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Analysis of fuzzy multi criteria decision making (FMCDM) in dairy products selection

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Abstract
To address difficult mathematics and technical issues, modellers have turned to multiple criteria decision making (MCDM). Incomplete and ambiguous data presents decision makers with several challenges. In order to solve a wide range of complicated systems, the best modelling method in recent years has been fuzzy set theory combined with MCDM criteria.
Helping the decision maker (DM) choose one option from a limited range of possibilities or to rank those options according to many criteria is what multi-criteria decision-making (MCDM) is all about. The greatest dairy product in Uttarakhand is determined by considering its components in this study report. When selecting a choice from a small set of options with many characteristics, TOPSIS is one of the selection method strategies that might be useful. We are receiving more realistic, tangible, and sensitive outcomes with the use of MCDM approaches. To find the optimal solution to a decision-making issue, the Fuzzy TOPSIS approach is used. Finally, using Fuzzy MCDM we find the best alternative which maximize the resources and enhance the local benefits.

Keywords: Multi criteria decision making, fuzzy topsis, negative ideal solution, positive ideal solution.

Introduction

Operation Research (OR) has had far-reaching effects in modern times. At the moment, OR is a popular activity among management consulting companies. Activities in the OR include a wide range of fields, including transportation systems, libraries, hospitals, city planning, financial organisations, and more, in addition to military and commercial uses. Delhi Cloth Mills, Indian Railways, Indian Airlines, Defence Organisations, Hindustan Lever, Tata Iron & Steel Co., Fertiliser Corporation of India, and many more Indian enterprises have OR activities.

In practice, decision-makers often face competing priorities. Multiple objective decision analysis (MODA) must thus include a trade-off analysis. When upper management has more than one objective, they will typically use a priority system to rank them. Using priority coefficients (U's), goal programming allows for the preferable ordering of objectives. An objective function value of U1 is given to all objectives (deviational variables) that are deemed top or first priority. objectives that are deemed second in importance are awarded a U2 value. This procedure is repeated until all goals have been rated. There are no factors or variables associated with the coefficients U1, U2, etc. In most cases, they do not take on a numerical value; rather, they stand in for priority levels.

Making a choice amongst several viable options requires thought, analysis, and reasoning. This process is known as decision-making. Finding and selecting options in light of one's own values and preferences is the subject of decision making. When there are several criteria or attributes that may be used to assess potential alternatives, the process is called multi-criteria decision making (MCDM) as discussed by Jiang *et al*. [1]. The process of evaluating a group of options based on criteria that are often distinct, unequal, or even contradictory is known as "selection" Hwang and Yoon [2]. The goal of multi-criteria decision-making (MCDM) is to help the decision maker (DM) narrow down a set of possibilities to a single, optimal choice or to rank those options according to many criteria. Many popular MCDM approaches include Weighted sum modal (WSM), Weighted product modal (WPM), Analytic Hierarchy Process (AHP), Grey Relational Analysis (GRA), Technique for Order of Preference by Similarity to

Ideal Solution (TOPSIS), and many more. Although several MCDM approaches exist, TOPSIS has seen the heaviest usage. The TOPSIS method was initially proposed by Hwang and Yoon [2]. It is a popular MCDM strategy for situations where multiple criteria need to be considered. The best course of action should optimise benefits while limiting expenditures, as proposed by Benitez *et al.* [3] and then backed by Wang and Elang [4], Wang and Lee [5], and Lin *et al.* [6]. In addition, the ideal solution should be the one that maximises costs and minimises benefits, often known as the negative-ideal solution. This solution should be the one that is the shortest distance from the optimal option. It is utilised to select the optimal choice when additional conflicting criteria are presented. Conversely, the lowest conceivable criterion values constitute the negative ideal solution. Turkish cement companies were offered a method for performance assessment by Ertugrul and Karakasoglu [7]. This approach relies on the TOPSIS and fuzzy analytic hierarchy processes. In their paper, Wang and Lee [8] introduced a novel fuzzy TOPSIS that combines subjective and objective weights to assess options. In order to find an industrial zone suitable for a dairy product business, Mokhtarian and Vencheh [9] investigate a novel fuzzy TOPSIS approach that uses left and right scores. Khandekar and Chakraborty [10] conducted study on the topic of fuzzy axiomatic design principles as they pertain to group decision-making processes including facility site selection. While deciding on a laptop, Rajini H. [11] analyses fuzzy multi-criteria decision-making and multi-criteria decision-making with a focus on options and criteria. In an effort to improve the sustainability engineering process, Zavadkas *et al.* [12] looked into the MCDM technique. Using the fuzzy TOPSIS method, Sahin *et al.* [13] selected a dry bulk carrier from among several potential options. Fuzzy TOPSIS was utilised by Cakar and Cavus [14] to select dairy industry suppliers. The selection of an industrial zone for the construction of a dairy products plant is a fuzzy multiple criterion decision making issue that Seyed *et al.* [15] attempted to address using a linear programming approach. Evaluation of output and consumption in the Indian dairy business by Kumar *et al.* [16].

A network architecture for the dairy industry's supply chain was suggested by Kordshouli *et al.* [17] based on a multistage decision-making framework. As a hybrid strategy for farmer selection in the food business, Abdallah *et al.* [18] conduct a case study from a Tunisian viewpoint utilising the MCDM method. In recent years, the application of fuzzy and hybrid TOPSIS models has expanded significantly across diverse fields. Majd *et al.* [19] introduced a Fermatean fuzzy TOPSIS approach for ranking business intelligence strategies in smart cities, while Aminoroaya *et al.* [20] proposed a fuzzy TOPSIS method preserving linguistic uncertainty through interval-valued analysis.

2. Mathematical Formulation and Analysis

When a more straightforward weighing strategy is preferred, TOPSIS is one of the helpful, easy-to-implement Multi Attribute Decision Making methods.

According to this approach, the best option is the one that minimises the distance between the negative and positive ideal solutions from a geometrical standpoint.

Each attribute is assumed to have a monotonically rising or decreasing utility according to TOPSIS. The ideal and non-ideal solutions can thus be readily found. To find out how near different options are to the perfect answer, we utilise the Euclidean distance method. In this way, the relative distances between options may be used to determine their preferred order.

$$D = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1N} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2N} \\ . & & & & . \\ . & & & & . \\ . & & & & . \\ x_{M1} & x_{M2} & x_{M3} & \cdots & x_{MN} \end{bmatrix}.$$

where xij represents the i-th alternative's performance metric according to the j-th criterion. The TOPSIS approach is outlined in the following stages to help you comprehend it properly.

Step 1. Construct the Normalized Decision Matrix

It is the goal of this procedure to transform the dimensional qualities into their non-dimensional equivalents. To determine an element of the normalised decision matrix r_{ij}, one may use the following formula -

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}(x_{ij})^2}},\ i= 1,2,\ldots\ldots,m,\ j=1, 2,\ldots..,n. \qquad (1).$$

Step 2. Construct the Weighted Normalized Decision Matrix

A set of weights $W = (w_1, w_2, w_3,..., w_n)$, (where: $\sum w_i = 1$) To generate the weighted normalised matrix V, the decision matrix incorporates the decision maker's specifications in the following manner:

$$V = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & w_3 r_{13} & \cdots & w_N r_{1N} \\ w_1 r_{21} & w_2 r_{22} & w_3 r_{23} & \cdots & w_N r_{2N} \\ . & & & & . \\ . & & & & . \\ . & & & & . \\ w_1 r_{M1} & w_2 r_{M2} & w_3 r_{M3} & \cdots & w_N r_{MN} \end{bmatrix}. \qquad (2).$$

Step 3. Determine the Positive Ideal and the Negative Ideal Solutions

Here are the definitions of the ideal A* and negative-ideal A- solutions:

Positive Ideal Solution

$A^* = \{v_1, v_2, v_2, \ldots, v_n\}$

Where

$v_j^* = \{\max(v_{ij}) \text{ if } j \in J\ ;\ \min(v_{ij}) \text{ if } j \in J'\}$ (3).

Negative Ideal Solution;

$A^- = \{v_1, v_2, v_3, \ldots, v_n\}$

Where $V_j^- = \{\min(v_{ij}) \text{ if } j \in J\ ;\ \max(v_{ij}) \text{ if } j \in J'\}$ (4).

This instance displays the set of cost characteristics J' (smaller-the-better type) and the set of benefit attributes J (larger-the-better type).

Step 4. Calculate the separation measures for each alternative

The distinction between each option from the best feasible one is

$$S_i^{n+} = \sqrt{\sum_{j=1}(v_{ij} - v_j^-)}\ ;\ i= 1, 2,\ldots\ldots m \qquad (5).$$

The distancing of each option from the negative ideal choice is

$$S_i^{n-} = \sqrt{\sum_{j=1}(v_{ij} - v_j^-)}\ ;\ i= 1, 2,\ldots\ldots m \qquad (6).$$

Step 5. Calculate the relative closeness to the ideal solution

The definition that follows is used to indicate how similar an alternative Ai is to the ideal solution A*:

$$C_i^* = S_i^- / (S_i^* + S_i^*)\ ;\ 0 < Ci^* < 1 \qquad (7).$$

Note that when Ai = A* where Ci* = 1

When A_i = A- where Ci* = 0

Step 6. Rank the Preference Order

By comparing Ci* values, the ranking of alternatives are determined. Choose an alternative with maximum Ci* or rank alternatives according to Ci* in descending order.

3. Problem Description and Optimization Procedure

Milk is recognised as one of the world's healthiest and most nourishing beverages. To develop and maintain a robust and healthy physique, we need milk beginning at a young age. Milk is emphasised by the World Health Organization's guidelines, which designate Dairy as a distinct dietary category. Milk is a great dietary option because it is packed with nutrients that are essential for overall health. These nutrients make milk a valuable part of a balanced diet, particularly for children, adolescents, and pregnant or breastfeeding women with increased nutrient needs. Dairy products, including milk, provide many health benefits and, when eaten regularly, may help lower the chance of getting chronic illnesses.

In this research paper, we choose some key nutrients found in milk as criteria along with the cost and energy produced by milk per 100 ml -

1. **Calcium:** Crucial for a healthy mouth and strong bones. Preventing osteoporosis requires a lifetime commitment to an adequate calcium diet.
2. **Protein:** Important for muscle growth and repair, as well as supporting the immune system.
3. **Carbohydrates:** Milk contains lactose, a type of carbohydrate composed of glucose and galactose. Lactose provides a source of energy for the body and is particularly beneficial for children and individuals with active lifestyles who need quick energy.
4. **Fat:** Milk contains a variety of fats, including saturated, unsaturated, monounsaturated, polyunsaturated, and even small amounts of trans fats. These fats are important for:
   - The quantity of energy provided by energy fats is more than double that of carbs or proteins per gramme, making them a concentrated source of energy.
   - **Fat-soluble vitamins:** Vitamins A, D, E, and K are fat-soluble, meaning they require fat for digestion. Milk fat aids in the absorption of these vitamins, which is good for your health in general.
   - **Cellular structure:** Fats are involved in cellular homeostasis and act as structural and functional components of cell membranes.
5. **Energy:** The combination of carbohydrates, fats, and proteins in milk provides a significant source of energy. This energy is crucial for daily activities, physical exercise, and overall metabolic functions.

Table 1 shows the results of the study paper's usage of TOPSIS and Fuzzy TOPSIS, MCDM approach to determine the best accessible milk throughout the state of Uttarakhand based on a number of competing variables, including nutritional levels, cost, and availability. All the nutrient value or cost are as per 100 ml of milk. We also compare optimized results find by TOPSIS and Fuzzy TOPSIS, MCDM methods. The consumer has their preferences while purchasing the milk from market, in this paper we set some preference order i.e. cost, energy, protein, carbohydrate, fat, calcium.

Table 1: All the nutrient value or cost are as per 100 ml of milk

Alternative / Criteria	Cost INR	Energy in KCl	Protein in gm	Carbohydrate in gm	Fat in gm	Calcium in mg
Ananda Cow milk (Milk 1)	6	61	3.2g	4.8g	3.2g	117 mg
Anchal Standard milk (Milk 2)	5.7	73	3.1g	4.8g	4.5 g	142 mg
Amul Cow milk (Milk 3)	5.6	69	3.1g	4.9g	4.0g	116 mg
Mother Dairy Cow milk (Milk 4)	5.6	85	3.1g	4.8g	4.1g	68 mg
Snow Pure Cow milk (Milk 5)	7.0	70.4	3.48g	5.8g	3.68g	148 mg

A. Numerical calculations using TOPSIS method

The TOPSIS analysis makes use of the Decision Matrix table, which is shown in Table 2.

Table 2: Decision Matrix

Ananda (Milk 1)	Anchal (Milk 2)	Amul (Milk 3)	Mother Dairy (Milk 4)	Snow Pure (Milk 5)	Alternative
7	5	5	5	9	Cost
7	5	7	3	7	Energy
5	7	7	7	5	Protein
5	5	7	5	3	Carbohydrate
7	5	5	5	7	Fat
5	3	5	9	3	Calcium

Eq. (1) is used to normalise each element according to the first phase of the TOPSIS method. During this process, dimensional qualities are transformed into non-dimensional ones. Table 3 displays the normalised decision matrix of the TOPSIS analysis.

Table 3: Normalized Decision Matrix

Ananda (Milk 1)	Anchal (Milk 2)	Amul (Milk 3)	Mother Dairy (Milk 4)	Snow Pure (Milk 5)	Alternative
0.4698	0.3977	0.3355	0.3417	0.6040	Cost
0.4698	0.3977	0.4698	0.2050	0.4698	Energy
0.3355	0.5568	0.4698	0.4785	0.3355	Protein
0.3355	0.3977	0.4698	0.3417	0.2013	Carbohydrate
0.4698	0.3977	0.3355	0.3417	0.4698	Fat
0.3355	0.2386	0.3355	0.6152	0.2013	Calcium

In order to determine the weighted normalised ratings, the second step is to gather the attribute weight data. The AHP method allows one to assign relative importance to each criterion. You may find the definitions of the important ratios in Table 4.

Table 4: Linguistic Definition

Level of importance a_{ij}	Linguistic Definition for comparison of the i^{th} and the j^{th} items
1	The i^{th} item is equally important as the j^{th} item
3	The i^{th} item is slightly more important than The j^{th} item
5	The i^{th} item is more important than the j^{th} item
7	The i^{th} item strongly important than j^{th} item
9	The i^{th} item is extremely important than j^{th} item
2,4,6,8	The intermediate values between the two adjacent judgements
$1/a_{ij}$	The inverse comparison between i^{th} and j^{th} item

Table 5(a) shows the relative weights of three criteria, and a pair-wise comparison table is also provided.

Table 5(a): Weight of criteria

Criteria	Cost C_{11}	Energy C_{12}	Protein C_{13}	Weight
Cost C_{11}	1	3	3	0.55
Energy C_{12}	1/5	1	1/5	0.12
Protein C_{13}	1/3	5	1	0.33

Table 5(b) displays the weights of all assessment goals in a similar fashion.

Table 5(b): Other weights of criteria

Criteria	Carbohydrate C_{21}	Fat C_{22}	Calcium C_{23}	Weight
Carbohydrate C_{21}	1	3	1/5	0.24
Fat C_{22}	1/3	1	1/3	0.14
Calcium C_{23}	5	3	1	0.62

The weights obtained from all objective criteria are
$C_{11} = 0.55$, $C_{12} = 0.12$, $C_{13} = 0.33$
$C_{21} = 0.24$, $C_{22} = 0.14$, $C_{23} = 0.62$

After that, we multiply each value by its appropriate weight to get a weighted normalised matrix. Table 6 displays the decision matrices for each choice with regard to the criteria, normalised and weighted. We may obtain the positive and negative ideal solutions by utilising the highest and lowest values for each criterion in Equations (3) and (4). Afterwards, we find the distance of each alternative from the positive ideal solution (PIS) and the negative ideal solution (NIS) in relation to each criterion using Equations (5) and (6). The results of calculating the closeness coefficient for each logistics service provider using Equation (7) are displayed in Table 6. These values are then used to rank the alternatives.

Table 6: TOPSIS Result

Criteria	Milk 1	Milk 2	Milk 3	Milk 4	Milk 5	Vj^+	Vj^-
C11	0.2583	0.2187	0.1845	0.1879	0.3322	0.3322	0.1845
C12	0.0563	0.0477	0.0563	0.0246	0.0563	0.0563	0.0246
C13	0.1107	0.1837	0.1550	0.0676	0.1550	0.1837	0.0676
C21	0.0805	0.0954	0.1127	0.0820	0.0483	0.1127	0.0483
C22	0.0657	0.0556	0.0469	0.0478	0.0657	0.0657	0.0469
C23	0.2080	0.1479	0.2080	0.3814	0.1248	0.3814	0.1248
S_i^+	0.2046	0.2605	0.2295	0.1912	0.2661		
S_i^-	0.1289	0.1342	0.1401	0.2588	0.1755		
C_i^+	0.3865	0.3400	0.3790	0.5751	0.3974		

Step six concludes by arranging the options in descending order using Table 6. Using the TOPSIS approach, the options were ranked in the following order:
Milk 4 > Milk 5 > Milk 1 > Milk 3 > Milk 2.

B. Numerical calculations using fuzzy TOPSIS method: Linguistic variables, which can be stated in words, sentences, or even artificial languages, are a great help when dealing with too complicated situations. Linguistic variables include the relative importance of different criteria and the ratings given to qualitative criteria. The positive triangular fuzzy numbers can be used to express these language variables, as shown in Table 7.

Table 7: Fuzzy triangular numbers for linguistic variable

Fuzzy Numbers	Alternative Assessment	Weight
(1,1,3)	Very poor (VP)	Very low (VL)
(1,3,5)	Poor (P)	Low (L)
(3,5,7)	Fair (F)	Medium (M)
(5,7,9)	Good (G)	High (H)

To investigate performance evaluations as fuzzy linguistic variables, we can normalise the decision matrix such that all criteria fall into the interval [0, 1] as shown below:

Table 8: Normalized decision Matrix for Fuzzy TOPSIS analysis

	Milk 1	Milk 2	Milk 3	Milk 4	Milk 5
C11	0.5	0	0	0	1
C12	1	0.5	1	0	1
C13	0	1	1	1	0
C21	0.5	0.5	1	0.5	0
C22	1	0	0	0	1
C23	0.33	0	0.33	1	0

The syntax of the variables that have been allocated to different qualities and Criteria are used by the decision makers. The linguistic variables are shown in Table 9 as triangular fuzzy numbers, and the transformation is shown in Table 10.

Table 9: Linguistic variable and Fuzzy Triangular membership function

Linguistic Variable	Triangular Fuzzy Number
Very Low (VL)	0, 0, 0.1
Low (L)	0, 0.1, 0.3
Medium Low (ML)	0.1, 0.3, 0.5
Medium (M)	0.3, 0.5, 0.7
Medium High (MH)	0.5, 0.7, 0.9
High (H)	0.7, 0.9, 1
Very High	0.9, 1, 1

Table 10: Decision Matrix using Fuzzy linguistic variable

	Milk 1	Milk 2	Milk 3	Milk 4	Milk 5
C11	M	VL	VL	VL	VH
C12	VH	M	VH	VL	VH
C13	VL	VH	VH	VH	VL
C21	M	M	VH	M	VL
C22	VH	VL	VL	VL	VH
C23	L	VL	L	VH	VL

After making fuzzy linguistic decision matrix, Table 11 is obtained which includes triangular membership function and attribute weight.

Table 11: Fuzzy decision matrix and Fuzzy attribute weight

	Milk 1	Milk 2	Milk 3	Milk 4	Milk 5	Weight
C11	(0.3, 0.5, 0.7)	(0, 0, 0.1)	(0, 0, 0.1)	(0, 0, 0.1)	(0.9, 1, 1)	(0.5, 0.7, 0.9)
C12	(0.9, 1, 1)	(0.3, 0.5, 0.7)	(0.9, 1, 1)	(0, 0, 0.1)	(0.9, 1, 1)	(0.1, 0.3, 0.5)
C13	(0, 0, 0.1)	(0.9, 1, 1)	(0.9, 1, 1)	(0.9, 1, 1)	(0, 0, 1)	(0.5, 0.7, 0.9)
C21	(0.3, 0.5, 0.7)	(0.3, 0.5, 0.7)	(0.9, 1, 1)	(0.3, 0.5, 0.7)	(0, 0, 0.1)	(0.1, 0.3, 0.5)
C22	(0.9, 1, 1)	(0, 0, 0.1)	(0, 0, 0.1)	(0, 0, 0.1)	(0.9, 1, 1)	(0, 0, 0.1)
C23	(0, 0.1, 0.3)	(0, 0, 0.1)	(0, 0.1, 0.3)	(0.9, 1, 1)	(0, 0, 0.1)	(0.9, 1, 1)

The fuzzy weighted decision matrix is then computed using the fuzzy TOPSIS method, as shown in Table 12.

Table 12: Fuzzy weighted decision matrix

	Milk 1	Milk 2	Milk 3	Milk 4	Milk 5
C11	(0.15, 0.35, 0.63)	(0, 0, 0.09)	(0, 0, 0.09)	(0, 0, 0.09)	(0.45, 0.7, 0.9)
C12	(0.09, 0.3, 0.5)	(0.03, 0.15, 0.35)	(0.09, 0.3, 0.5)	(0, 0, 0.05)	(0.09, 0.3, 0.5)
C13	(0, 0, 0.05)	(0.45, 0.3, 0.9)	(0.45, 0.3, 0.9)	(0.45, 0.3, 0.9)	(0, 0, 0.09)
C21	(0.03, 0.15, 0.35)	(0.03, 0.15, 0.35)	(0.09, 0.3, 0.5)	(0.03, 0.15, 0.35)	(0, 0, 0.05)
C22	(0, 0, 0.1)	(0, 0, 0.01)	(0, 0, 0.01)	(0, 0, 0.01)	(0, 0, 0.1)
C23	(0, 0.1, 0.3)	(0, 0, 0.1)	(0, 0.1, 0.3)	(0.81, 1, 1)	(0, 0, 0.1)

After the generation of the fuzzy weight decision matrix, the distance of each option from the fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS) with respect to each criterion is tabulated.

Table 13: Result fuzzy TOPSIS analysis

	Milk 1	Milk 2	Milk 3	Milk 4	Milk 5	A^+	A^-
C11	(0.15, 0.35, 0.63)	(0, 0, 0.09)	(0, 0, 0.09)	(0, 0, 0.09)	(0.45, 0.7, 0.9)	(1, 1, 1)	(0, 0, 0)
C12	(0.09, 0.3, 0.5)	(0.03, 0.15, 0.35)	(0.09, 0.3, 0.5)	(0, 0, 0.05)	(0.09, 0.3, 0.5)	(1, 1, 1)	(0, 0, 0)
C13	(0, 0, 0.05)	(0.45, 0.3, 0.9)	(0.45, 0.3, 0.9)	(0.45, 0.3, 0.9)	(0, 0, 0.09)	(1, 1, 1)	(0, 0, 0)
C21	(0.03, 0.15, 0.35)	(0.03, 0.15, 0.35)	(0.09, 0.3, 0.5)	(0.03, 0.15, 0.35)	(0, 0, 0.05)	(1, 1, 1)	(0, 0, 0)
C22	(0, 0, 0.1)	(0, 0, 0.01)	(0, 0, 0.01)	(0, 0, 0.01)	(0, 0, 0.1)	(1, 1, 1)	(0, 0, 0)
C23	(0, 0.1, 0.3)	(0, 0, 0.1)	(0, 0.1, 0.3)	(0.81, 1, 1)	(0, 0, 0.1)	(1, 1, 1)	(0, 0, 0)
di^+	3.1600	3.0405	2.2650	2.0201	3.0947		
di^-	1.9091	1.6473	1.3274	1.3491	1.8394		
Cc^+	0.3766	0.3514	0.3695	0.4004	0.3727		

According to Table 13, the following is the order in which the options were ranked using the Fuzzy TOPSIS method:
Milk 4 > Milk 1 > Milk 5 > Milk 3 > Milk 2.

4. Results and Discussion

The first step in making the best choice of dairy products is to establish what options are available and what criteria to use. To determine the linguistics grade and weights depending on experts, the words should be represented as triangular fuzzy numbers (TFNs). Here, dairy-products that is best available milk across Uttarakhand state on the different conflicting criteria such as their nutrient values, cost etc. as per 100 ml of milk is studied and analysed. The main aim is to find the right supplier having low-cost milk and highly nutrient values. In order to accurately determine the ranks and weights in a fuzzy environment, Table 14 displays the outcomes of comparing the TOPSIS method with the fuzzy TOPSIS technique. This was necessary since the supplier selection process is an MCDM issue.

Table 14: The order of ranking of the alternatives for different methods

Ranking	1	2	3	4	5
TOPSIS	Milk 4	Milk 5	Milk 1	Milk 3	Milk 2
Fuzzy TOPSIS	Milk 4	Milk 1	Milk 5	Milk 3	Milk 2

Based on Table 14 both the methods lead to the choice milk 4, hence milk 4 has highest quality. While other than Milk 4 preferences vary between methods.

5. Conclusion

In this research, we learn how to tailor TOPSIS and Fuzzy TOPSIS to solve a milk selection issue according to nutritional value. Future strategic planning for the organisation may benefit from the study's methodologies and lessons learnt. When it comes to the suggested issue, TOPSIS is the way to go, and it works well with clear performance evaluations. Fuzzy TOPSIS is the method of choice when performance evaluations are imprecise and nebulous. This research study presents a Fuzzy TOPSIS technique that is based on positive and negative Ideal Solutions. In robust FMCDM issue ranking, the suggested technique might be useful. A user-friendly and straightforward approach is suggested. In future, other fuzzy membership function can be used to optimize result of Fuzzy TOPSIS. Furthermore, the long-term viability of these approaches may be assessed by sensitivity analysis.

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