



Analysis of Application of Technique For Order Preference By Simillarity To Ideal Solution In Selecting Energy Save Electrical Lights Ball For Household

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ABSTRACT

In this bulb selection of users is often confused with the selection of bulbs that are so much circulating in the market, ranging in terms of brand, type, quality, competitive price and with other advantages that in offer often make the users confused to get a light bulb that is energy efficient at an affordable price and with the best quality. Problems not only stop at the time when the bulb placement in each room of the house also often gets a problem. A common problem is inconsistency, which is common when a light bulb has been placed. Watt capacity available in bulb often does not correspond to the size of the room, resulting in less optimal illumination, watt capacity or large power consumption sometimes also does not guarantee to be able to get a good illumination. Therefore it takes a decision support system that can do the calculation of value to be able to help the user determine the bulb that is desired well and precisely according to the needs. This decision support system implements the method of technique for order preference by Simillarity to ideal solution (TOPSIS), which is a method that can provide a weighted and straddles for each of its criteria. With the technique for order preference by Simillarity to ideal solution (TOPSIS) This author creates a system that hopefully can help the decision making in the selection of electric light bulb. Therefore, the authors feel the need for a decision support system to solve the problem of electric bulb selection for the household..

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1. Introduction

A decision support system can also be explained as a means or tool to support the decision. It can generally be defined as a system capable of providing problem-solving capabilities as well as communication capabilities for semi-structured problems. The lamp becomes a must-have component and is paired in each house, to be able to provide lighting in each room of the house, ranging from the living room, room space, terrace of the house, kitchen, lighting at the desk and other rooms. In this bulb selection of users are often confused with the selection of bulbs that are so much circulating in the market, ranging in terms of brand, type, quality, competitive price and with other advantages that in offer often make the users confused to get a light bulb that is energy-efficient at an affordable price and with the best quality.

At the time of the light bulb placement in each room of the house also often gets a problem. A common problem is inconsistency, which is common when a light bulb has been placed. The watt capacity in the light bulb often does not fit the size of the room resulting in less optimal illumination, watt capacity or large power consumption sometimes also does not guarantee to be able to get a good illumination. The bulb selection as described above, the author Pervers to make a decision support system to solve the problem of light bulb selection in the household with the method of technique for order preference by Simillarity to ideal solution which is one of the methods of Multicriteria decision making.

2. Theoretical Basis

A. Fuzzy Multi Attribute Decision Making



Fuzzy Multiple Attribute Decision Making (FMADM) is a method used to find the optimal alternatives of a number of alternatives to certain criteria. The core of the FMADM is to determine the weight value for each attribute, then proceed with the process that will select the alternative already given. In general, FMADM has a specific purpose that can be classified in 2 types, i.e. selecting alternatives with attributes (criteria) with the best traits, and classifying alternatives based on specific roles.

There are several methods that can be used to solve MADM problems, among others:

- 1) *Simple Additive Weighting Method (SAW)*
- 2) *Weighted Product (WP)*
- 3) *Electre*
- 4) *Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)*
- 5) *Analytic Hierarchy Process (AHP).*

B. Definition of TOPSIS

TOPSIS is based on a concept where the chosen or best alternatives not only have the closest distance from an ideal positive solution, but it also has the farthest distance from the ideal negativity solution from a geometric point of view by using the Euclidean distance to determine the relative proximity of an alternative with optimal solutions. The ideal positive solution is defined as the sum of all the best values achievable for each attribute, while the negative-ideal solution consists of all the worst values achieved for each attribute.

TOPSIS considers both, the distance to the ideal solution positively and the distance to the ideal negative solution by taking the proximity relative to the ideal positive solution. Based on comparisons to their relative distances, alternative priority arrangements can be achieved. This method is widely used on some MADM models to solve practical decision making problems.

The following are the stages in implementing the TOPSIS method:

- 1) Create a normalised decision matrix.
- 2) Create a weighted normalized decision matrix
- 3) Create an ideal positive solution matrix and an ideal negative solution matrix
- 4) Determine the distance between the values of each alternative with a matrix of ideal positive solutions and the ideal negative matrix solution.
- 5) Specify preference values for each alternative
 - a. Decision Matrix D refers to alternative m that will be evaluated based on criteria defined.
 - b. By x_{ij} declare the performance of the calculations for -i alternative to the -j attribute.

The following is the working step of the TOPSIS method:

- 1) Build a normalized decision matrix. TOPSIS requires the performance rating of each alternative A_i criteria of C_j normalized, i.e:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}};$$

where $i = 1,2,3, \dots, m$; dan $j = 1,2,3, \dots, n$

Where :

r_{ij} = Normalised matrix [i] [j]

x_{ij} = Matrix decision [i] [j]

- 2) The ideal solution of positive A^+ negative ideal solution A^- can be determined based on the normalized weight rating

$$y_{ij} = w_i r_{ij} ; \text{with } i = 1,2,3, \dots, m; \text{ dan } j = 1,2,3, \dots, n$$

- a. The ideal positive solution (A^+) calculated based on:

$$A^+ = (Y_1^+, Y_2^+, Y_3^+, \dots, Y_n^+)$$

with :

$$y_j^+ = \begin{cases} \max_i y_{ij}; & \text{if } j \text{ is attribute advantages} \\ \min_i y_{ij}; & \text{if } j \text{ is cost attribute} \end{cases}$$



b. An ideal negative solution (A^-) Calculated based on:

$$A^- = (Y_1^-, Y_2^-, Y_3^-, \dots, Y_n^-)$$

with:

$$y_j^- = \begin{cases} \min_i y_{ij}; & \text{if } j \text{ is attribute advantages} \\ \max_i y_{ij}; & \text{if } j \text{ is cost attribute} \end{cases}$$

3) Determining the distance between alternatives A_i an ideal positive solution and the ideal negative solution.

a. Alternative distance A_i with an ideal positive solution:

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^+)^2}; i = 1, 2, 3, \dots, m.$$

where :

D_i = Alternate distances A_i with an ideal positive solution:

y_i = The ideal positive solution [i]

y_{ij} = Weighted normalized matrix [i] [j]

b. Alternate distances A_i with an ideal negative solution:

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^-)^2}; i = 1, 2, 3, \dots, m$$

dimana :

D_i = Alternate distances A_i with an ideal negative solution:

y_i = The ideal negative solution [i]

y_{ij} = Weighted normalized matrix [i] [j]

4) Determine the preference value for each alternative.

Preference Value V_i for each alternative given as the next:

$$V = \frac{D_i^-}{D_i^- + D_i^+}; i = 1, 2, 3, \dots, m$$

where:

V_i = Proximity of each alternative to the ideal solution

D_i^- = Alternate distances A_i with an ideal negative solution [i]

D_i^+ = Alternate distances A_i with an ideal positif solution [i]

A larger V_i value indicates that the alternative A_i is preferred. Alternatives are driven by distance to the ideal positive solution and the ideal negative solution. The best alternative is the shortest with a positive and the farthest ideal solution with the ideal negative solution. (Sri Kusumadewi, 2006, 87-89).

3. Analysis

A. Analysis with Technique For Order Preference by Similarity to Ideal Solution (TOPSIS) Method.

The Technique For Order Preference by Similarity to Ideal Solution (TOPSIS) is one of the problem solving methods of Fuzzy Multiple Attribute Decision Making (FMADM), so in solving the assessment problem of electric bulb selection using the Technique For Order Preference by Similarity to Ideal Solution (TOPSIS) method, which will give the recommendation of electric bulb with the criteria of assessment and weight. Criteria and weights are required to perform calculations in the Technique For Order Preference by Similarity to Ideal Solution (TOPSIS) method, so that the best alternatives will be obtained. The alternative referred to in this case is the bulb which has the highest value of the sum of all the criteria and the value of a predetermined weight.



The following are the alternate tables and criteria that have been analyzed earlier:

Table 1.
Alternate electric bulb with space 4M²

No	Alternative	Criteria				
		C ₁	C ₂	C ₃	C ₄	C ₅
1	A ₁	Rp.19.000	5watt	4M ²	8.000 hours	12 Month
2	A ₂	Rp. 26.000	5watt	4M ²	10.000 hours	18 Month
3	A ₃	Rp. 18.000	7watt	4M ²	8.800 hours	24 Month
4	A ₄	Rp. 16.500	5watt	4M ²	6.000 hours	6 Month

Based on the criteria of each alternative in each criteria specified, then the weight description of each criterion has been converted with a fuzzy number.

1. Price

Price is a criterion that is used for assessment of every alternate bulb that is in consideration, predefined assessments are converted into fuzzy numbers such as the following table:

Table 2.
Price conversion

Criteria	Fuzzy numbers	Weights
C ₁ <= 18.500	Very high	1
C ₁ >= 19.000 – 23.000	High	0,75
C ₁ >= 24.000 – 30.000	Enough	0,5
C ₁ >= 31.000 – 40.000	Low	0,25
C ₁ > 40.000	Very Low	0

2. Power consumption

Power consumption is a criterion used for assessment of how much power consumption is absorbed by the bulb that is usually stated with Watt that is an alternative consideration. Predefined assessments are converted into fuzzy numbers such as the following table:

Table 3.
Power consumption

Criteria	Fuzzy numbers	Weights
C ₂ <= 5watt	Very high	1
C ₂ > =7watt – 14watt	High	0,75
C ₂ > =15watt – 18watt	Enough	0,5
C ₂ > =20watt – 23watt	Low	0,25
C ₂ > 23watt	Very Low	0

3. Room size

Assessment criteria The specified room size is converted into fuzzy numbers as following table:

Table 4.
Room size Conversion

Criteria	Fuzzy numbers	Weights
C ₃ < 4M ²	Very high	0
C ₃ >= 4M ² – 6M ²	High	0,25
C ₃ >= 7M ² – 10M ²	Enough	0,5
C ₃ >= 11M ² – 15M ²	Low	0,75
C ₃ >= 16M ²	Very Low	1

4. Service life

Assessment of the defined life criteria is converted into the fuzzy number as the next table:

Table 5.
Lifetime conversion

Criteria	Fuzzy numbers	Weights
C ₄ < 5.000 jam	High	0
C ₄ >= 6.000 – 8.000 jam	Enough	0,25
C ₄ >= 8.500 – 8.800 jam	Low	0,5
C ₄ >= 8.900 – 9.900 jam	Very Low	0,75
C ₄ > =10.000 jam	High	1

5. Warranty

A predefined warranty assessment is converted into fuzzy numbers like the following table:

Table 6.
Warranty Conversion

Criteria	Fuzzy numbers	Weights
C ₅ <6 bulan	High	0
C ₅ >= 6 bulan -11 bulan	Enough	0,25
C ₅ >=12 bulan -18 bulan	Low	0,5
C ₅ >= 19 bulan – 23 bulan	Very Low	0,75
C ₅ >=24 bulan	High	1

After all the weight description each criterion has been converted with a fuzzy number. Then the next one is to create a table matching data match scoring criteria based on the scoring weights that have been determined for each room and perform calculations to get the decision result. Here are the tables of the matching rankings and the calculations:

Table 7.
Room Match Ranking Table

No	Alternative	Criteria				
		C ₁	C ₂	C ₃	C ₄	C ₅
1	A ₁	0,75	1	0,25	0,25	0,5
2	A ₂	0,5	1	0,25	1	0,5
3	A ₃	1	0,75	0,25	0,5	1
4	A ₄	1	1	0,25	0,25	0,25

Further forming the normalizing decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}};$$

$$\begin{aligned} X_1 &= \sqrt{0,75^2 + 0,5^2 + 1^2 + 1^2} \\ &= \sqrt{0,5625 + 0,25 + 1 + 1} \\ &= \sqrt{2,8125} \\ &= 1,6770509 \end{aligned}$$

$$r_{1,1} = \frac{x_{1,1}}{x_1} = \frac{0,75}{1,6770509} = 0,4472136$$

$$r_{1,2} = \frac{x_{1,2}}{x_1} = \frac{0,5}{1,6770509} = 0,2981424$$

$$r_{1,3} = \frac{x_{1,3}}{x_1} = \frac{1}{1,6770509} = 0,5962848$$

$$r_{1,4} = \frac{x_{1,4}}{x_1} = \frac{1}{1,6770509} = 0,5962848$$

Table 8.
Value preference for each alternative

Alternativ	Preference Value
A ₁	0,3790308
A ₂	0,4754463
A ₃	0,6234870
A ₄	0,5282364

Alternatives are based on the value of preference owned by each alternative, from the table of preference above can be formed in the following settings:



Tabel 9.
Results based on preference value

Ranking	Alternative	Preference Value
1	A ₃	0,6234871
2	A ₄	0,5282364
3	A ₂	0,4754463
4	A ₁	0,3790308

4. Conclusion

Based on the results of the research and discussion that has been done, it can be concluded that the research that has been done can be determined what is the criteria and what is the alternative in the selection of electric light bulbs for households. Technique for order preference by Similarity to ideal solution (TOPSIS) can provide good decision result in the problem of selection of electric bulbs consisting of several alternative bulbs. Based on the criteria that have been the material consideration.

The decision support system of electric light bulb selection for the household, can facilitate the consumers in choosing a good electric light bulb and that suits the needs.

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