Application of TOPSIS for Best Domestic Refrigerator Selection

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Received: May 14, 2018 Accepted: June 19, 2018

ABSTRACT *In this paper an attempt is made to evaluate the best possible domestic refrigerator by using TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution) under Multi-criteria Decision Making tool (MCDM). Here TOPSIS is applied for finding best domestic refrigerator model from lots of similar conflicting criteria and sub-criteria's. In present days acquiring of electronic gadgets like refrigerator has become extremely confusing and difficult to the customers because of day to day changes in different specialized and operational parameters particularly like size or capacity, star rating, colour, door type, cooling technology and so on. TOPSIS is one of the best choice methodology systems to resolve such problems. In this paper a few refrigerators are considered with various qualities to select the best domestic refrigerator utilizing TOPSIS system.*

Keywords: *TOPSIS, multi criteria decision making, domestic refrigerator selection.*

I. INTRODUCTION

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria choice investigation strategy, which was initially developed by Hwang and Yoon in 1981 [1]. Later the technique was further advanced Yoon in 1987 [2], and Hwang, Lai and Liu in 1993 [3].

TOPSIS is a type of Multi-Criteria Decision Making method which includes complete information on the criteria and sub-criteria. This information is expressed in their actual numerical forms which is more realistic than other MCDM methods. This method is capable of dealing and solving the real problems. It provides us with ranking or the optimal solution.

Among others Ewa Roszkowska [4] in his paper described the TOPSIS method showing its advantages and effectiveness with example. Zoran MARKOVIC [5] made certain modifications in TOPSIS methodology in solving certain real life business problems. Sri Krishna S et al. [6] applied TOPSIS method for selecting best possible car among many for a customer.

In this present investigation TOPSIS methodology is constructed and used in choosing the best domestic refrigerator for a typical middle class family range of India with the help of market survey considering the relative preferences of the customers for different selective criteria and their sub-criteria. Also the consistency of the decision is checked which reinforces the validity and reduce the biasness in decision making process.

II.THEORETICAL ANALYSIS

The TOPSIS method is used to solve a complex decision making problem. TOPSIS attempts to indicate the best alternative that simultaneously has the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution .The positive ideal solution is a solution that tries to maximize the profit criteria and minimize the cost criteria, whereas the negative ideal solution is just opposite to previous one. In the TOPSIS method, precise scores that each alternative receives from all the criteria are used in the formation of a decision matrix and normalized decision matrix. By taking into consideration the rates of all attributes, positive and negative ideal solutions are found. By comparing the distance coefficient of each alternative, the preference order of the alternatives is determined. [7]

we have to collect data of the specific models for the specific criteria and if the criteria does not contains any numerical values then we have to number it according to the comparison scale as shown in table 1.

Table- 1: Hwang and Yoon's pair wise comparison scale

Qualitative estimation	Bad	Good	Average	Very Good	Excellent	Type of criteria
Quantitative estimation	1	3	5	7	9	Max.
	9	7	5	3	1	Min.

A. THE STEPWISE PROCEDURE OF TOPSIS IS AS FOLLOWS:

- Step 1(structuring the problem): Identify the problem and structure the evaluation criteria alternatives.
- Step 2 (Collecting the actual data): Collecting data from different websites of the specific models.
- Step 3(evaluating the alternatives): Collect the reviews by rating according to own reference.
- Step 4(Identifying the ideal solutions): Forming the positive and negative ideal solution.
- Step 5 (Calculating the relative closeness value): Calculating the closeness co-efficient and ranking it.

B. APPLICATION OF TOPSIS IN SELECTION OF BEST DOMESTIC REFRIGERATOR :

Domestic refrigerator selection is a confusing and time consuming process that requires extensive reviews of market survey for possible selection. Comprehensive reviews provide information about refrigeration configurations, their capacity selection, cooling technology selection, star rating etc. Yet, the selection task stays vulnerable with the lack of some intellect in the process. In this paper, a rational approach is presented to help find the best refrigerator considering multiple criteria factors. [8]

The following five numbers of criteria are considered:

- Capacity or size of refrigerator
- Star rating
- Door type
- Cooling technology
- Colour

THE SELECTION CRITERIA IS SHOWN BELOW IN THE HIERARCHY TREE-

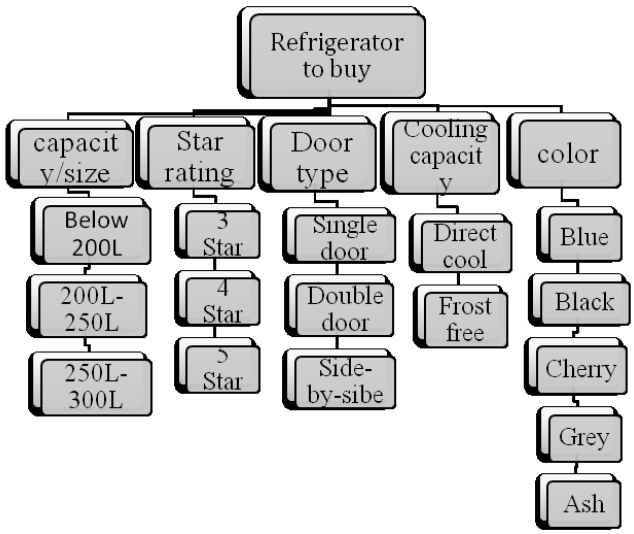

Fig 1: Selection criteria of TOPSIS

C. REVIEWS OF SOME CUSTOMER OR BUYERS:

The ratings on criteria and sub-criteria for domestic refrigeration selection are evaluated from the users and prospective middle class buyers of refrigerators, comprising of 1 to 4 family members, through physical market survey. Based on this AHP method is employed for best possible selection.

Order of preference of the criteria's and sub-criteria according to the groups of people are given below in table 3, 4,5,6,7.

Table-2: 1st group

Criteria preference (by order)	sub-criteria preference (by order)
Size/capacity	250L-300L
Star rating	5 Star
Cooling technology	Frost free
Color	Blue
Door type	Double

Table-3: 2nd group

Criteria preference (by order)	sub-criteria preference (by order)
Size	200L-250L
Star rating	5 Star
Door	Single
Cooling Technology	Frost free
Color	Cherry

Table-4: 3rd group

Criteria preference (by order)	sub-criteria preference (by order)
Star rating	5 Star
Size/capacity	250L-300L
Door type	Double
Color	Cherry
Cooling technology	Frost free

Table-5: 4thgroup

Criteria preference (by order)	sub-criteria preference (by order)
Size/capacity	200L-250L
Star rating	3 Star
Cooling technology	Direct cool
Door	Ash
Color	Single

Table-6: 5th group

Criteria preference (by order)	sub-criteria preference (by order)
Size/capacity	200L-250L
Star rating	4 Star
Cooling technology	Direct cool
Color	Grey
Door type	Single

D. APPLICATION OF TOPSIS IN SELECTION OF BEST DOMESTIC REFRIGERATOR

TABLE 7: CRITERION PARAMETRIC VALUES & ELEMENTS OF THE DECISION MATRIX OF DOMESTIC REFRIGERATOR

	SIZE/CAPACITY	STAR RATING	DOOR TYPE	COOLING TECHNOLOGY	COLOR
MODEL A	5	5	3	1	9
MODEL B	7	3	9	9	7
MODEL C	9	9	1	7	1
MODEL D	1	7	5	3	3
MODEL E	3	1	7	5	5

After taking the decision matrix from selection criteria, first normalise decision matrix is constructed. According to the formula R_{ij} as written in the above method.

$R_{13}=9/ (5^2+7^2+9^2+1^2+3^2)^{1/2} = 0.700389105$.

TABLE-8: NORMALISED VALUES OF DECISION MATRIX OF DOMESTIC REFRIGERATOR

	SIZE/CAPACITY	STAR RATING	DOOR TYPE	COOLING TECHNOLOGY	COLOR
WEIGHTS	0.5	0.26	0.07	0.14	0.03
MODEL A	0.389105058	0.389105058	0.233463035	0.077821012	0.700389
MODEL B	0.544747082	0.233463035	0.700389105	0.700389105	0.544747
MODEL C	0.700389105	0.700389105	0.077821012	0.544747082	0.077821
MODEL D	0.077821012	0.544747082	0.389105058	0.233463035	0.233463
MODEL E	0.233463035	0.077821012	0.544747082	0.389105058	0.389105

Then it is multiplied with weight criteria. Therefore it is , V_{13}= 0.5×0.700389105 = 0.350194553

TABLE-9: WEIGHTED VALUES OF DECISION MATRIX OF DOMESTIC REFRIGERATOR

	SIZE/CAPACITY	STAR RATING	DOOR TYPE	COOLING TECHNOLOGY	COLOR
MODEL A	0.194552529	0.101167315	0.016342412	0.010894942	**0.021012**
MODEL B	0.272373541	0.060700389	**0.049027237**	**0.098054475**	0.016342
MODEL C	**0.350194553**	**0.182101167**	0.005447471	0.076264591	0.002335
MODEL D	0.038910506	0.141634241	0.027237354	0.032684825	0.007004
MODEL E	0.116731518	0.020233463	0.038132296	0.054474708	0.011673

The positive ideal (A^+) and the negative ideal (A^-) solutions are defined according to the weighted decision matrix via equations. A^+ shows the highest values of the criteria whereas A^- shows the lowest.

A POSITIVE=(0.350194553,0.182101167,0.049027237,0.098054475,0.021012)
A NEGATIVE=(0.038910506,0.020233463,0.005447471,0.010894942,0.002335)

TABLE-10: DETERMINING POSITIVE IDEAL SOLUTION OF DOMESTIC REFRIGERATOR

POSITIVE					
	SIZE/CAPACITY	STAR RATING	DOOR TYPE	COOLING TECHNOLOGY	COLOR
MODEL A	0.024	0.007	0.188	0.008	**0**
MODEL B	0.006	0.015	**0**	**0**	0.00003
MODEL C	**0**	0	0.198	0.0005	0.0004
MODEL D	0.002	0.002	0.179	0.004	0.0002
MODEL E	0.054	0.026	0.17	0.004	0.00008

TABLE-11: DETERMINING NEGATIVE IDEAL SOLUTION OF DOMESTIC REFRIGERATOR

NEGATIVE					
	SIZE/CAPACITY	STAR RATING	DOOR TYPE	COOLING TECHNOLOGY	COLOR
MODEL A	0.038	0.007	0.00012	0	**0.0004**
MODEL B	0.014	0.0017	**0.0019**	**0.008**	0.0002
MODEL C	**0.0015**	**0.026**	0	0.004	0
MODEL D	0	0.015	0.0005	0.0005	0.00003
MODEL E	0.074	0	0.001	0.0018	0.0001

Then we calculate the separation distance of each competitive alternative from the ideal and non-ideal solution.

TABLE-12: DETERMINE SEPARATION FROM POSITIVE AND NEGATIVE IDEAL SOLUTION OF DOMESTIC REFRIGERATOR

SEPARATION MEASURES FROM:					
POSITIVE IDEAL SOLUTION			NEGATIVE IDEAL SOLUTION		
S_1^*	0.476		S_1^-	0.213	
S_2^*	0.145		S_2^-	0.161	
S_3^*	0.446		S_3^-	0.177	
S_4^*	0.433		S_4^-	0.127	
S_5^*	0.504		S_5^-	0.277	

Here, S denotes separation measures. S^* denotes positive separation measures whereas S^- denotes negative separation measures. S means the measure of separation from the ideal belief solutions to the positive or negative ideal solutions.

III. RESULTS AND DISCUSSIONS

A. RELATIVE CLOSENESS VALUE & RANKING OF DOMESTIC REFRIGERATOR OBTAINED FROM TOPSIS-

TABLE-13: RELATIVE CLOSENESS VALUES OF DOMESTIC REFRIGERATOR

RELATIVE CLOSENESS VALUES			
	CLOSENESS CO-EFFICIENT	**(%)**	**RANKING**
C_1*	0.309498624	30.94986239	RANK 3
C_2*	0.525530839	52.55308392	RANK 1
C_3*	0.28467123	28.46712299	RANK 4
C_4*	0.2263814	22.63814002	RANK 5
C_5*	0.354899458	35.48994581	RANK 2

Here, C* denotes closeness co-efficient obtained after applying TOPSIS method.

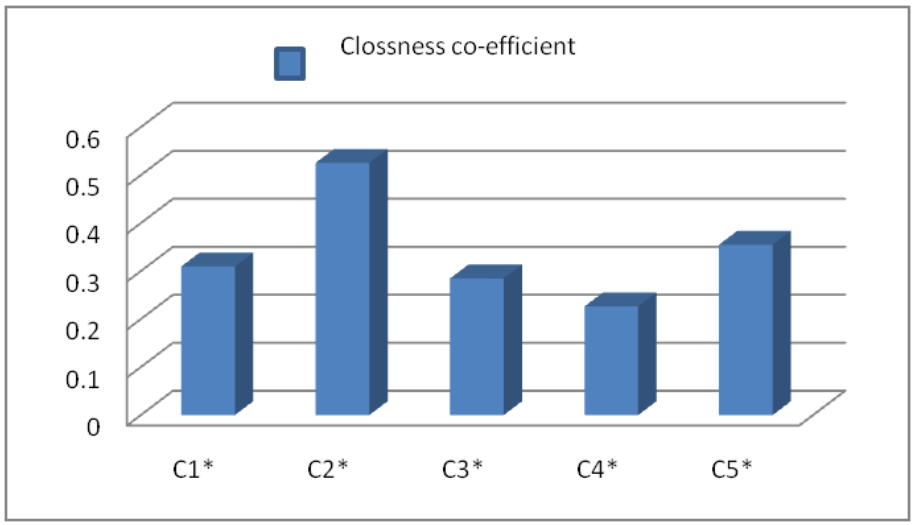

Fig-2: Graph showing the ranking order of the model (Refrigerator)

The domestic refrigerator model is now ranked according to their overall priorities of criteria and sub-criteria, as follows: B, E, A, C, and D, indicating that B is the best qualified model for selection.
There are many MCDM tools by which we can optimize the model containing different criteria of different product or processes. TOPSIS is a type of MCDM tool by which we can analyze the best possible selection of the different product and processes. Its results are more probabilistic because it measures the separation between the ideal solution and the probabilistic models and ranks the models with the closeness co-efficient.

IV. CONCLUSION

In this investigation TOPSIS method has been applied for the selection of best possible refrigerator for a middle class family. The applied preferences for the criteria and sub criteria other than the numerical forms for the five most useful refrigerator selection are taken from the market surfing and the weights are calculated by AHP. Detailed TOPSIS analysis are showed and the closeness co-efficient is also calculated. This value of co-efficient implies the ranking order of the alternatives. The process may be extended by considering more criteria and sub-criteria or by applying other methods for best possible selection.

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