}, \widetilde{n}_{j,}^{*})$ and $R_i^- = \sum_{j=1}^{n} d(\widetilde{n_{ij}}, \widetilde{n}_{j,}^{-})$

Table 9. Distance using FPIS and R_i^*

Alternatives	Criteria 1 C_1	Criteria 2 C_2	Criteria 3 C_3	R_i^*
A_1	3.532	4.465	1.26	9.26
A_2	0.579	0	0	0.579
A_3	0	3.466	1.115	4.581

Table10. Distance using FNIS and R_i^-

Alternatives	Criteria 1 C_1	Criteria 2 C_2	Criteria 3 C_3	R_i^-
A_1	3.466	0	0.514	3.98
A_2	0	4.465	1.115	5.58
A_3	0.579	1.008	0	1.587

Step 9. Evaluate the closeness coefficient (CCi^*)

$CCi^* = \frac{R_i^-}{R_i^* + R_i^-}$ and rank each alternative.

Table 11. Closeness coefficient

Alternatives	R_i^*	R_i^-	CCi^*	Ranking
A_1	9.26	3.98	0.3006	III
A_2	0.579	5.58	0.905	I
A_3	4.581	1.587	0.733	II

5. Conclusion

In this paper, we prioritize the alternative by assessing the various criteria's and suggested that the alternative A_2 was found to be best in all quality aspects. Here, Fuzzy TOPSIS approach has been implemented to the problem, to execute the output. Also, a brief procedure is presented, and while problem the solved, and we came into conclusion the alternative A_2 has got ranks one position, alternative A_3 has got ranks two position, alternative A_1 has got ranks three positions. This paper will provide good suggestion for the customers who needs to buy the good quality refrigerator, available in the market. Also, the model can be further extended, by taking more criteria's which ensures quality of a product, and thus it will offer improvised results. There are many more MCDM approaches, like VIKOR, ELECTRE, Fuzzy AHP, which can applied to the purposed model, that can offer appropriate output which can be done in future.

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