Decision Support System in the Selection of Used Motorcycles with the Multi Attribute Utility Theory (MAUT) Method

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Abstract
Transportation is a tool that is useful for moving goods or people in a certain quantity, to a certain place, within a certain period of time. The need for means of transportation has now become a primary need. Compared to public transportation, some people prefer to use private vehicles, especially motorbikes. Besides being an agile and practical means of transportation when used to get through traffic jams both in the city and outside the city, motorcycle fuel consumption is lower when compared to four-wheeled vehicles. As the times progress, more and more motorbike choices are offered by motor manufacturers. With the many latest motorbike outputs coupled with the increasingly intensive advertising of new motorbikes, some consumers are interested and encouraged to exchange (sell) their motorbikes and replace them with the latest motorbikes, so this creates used motorbikes that are still fit for use to be re-traded to consumers. others. Rifdah Motor Khatib is a company engaged in the sale of used motorbikes. The problem experienced by Rifdah Motor Khatib is the difficulty in processing used motorbike sales transactions because the recording process still uses the manual method, namely recording directly in the ledger and in the form of notes on the purchase of used motorbikes. The process takes a long time to record sales of used motorcycles. To overcome this problem, a decision support system was designed using the Multi Attribute Utility Theory (MAUT) method. From the results of the study it was found that the system can assist the company in making decisions on the selection of the best used motorbikes that are effective and efficient.

Keywords: Motorcycle, Multi Attribute Utility Theory, Decision Support Systems, Transportation.

1. Introduction
Transportation is a tool that is useful for moving goods or people in a certain quantity, to a certain place, within a certain period of time [1]. The need for means of transportation has now become a primary need. Compared to public transportation, some people prefer to use private vehicles, especially motorbikes [2]. Apart from being an agile and practical means of transportation when used to get through traffic jams both in the city and outside the city, motorcycle fuel consumption is lower when compared to four-wheeled vehicles [3]. As the times progress, more and more motorbike choices are offered by motor manufacturers. With the many latest motorbike outputs coupled with the increasingly intensive advertising of new motorbikes, some consumers are interested and encouraged to exchange (sell) their motorbikes and replace them with the latest motorbikes, so this creates used motorbikes that are still fit for use to be re-traded to consumers. others [4].

Information systems are one of the factors that influence the success of an organization. Because information systems and technology continue to develop, an organization needs to design an IS/IT strategy. Planning includes defining organizational goals, establishing an overall strategy for achieving those goals and compiling a series of overall plans to integrate and coordinate an organizational work [5]. A system consists of a combination of subsystems that are smaller in scope or scope, but are also part of a larger supersystem [6].

A system is a collection of data elements, a network of interacting procedures, human resources, hardware technology and software that are interconnected to achieve certain goals or objectives that have the same goal [7] . A system, surrounded and affected by its environment, is defined by its boundaries, structure, goals and is expressed in its functions. Understanding the system can be understood in terms of language [8].

Decision Support Systems (DSS) are computer-based information systems that are flexible, interactive and adaptable, developed to support solutions to specific unstructured management problems [9]. Decision Support Systems use data, provide an easy user interface and can incorporate decision-making thinking[10].

Multi-Attribute Utility Theory (MAUT) is a scheme in which the final evaluation, v(x), of an object x is defined as the weight summed with a value relevant to the dimension value. The expression usually used to call it is utility value [11]. MAUT is used to convert multiple interests into numerical values on a scale of 0-1 with 0 representing the worst choice and 1 being the best, this allows direct comparison of various measures.
The end result is a ranking order of alternative evaluations that describes the choices of decision makers.

2. Research methodology

This research was conducted at the Rifdah Motor Khatib Used Motorcycle Dealer. This dealer is located at Jalan Jl. Khatib Sulaiman No. 30, Lolong Belanti Village, North Padang District, Padang City, West Sumatra, Indonesia. The steps taken by the author in this design are arranged from the main points and are easier to understand. The sequence of steps to be made in this study can be seen in the following figure:

![Research Framework Diagram]

2.1 Preliminary Research

After finding the problem with the object you want to research, carry out an analysis of the object to be processed. Studying how the object can solve problems, environmental factors and the impact of the object. Preliminary research can provide initial evidence that the problem we will be researching in the field really exists. Therefore, time is needed for data collection, research time, research location, research methods, field research and library research.

2.2 Data collection

In collecting data, the authors obtain data from various sources, such as in this study, obtained from articles, and obtained from other references. And this research was also carried out by applying the interview method.

2.3 Analysis

In this sub-chapter, the analysis and design will be explained as follows. The analysis phase is one of the important stages in this research, because it is at this stage that identification of the Rifdah Motor Used Motorcycle Dealers will be carried out, as well as analyzing the data obtained, where the data in the form of data on the selection of the best teacher performance Rifdah Motor Used Motorcycle Dealers. Analysis in this analysis phase can be done in three stages, namely:

1. Data Analysis
   Data analysis is the most important stage in building a system. After obtaining data taken from field observations, the author will analyze the need to build this system which aims to solve problems and produce solutions.

2. Process Analysis
   This analysis was carried out to find out what is needed in designing a decision support system information system for selecting the best teacher criteria using the PHP programming language and MYSQL database.

3. System Analysis
   This analysis is carried out to find out what is needed in system design. So as to produce a system that is effective and efficient in its implementation. Where the system to be built uses the PHP programming language and MySQL database.

2.4 Planning

At this stage the author will make a system design that will be run using UML as a tool in explaining the flow of program analysis. UML (Unified Modeling Language) is one of the most reliable tools in the world of object-oriented system development.

2.5 Implementation

System implementation is the stage of putting the system in place so that it is ready to operate. Implementation aims to confirm the design modules, so that users can provide input into application development. At this stage the application design is carried out using the PHP programming language and MySQL database.

2.6 Testing

After the implementation phase, testing will be carried out with the aim of directly practicing the results of the analysis which aims to test the correctness of the designed system and make improvements if there are errors and deficiencies in the program. Testing is carried out by seeing whether the application is running correctly and in accordance with the design carried out. This is done to find out whether the program is running according to the design.

3. Results and Discussion

The process of analysis and results for the selection of used motorbikes has several stages, namely:
3.1 MAUT Method Calculation Analysis

In this research, the criteria used in the used motorbike selection process have 4 criteria, namely:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Information</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Production year</td>
<td>Benefits</td>
</tr>
<tr>
<td>C2</td>
<td>Machine Capacity</td>
<td>Benefits</td>
</tr>
<tr>
<td>C3</td>
<td>Color</td>
<td>Benefits</td>
</tr>
<tr>
<td>C4</td>
<td>Type</td>
<td>Benefits</td>
</tr>
<tr>
<td>C5</td>
<td>Price</td>
<td>cost</td>
</tr>
</tbody>
</table>

After the criteria have been determined, the calculation process can be seen in the following steps:

1. Make the importance weights used for each criterion as follows:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Importance Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production year</td>
<td>4</td>
</tr>
<tr>
<td>Machine Capacity</td>
<td>5</td>
</tr>
<tr>
<td>Color</td>
<td>3</td>
</tr>
<tr>
<td>Type</td>
<td>3</td>
</tr>
<tr>
<td>Price</td>
<td>5</td>
</tr>
</tbody>
</table>

2. Normalize the weight values of each criterion with the following equation:

\[ w_i = \frac{w_i^t}{\sum w_i^t} \]  \( (1) \)

   a. C1 Weight Normalization:

   \[ w_{C1} = \frac{4}{4 + 5 + 3 + 3 + 5} = \frac{4}{20} = 0.2 \]

   b. C2 Weight Normalization:

   \[ w_{C2} = \frac{5}{4 + 5 + 3 + 3 + 5} = \frac{5}{20} = 0.25 \]

   c. C3 Weight Normalization:

   \[ w_{C3} = \frac{3}{4 + 5 + 3 + 3 + 5} = \frac{3}{20} = 0.15 \]

   d. C4 Weight Normalization:

   \[ w_{C4} = \frac{3}{4 + 5 + 3 + 3 + 5} = \frac{3}{20} = 0.15 \]

   e. C5 Weight Normalization:

   \[ w_{C4} = \frac{5}{4 + 5 + 3 + 3 + 5} = \frac{5}{20} = 0.25 \]

3. The following are examples of 10 alternative motorbikes that have alternative motorbikes with the following data:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A01</td>
<td>2014</td>
<td>110</td>
<td>5</td>
<td>2</td>
<td>Rp. 5,800,000</td>
</tr>
<tr>
<td>A02</td>
<td>2018</td>
<td>115</td>
<td>4</td>
<td>1</td>
<td>Rp. 12,400,000</td>
</tr>
<tr>
<td>A03</td>
<td>2019</td>
<td>150</td>
<td>1</td>
<td>1</td>
<td>Rp. 17,300,000</td>
</tr>
<tr>
<td>A04</td>
<td>2017</td>
<td>125</td>
<td>5</td>
<td>2</td>
<td>Rp. 9,800,000</td>
</tr>
<tr>
<td>A05</td>
<td>2017</td>
<td>150</td>
<td>3</td>
<td>1</td>
<td>Rp. 18,600,000</td>
</tr>
<tr>
<td>A06</td>
<td>2015</td>
<td>150</td>
<td>1</td>
<td>4</td>
<td>Rp. 21,000,000</td>
</tr>
</tbody>
</table>

4. Determine the maximum value and minimum value of each criterion as follows:

<table>
<thead>
<tr>
<th>Criteria Name</th>
<th>Maximum Value (x,( ^{+} ))</th>
<th>Minimum Value (x,( ^{-} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production year</td>
<td>2019</td>
<td>2014</td>
</tr>
<tr>
<td>Machine Capacity</td>
<td>250</td>
<td>110</td>
</tr>
<tr>
<td>Color</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Price</td>
<td>39900000</td>
<td>5800000</td>
</tr>
</tbody>
</table>

5. Normalize the criteria for each alternative using the utility function with the following equation:

\[ U(x) = \frac{x - x_{i}^{-}}{x_{i}^{+} - x_{i}^{-}} \]

   a. Normalization of Criteria A01 Value:

   Normalization C1:

   \[ U_{C1}(A1) = \frac{2014 - 2014}{2019 - 2014} = 0 = 0 \]

   Normalization C2:

   \[ U_{C2}(A1) = \frac{110 - 110}{250 - 110} = 0 = 0 \]

   Normalization C3:

   \[ U_{C3}(A1) = \frac{5 - 1}{5 - 1} = 4 = 4 \]

   Normalization C4:

   \[ U_{C4}(A1) = \frac{2 - 1}{5 - 1} = 1 = 1 \]

   Normalization C5:

   \[ U_{C5}(A1) = \frac{39900000 - 5800000}{39900000 - 5800000} = 34100000 = 34100000 \]

   b. Normalization of Criteria A02 Value:

   Normalization C1:

   \[ U_{C1}(A2) = \frac{2018 - 2014}{2019 - 2014} = 4 = 0.8 \]

   Normalization C2:

   \[ U_{C2}(A2) = \frac{115 - 110}{250 - 110} = 5 = 0.0357 \]

   Normalization C3:

   \[ U_{C3}(A2) = \frac{4 - 1}{5 - 1} = 3 = 0.75 \]

   Normalization C4:

   \[ U_{C4}(A2) = \frac{1 - 1}{5 - 1} = 0 = 0 \]

   Normalization C5:
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\[ U_{C3}(A2) = \frac{39900000 - 12400000}{39900000 - 5800000} = \frac{27500000}{34100000} = 0.8065 \]

\[ U_{C5}(A2) = \frac{39900000 - 12400000}{39900000 - 5800000} = \frac{27500000}{34100000} = 0.8065 \]

c. Normalization of A03 Criterion Values:
Normalization C1 :
\[ U_{C1}(A3) = \frac{2019 - 2014}{2019 - 2014} = \frac{5}{5} = 1 \]
Normalization :
\[ U_{C2}(A3) = \frac{150 - 110}{250 - 110} = \frac{40}{140} = 0.2857 \]
Normalization :
\[ U_{C3}(A3) = \frac{1 - 1}{5 - 1} = \frac{0}{4} = 0 \]
C4 normalization :
\[ U_{C4}(A3) = \frac{1 - 1}{5 - 1} = \frac{0}{4} = 0 \]
C5 Normalization :
\[ U_{C5}(A3) = \frac{39900000 - 17300000}{39900000 - 5800000} = \frac{22600000}{34100000} = 0.6628 \]

d. Normalization of A04 Criterion Values:
Normalization C1 :
\[ U_{C1}(A4) = \frac{2017 - 2014}{2019 - 2014} = \frac{3}{5} = 0.6 \]
Normalization :
\[ U_{C2}(A4) = \frac{125 - 110}{250 - 110} = \frac{15}{140} = 0.1071 \]
Normalization :
\[ U_{C3}(A4) = \frac{5 - 1}{5 - 1} = \frac{4}{4} = 1 \]
Normalization :
\[ U_{C4}(A4) = \frac{2 - 1}{5 - 1} = \frac{1}{4} = 0.75 \]
C5 Normalization :
\[ U_{C5}(A4) = \frac{39900000 - 9800000}{39900000 - 5800000} = \frac{30100000}{34100000} = 0.8827 \]

e. Normalization of A05 Criterion Values:
Normalization :
\[ U_{C1}(A5) = \frac{2017 - 2014}{2019 - 2014} = \frac{3}{5} = 0.6 \]
Normalization :
\[ U_{C2}(A5) = \frac{150 - 110}{250 - 110} = \frac{40}{140} = 0.2857 \]
Normalization :
\[ U_{C3}(A5) = \frac{5 - 1}{5 - 1} = \frac{4}{4} = 1 \]
C4 normalization :
\[ U_{C4}(A5) = \frac{3 - 1}{5 - 1} = \frac{2}{4} = 0.5 \]
C5 Normalization :
\[ U_{C5}(A5) = \frac{39900000 - 18600000}{39900000 - 5800000} = \frac{21300000}{34100000} = 0.6246 \]

\[ U_{C3}(A6) = \frac{1 - 1}{5 - 1} = \frac{0}{4} = 0 \]
C4 normalization :
\[ U_{C4}(A6) = \frac{4 - 1}{5 - 1} = \frac{3}{4} = 0.75 \]
C5 Normalization :
\[ U_{C5}(A6) = \frac{39900000 - 21000000}{39900000 - 5800000} = \frac{18900000}{34100000} = 0.5543 \]

g. Normalization of A07 Criterion Values:
Normalization C1 :
\[ U_{C1}(A7) = \frac{2017 - 2014}{2019 - 2014} = \frac{1}{5} = 0.2 \]
Normalization :
\[ U_{C2}(A7) = \frac{250 - 110}{250 - 110} = \frac{140}{140} = 1 \]
Normalization :
\[ U_{C3}(A7) = \frac{1 - 1}{5 - 1} = \frac{0}{4} = 0 \]
C4 Normalization :
\[ U_{C4}(A7) = \frac{5 - 1}{5 - 1} = \frac{4}{4} = 1 \]
C5 Normalization :
\[ U_{C5}(A7) = \frac{39900000 - 39900000}{39900000 - 5800000} = \frac{0}{34100000} = 0 \]

h. Normalization of A08 Criterion Values:
Normalization :
\[ U_{C1}(A8) = \frac{2017 - 2014}{2019 - 2014} = \frac{1}{5} = 0.2 \]
Normalization :
\[ U_{C2}(A8) = \frac{125 - 110}{250 - 110} = \frac{15}{140} = 0.1071 \]
Normalization :
\[ U_{C3}(A8) = \frac{5 - 1}{5 - 1} = \frac{4}{4} = 1 \]
Normalization :
\[ U_{C4}(A8) = \frac{2 - 1}{5 - 1} = \frac{1}{4} = 0.25 \]
C5 Normalization :
Normalization of A09 Criterion Values:
Normalization C1:
\[ U_{C1}(A9) = \frac{2019 - 2014}{2019 - 2014} = 1 \]
Normalization:
\[ U_{C2}(A9) = \frac{155 - 110}{250 - 110} = \frac{45}{140} = 0.3214 \]
Normalization:
\[ U_{C3}(A9) = \frac{3 - 1}{5 - 1} = \frac{2}{4} = 0.5 \]
Normalization:
\[ U_{C4}(A9) = \frac{1 - 1}{5 - 1} = \frac{0}{4} = 0 \]
C5 Normalization:
\[ U_{C5}(A9) = \frac{39900000 - 20200000}{39900000 - 58000000} = \frac{19700000}{34100000} = 0.5777 \]

j. Normalization of A10 Criterion Values:
Normalization C1:
\[ U_{C1}(A10) = \frac{2018 - 2014}{2019 - 2014} = \frac{4}{5} = 0.8 \]
Normalization:
\[ U_{C2}(A10) = \frac{150 - 110}{250 - 110} = \frac{40}{140} = 0.2857 \]
Normalization:
\[ U_{C3}(A10) = \frac{2 - 1}{5 - 1} = \frac{1}{4} = 0.25 \]
C4 normalization:
\[ U_{C4}(A10) = \frac{3 - 1}{5 - 1} = \frac{2}{4} = 0.5 \]
C5 Normalization:
\[ U_{C5}(A10) = \frac{39900000 - 19000000}{39900000 - 58000000} = \frac{20900000}{34100000} = 0.6129 \]

Table 5. Criteria Normalization Matrix Results for Each Alternative

<table>
<thead>
<tr>
<th>Alternative</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A01</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.25</td>
<td>1</td>
</tr>
<tr>
<td>A02</td>
<td>0.8</td>
<td>0.0375</td>
<td>0.75</td>
<td>0</td>
<td>0.8065</td>
</tr>
<tr>
<td>A03</td>
<td>1</td>
<td>0.2857</td>
<td>0</td>
<td>0</td>
<td>0.6628</td>
</tr>
<tr>
<td>A04</td>
<td>0.6</td>
<td>0.1071</td>
<td>1</td>
<td>0.25</td>
<td>0.8827</td>
</tr>
<tr>
<td>A05</td>
<td>0.6</td>
<td>0.2857</td>
<td>1</td>
<td>0.5</td>
<td>0.6246</td>
</tr>
<tr>
<td>A06</td>
<td>0.2</td>
<td>0.2857</td>
<td>0</td>
<td>0.75</td>
<td>0.5543</td>
</tr>
<tr>
<td>A07</td>
<td>0.2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A08</td>
<td>0.4</td>
<td>0.1071</td>
<td>1</td>
<td>0.25</td>
<td>0.8534</td>
</tr>
<tr>
<td>A09</td>
<td>1</td>
<td>0.3214</td>
<td>0.5</td>
<td>0</td>
<td>0.5777</td>
</tr>
<tr>
<td>A10</td>
<td>0.8</td>
<td>0.2857</td>
<td>0.25</td>
<td>0.5</td>
<td>0.6129</td>
</tr>
</tbody>
</table>

6. Perform a total evaluation calculation by multiplying the normalization matrix from the criterion value and the weight value. After that, add up the multiplication results to find the value of the total evaluation for each alternative with the following equation:
\[ v(x) = \sum_{i=1}^{n} w_i v_i(x) \]

Table 6 Table of Ranking Results

<table>
<thead>
<tr>
<th>No</th>
<th>Alternative</th>
<th>Total Evaluation</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New V-Ixion KS SE</td>
<td>0.5726</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Jupiter Z1</td>
<td>0.555</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>New Supra</td>
<td>0.5076</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Aerox 155 GP</td>
<td>0.4998</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>CB150R Streetfire</td>
<td>0.4972</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Beat FL Sporty CW</td>
<td>0.483</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Ninja 250</td>
<td>0.44</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Absolute Revo</td>
<td>0.4375</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>Variety 150</td>
<td>0.4371</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>KLX 150 BF SE</td>
<td>0.3625</td>
<td>10</td>
</tr>
</tbody>
</table>

From the table above, it can be concluded that the New V- Ixion KS SE is the best alternative according to predetermined weights and criteria.
4. Conclusion

After conducting research with several stages needed to evaluate a decision support system by managing data from the Rifdah Motor Khatib company, it was found that the decision support system using the MAUT method can assist companies in making decisions effectively and efficiently and obtain the best alternative according to the weights and criteria which has been specified.

References


