The Comparison of VIKOR and MAUT Methods in the Selection of Used Cars

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Abstract

A used car is a car that has been used by other people. Choosing a used car according to the needs of the buyer is very much a consideration. Used car buyers, of course, make their choices based on several criteria. The criteria for choosing a used car include transmission, price, passenger capacity, luggage capacity, year of manufacture, color, and engine capacity. These criteria are the buyer's consideration in choosing a used car because it is not easy for those who do not understand the criteria for choosing a used car. This research aims to compare the selection of used cars with the VIKOR method (Vise Kriterijumska Optimizacija I Kompromisno Resenje) and MAUT (Multi-Attribute Utility Theory). The VIKOR method is a ranking method using a multicriteria ranking index based on a certain measure of closeness to the ideal solution. Meanwhile, the MAUT method is a multi-attribute method that usually combines measurements of different risks and benefits. The research method used is descriptive research with a quantitative approach. The results of this study can be seen that using the VIKOR and MAUT methods obtained the same results, namely A5 as the selected used car.

Keywords: Decision Support System, MAUT Method, VIKOR Method, Used Car

INTRODUCTION

The car is a means of transportation that is considered to make human life easier. Since the discovery of this means of transportation, the movement of human life has changed to become faster and more dynamic (Nababan et al., 2018). Apart from daily necessities, activities and comfort from weather conditions, cars can carry a lot of passengers and are great for long trips. In addition, cars are also used for lifestyle and social status in the midst of society (Rizaldi & Anggraeni, 2020).

Even though there are many car vehicles, some people find it difficult to get a new car due to economic factors, so they choose to buy a used car (Rizaldi & Anggraeni, 2020). A used car is a car that has been used and then resold by the owner. A used car has a special sales area which is often called a showroom. The types of used cars sold in the showroom include SUV, MPV and sedans from various brands and years (Setiadi, 2019). The purpose of having a used car showroom is to
provide facilities for vehicle needs at a more affordable price than new cars (Oktavia et al., 2016).

In purchasing a car, we can choose a new car or a used car. But the choice of a new car or a used car depends on the wishes of the buyer. And the condition of a used car is not the same as a new car, both in terms of the exterior, car paint, interior in the car, car engines, and so on. Between a new car and a used car cannot be equated because the condition of the new car is still 100%, while used cars are under 100% condition (Oktaviandi & Putra, 2019).

Based on these problems, a decision support system is needed that can assist prospective buyers in making car purchases to make it easier and faster for prospective car buyers to determine the car to be purchased. Some methods can be applied in building a decision support system, including the VIKOR and MAUT methods. The VIKOR method is a ranking method using a multicriteria ranking index based on a certain measure of closeness to the ideal solution (Dwimas et al., 2019). This method is used to assist decision makers in getting the final decision (Sarumaha et al., 2018). Whereas the MAUT method can help convert some interests into numerical values on a scale of zero to one, to produce decisions (Maharani & Sena, 2020).

In previous research, Nababan et al, used the VIKOR method in purchasing used cars, with 5 criteria, namely price, year of release, transmission, engine capacity, and passenger capacity. The results obtained in this study, the VIKOR method can assist buyers in making decisions in selection of used car (Nababan et al., 2018). In addition, Trisnani et al., Stated that the Selection of Outstanding Employees using the VIKOR method can be done so that they can quickly select high-achieving employees (Trisnani et al., 2018). Meanwhile, Sari & Hayati conducted research in selecting boarding houses using the MAUT method. By applying the MAUT method in choosing a boarding house, you can objectively provide good boarding house recommendations (Sari & Hayati, 2019). Furthermore, Maharani & Nata also conducted research using the MAUT method, where the research compared the MFEP and MAUT methods in the selection of prospective participants in the national science olympiad. And the result of this study is that it has different results, namely the MFEP method produces A13 as the best participant, while the MAUT method produces A5 as the best participant (Maharani & Nata, 2020).

Based on these researchs, it can be seen that the VIKOR and MAUT methods are methods that can help in making decisions. This study aims to solve the problem of buying a used car using the VIKOR and MAUT methods. The two methods were chosen because they were expected to produce the same results in the selection of used cars, as well as to assist potential buyers in selecting used cars according to the criteria they wanted.

**RESEARCH METHODS**

**VIKOR Method**

VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Rešenje) is one of the MCDM Techniques. VIKOR is based on the best solution obtained based on the closest ideal solution, then ranks it by comparing the distance to the ideal solution. This method aims to get the best solution with a profit rate (Azmi et al., 2018).

The calculation steps using the VIKOR method are as follows (Rahayu & Rahmadani, 2020):

1. Normalize the following formula:
   \[ R_{ij} = \left( \frac{x_{ij} - x_{ij}^{\min}}{x_{ij}^{\max} - x_{ij}^{\min}} \right) \]  
   \[ i = 1, 2, 3, ..., m \text{ and } j = 1, 2, 3, ..., n \] 
   Where \( R_{ij} \) and \( x_{ij} \) are the elements of the decision matrix (alternative \( i \) to criterion \( j \)) and \( x_{ij}^{\max} \) is the greatest element of criterion \( j \), \( x_{ij}^{\min} \) is the lowest element of criterion \( j \).

2. Calculate the value of \( S \) and \( R \) using the formula:
   \[ S_i = \sum_{j=1}^{n} W_j \left( \frac{x_{ij}^{\max} - x_{ij}}{x_{ij}^{\max} - x_{ij}^{\min}} \right) \]
   \[ R_i = \max_j \left[ W_j \left( \frac{x_{ij}^{\max} - x_{ij}}{x_{ij}^{\max} - x_{ij}^{\min}} \right) \right] \]
   Where \( W_j \) is the weight of each criterion \( j \).

3. Determine the index value
   \[ Q_i = \left( \frac{S_i - S^{\star}}{S^{\star} - S^{\min}} \right) V + \left( \frac{R_i - R^{\star}}{R^{\max} - R^{\star}} \right) (1 - V) \]
   Where \( S^{\star} = \max S_i \), \( S^{\min} = \min S_i \); and \( R^{\star} = \max R_i \), \( R^{\min} = \min R_i \), and \( V = 0.5 \).

4. The ranking results are the result of ordering \( S \), \( R \), \( Q \).

5. The best ranking alternative solution based on the minimum \( Q \) value becomes the best rank with the following conditions:
   \[ Q \left( A^{(2)} \right) \geq Q \left( A^{(1)} \right) \] 
   Where \( A^{(2)} \) is the alternative with the second order in the \( Q \) ranking and \( A^{(1)} = \) the alternative with the best order in the \( Q \) ranking while \( DQ = 1 - (m-1) \), where \( m \) is the number of alternatives. Alternative \( A^{(1)} \) must rank best on \( S \) and/or \( R \).

**MAUT Method**

Multi-Attribute Utility Theory (MAUT) is part of the Multi-Attribute Decision Making (MADM) method (Adali & Işık, 2017). The MAUT
The MAUT method is defined as an algorithm with the approach of calculating the final evaluation \( x \) on an element value \( x \) which is commonly called by weight value by calculation addition with the weight value in dimensions or so-called with utility (Maharani & Nata, 2020).

The steps for calculating the MAUT method are as follows (Ozdaglo& Cirk, 2019):

1. Make a decision matrix
   \[
   D = \begin{bmatrix}
   x_{11} & x_{12} & \cdots & x_{1n} \\
   x_{21} & x_{22} & \cdots & x_{2n} \\
   \vdots & \vdots & \ddots & \vdots \\
   x_{m1} & x_{m2} & \cdots & x_{mn} 
   \end{bmatrix}
   \] \tag{6}

2. Compute the normalized performance scores for all values in the decision matrix.
   If the benefit attribute, then it can be calculated by Equation 7:
   \[
   y_{ij} = \frac{x_{ij} - \min_{i} x_{ij}}{\max_{i} x_{ij} - \min_{i} x_{ij}} \tag{7}
   \]
   If the attribute is cost, then it can be calculated by Equation 8:
   \[
   y_{ij} = \frac{\max_{i} x_{ij} - x_{ij}}{\max_{i} x_{ij} - \min_{i} x_{ij}} \tag{8}
   \]

Based on these calculations, a normalized decision matrix such as Equation 9:
\[
Y = \begin{bmatrix}
   y_{11} & y_{12} & \cdots & y_{1n} \\
   y_{21} & y_{22} & \cdots & y_{2n} \\
   \vdots & \vdots & \ddots & \vdots \\
   y_{m1} & y_{m2} & \cdots & y_{mn} 
   \end{bmatrix}
   \] \tag{9}

3. Calculating the utility value of all alternatives in Equation 10:
   \[
   U_i = \sum_{j=1}^{n} (w_j * y_{ij}) \tag{10}
   \]
   Where the best alternative is the alternative that has the highest \( U_i \) value.

**Types of research**

This type of research is a descriptive study with a quantitative approach. This study collected data to test hypotheses or answer questions in choosing a used car purchase.

**Time and Place of Research**

The research was conducted for six months from September 2020 to February 2021. The research location was conducted at Restu Mobil, Imam Bonjol street No. 324, Kisaran.

**Research Target / Subject**

The research target or subject is a used car showroom in Kisaran City, North Sumatra Province. To obtain this data, we conducted a field study at Restu Mobil.

**Procedure**

The procedure in this study can be seen in Figure 1.

![Figure 1. Research Procedure](image)

**Data, Instruments, and Data Collection Techniques**

This study uses data sources including:

1. Primary data
   Primary data is obtained directly from used car showrooms.

2. Secondary data
   Secondary data were collected from the study literature, journals, reports, and other information related to choosing a used car.

Where the two data are obtained by data collection methods, namely as follows:

1. Observations
   Direct observation to find information about conditions directly at the Restu Mobil showroom.

2. Interview
   Interview with Restu Mobil showroom owner regarding the condition of used cars in the showroom and the interests of used car buyers.

3. Study of literature
   Gather good literature, data, information from scientific journals, books, and the internet related to choosing a used car.

**Data analysis technique**

In selecting a used car, there are 7 criteria that will be used in making a decision to choose a
used car according to customer wishes. As for the alternatives used, it can be seen in Table 1.

| No. | Alternative | Attribute Name          |
|-----|-------------|-------------------------|
| 1   | A₁          | Daihatsu Sirion         |
| 2   | A₂          | Daihatsu Terios         |
| 3   | A₃          | Honda Jazz              |
| 4   | A₄          | Honda Jazz IDSI         |
| 5   | A₅          | Kijang Innova           |
| 6   | A₆          | Suzuki Ertiga           |
| 7   | A₇          | Toyota Agya             |
| 8   | A₈          | Toyota Avanza G         |
| 9   | A₉          | Toyota Yaris            |

Each criterion data has a different weight value, which is adjusted to its needs. For more details, it can be seen in Table 2.

| Criteria | Specific | Weight | Type |
|----------|----------|--------|------|
| C₁       | Transmission | 15%    | Benefit |
| C₂       | Price     | 20%    | Cost  |
| C₃       | Passenger Capacity | 16%    | Benefit |
| C₄       | Passenger Capacity | 12%    | Benefit |
| C₅       | Production year | 11%    | Benefit |
| C₆       | Color     | 8%     | Benefit |
| C₇       | Engine Capacity | 18%    | Benefit |

Table 3 contains data on used cars that will be calculated using the VIKOR and MAUT methods.

| Alternative | C₁ | C₂ | C₃ | C₄ | C₅ | C₆ | C₇ |
|-------------|----|----|----|----|----|----|----|
| A₁          | Automatic | 82 Juta | 5 Passengers | Small | 2012 | Black | 1300 cc |
| A₂          | Automatic | 115 Juta | 5 Passengers | Big | 2013 | Black | 1500 cc |
| A₃          | Manual | 102 Juta | 5 Passengers | Moderate | 2010 | Others | 1500 cc |
| A₄          | Automatic | 72 Juta | 5 Passengers | Moderate | 2006 | Gray | 1500 cc |
| A₅          | Manual | 130 Juta | 5 Passengers | Small | 2011 | Silver | 2000 cc |
| A₆          | Automatic | 110 Juta | 5 Passengers | Big | 2014 | White | 1400 cc |
| A₇          | Manual | 82.5 Juta | 5 Passengers | Moderate | 2013 | Silver | 1000 cc |
| A₈          | Manual | 105 Juta | 5 Passengers | Small | 2012 | White | 1300 cc |
| A₉          | Automatic | 99 Juta | 5 Passengers | Small | 2011 | Silver | 1500 cc |

To simplify the calculation process, Table 4 is created which contains the suitability rating of each alternative for each criterion.

Table 4. Suitability Rating of Each Alternative on Each Criterion

| Alternative | C₁ | C₂ | C₃ | C₄ | C₅ | C₆ | C₇ |
|-------------|----|----|----|----|----|----|----|
| A₁          | 25 | 82 | 5 | 10 | 2012 | 50 | 1300 |
| A₂          | 25 | 115 | 5 | 50 | 2013 | 50 | 1500 |
| A₃          | 50 | 102 | 5 | 30 | 2010 | 10 | 1500 |
| A₄          | 25 | 72 | 5 | 30 | 2006 | 20 | 1500 |
| A₅          | 50 | 130 | 8 | 10 | 2011 | 30 | 2000 |
| A₆          | 25 | 110 | 5 | 50 | 2014 | 40 | 1400 |
| A₇          | 50 | 82.5 | 5 | 30 | 2013 | 30 | 1000 |
| A₈          | 50 | 105 | 8 | 10 | 2012 | 40 | 1300 |
| A₉          | 25 | 99 | 5 | 10 | 2011 | 30 | 1500 |
| Max         | 50 | 130 | 8 | 50 | 2014 | 50 | 2000 |
| Min         | 25 | 72 | 5 | 10 | 2006 | 10 | 1000 |

RESULTS AND DISCUSSION

Calculation of the VIKOR Method

1. Perform normalization

Use Equation 1 for the calculation. And the results obtained from these calculations can be seen in the following matrix.

\[
R_{ij} = \begin{bmatrix}
1.00 & 0.83 & 1.00 & 1.00 & 0.25 & 0.00 & 0.70 \\
1.00 & 0.26 & 1.00 & 0.00 & 0.13 & 0.00 & 0.50 \\
0.00 & 0.49 & 1.00 & 0.50 & 0.50 & 1.00 & 0.50 \\
1.00 & 1.00 & 1.00 & 0.50 & 1.00 & 0.75 & 0.50 \\
0.00 & 0.00 & 0.00 & 1.00 & 0.38 & 0.50 & 0.00 \\
1.00 & 0.35 & 1.00 & 0.00 & 0.00 & 0.25 & 0.60 \\
0.00 & 0.82 & 1.00 & 0.50 & 0.13 & 0.50 & 1.00 \\
0.00 & 0.43 & 0.00 & 1.00 & 0.25 & 0.25 & 0.70 \\
1.00 & 0.53 & 1.00 & 1.00 & 0.38 & 0.50 & 0.50
\end{bmatrix}
\]

2. Calculating the values of S and R

To calculate the value of S, you can use Equation 2, while the value of R can be calculated using Equation 3 so that the S and R values can be seen in Table 5.
The first stage in calculating the MAUT method is to calculate the MAUT method uses calculations based on types, values with a final evaluation scheme with weights and methods in selecting used cars, it can be concluded that the two methods have the same results in the selection of used cars, namely the A5 alternative. However, for some of the other rankings there are differences in the results. This is because the method used is different, where the VIKOR method is an MCDM method with a compromise ranking idea, while the MAUT method is an MADM method with a final evaluation scheme with weights and values relevant to the alternative. In addition, the MAUT method uses calculations based on types, namely benefits and costs, while the VIKOR method does not use it, so it has different results for its ranking.

### Calculation of the MAUT Method

1. Creating a Decision Matrix

\[
D = \begin{bmatrix}
25 & 82 & 5 & 10 & 2012 & 50 & 1300 \\
25 & 115 & 5 & 50 & 2013 & 50 & 1500 \\
50 & 102 & 5 & 30 & 2010 & 10 & 1500 \\
25 & 172 & 5 & 30 & 2006 & 20 & 1500 \\
50 & 150 & 8 & 10 & 2011 & 30 & 2000 \\
25 & 110 & 5 & 50 & 2014 & 40 & 1400 \\
50 & 82.5 & 5 & 30 & 2013 & 30 & 1000 \\
50 & 105 & 8 & 10 & 2012 & 40 & 1300 \\
25 & 99 & 5 & 10 & 2011 & 30 & 1500
\end{bmatrix}
\]

The first stage in calculating the MAUT method is to create a decision matrix such as equation 6. Where all the values of each criterion and alternatives in table 4 are made in the form of a matrix.

2. Calculating the Normalized Matrix

For the C2 criterion, namely price, we will use Equation 8, while the other criteria will use Equation 7 because of the types of benefits.

\[
Y = \begin{bmatrix}
0.00 & 0.93 & 0.00 & 0.00 & 0.75 & 1.00 & 0.30 \\
0.00 & 0.26 & 0.00 & 1.00 & 0.88 & 1.00 & 0.50 \\
1.00 & 0.49 & 0.00 & 0.50 & 0.50 & 0.00 & 0.50 \\
0.00 & 1.00 & 0.00 & 0.50 & 0.50 & 0.00 & 0.25 \\
1.00 & 0.00 & 1.00 & 0.00 & 0.63 & 0.50 & 1.00 \\
0.00 & 0.35 & 0.00 & 1.00 & 1.00 & 0.75 & 0.40 \\
1.00 & 0.82 & 0.00 & 0.50 & 0.88 & 0.50 & 0.00 \\
1.00 & 0.43 & 1.00 & 0.00 & 0.75 & 0.75 & 0.30 \\
0.00 & 0.53 & 0.00 & 0.00 & 0.63 & 0.50 & 0.50
\end{bmatrix}
\]

After being calculated, the results obtained from these calculations can be made in the form of a normalized decision matrix by Equation 9.

3. Calculating the Value of Utility

Perform calculations using Equation 10 to get the final result of the MAUT method, so that it can produce a ranking as in Table 7.

### Table 5. Value of S and R

| No. | Alternative | S   | R   |
|-----|-------------|-----|-----|
| 1   | A₁          | 0.749 | 0.166 |
| 2   | A₂          | 0.465 | 0.160 |
| 3   | A₃          | 0.542 | 0.160 |
| 4   | A₄          | 0.830 | 0.200 |
| 5   | A₅          | 0.201 | 0.120 |
| 6   | A₆          | 0.507 | 0.160 |
| 7   | A₇          | 0.618 | 0.180 |
| 8   | A₈          | 0.380 | 0.126 |
| 9   | A₉          | 0.708 | 0.160 |

3. Determine the Index Value

\[ S = 0.830 \quad R = 0.200 \]
\[ S' = 0.201 \quad R' = 0.120 \]

The next step is to calculate the value of Qᵢ using Equation 4.

Where \( V = 0.5 \).

Table 6 contains the results of the alternative ranking from lowest to highest using the VIKOR method.

### Table 6. The VIKOR Method Ranking Results

| Alternative | \( Qᵢ \) | Ranking |
|-------------|---------|---------|
| A₁          | 0.720   | 8       |
| A₂          | 0.460   | 3       |
| A₃          | 0.521   | 5       |
| A₄          | 1.000   | 9       |
| A₅          | 0.000   | 1       |
| A₆          | 0.493   | 4       |
| A₇          | 0.706   | 7       |
| A₈          | 0.179   | 2       |
| A₉          | 0.653   | 6       |

From the table 6 of the ranking results, it is found that A₅ is the lowest value with a result of 0.000 so it was chosen as the selected used car as needed.

### Table 7. The MAUT Method Ranking Results

| Alternative | \( Uᵢ \) | Ranking |
|-------------|---------|---------|
| A₁          | 0.382   | 7       |
| A₂          | 0.438   | 5       |
| A₃          | 0.452   | 4       |
| A₄          | 0.370   | 8       |
| A₅          | 0.599   | 1       |
| A₆          | 0.431   | 6       |
| A₇          | 0.510   | 3       |
| A₈          | 0.593   | 2       |
| A₉          | 0.306   | 9       |

From table 7, the decision with the highest value can be taken, namely A₅ as the selected used car.

### CONCLUSIONS AND SUGGESTIONS

**Conclusion**

Based on the research that has been carried out by comparing the VIKOR and MAUT methods in selecting used cars, it can be concluded that the two methods have the same results in the selection of used cars, namely the A₅ alternative. However, for some of the other rankings there are differences in the results. This is because the method used is different, where the VIKOR method is an MCDM method with a compromise ranking idea, while the MAUT method is an MADM method with a final evaluation scheme with weights and values relevant to the alternative. In addition, the MAUT method uses calculations based on types, namely benefits and costs, while the VIKOR method does not use it, so it has different results for its ranking.
Suggestion
To get maximum results, you can make comparisons with the same method techniques. In addition, you can also add other criteria in selection of used car.

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