Implementation of simple additive weighting algorithm in decision support system

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Abstract. The research focused on the problems of buying a second-hand Toyota vehicle. The ability to make fast, precise and accurate decisions will be the key to success in today's global competition. The number of factors that need to be considered when a purchaser wants to buy a second-hand car also leads the purchaser to make the wrong choice when selecting a second-hand car to buy. This problem is solved by developing a support system that helps consumers make choices about purchasing second-hand cars. This Decision Support System is generated using the Simple Additive Weighting (SAW) method. From this research it can be concluded that the SAW method is very appropriate to use as a decision support tool where three best second-hand car alternatives are obtained consisting of Toyota Fortuner with a preference value of 101, Toyota Rush car with a preference value of 90.4, and the Toyota Kijang Innova with a preference value of 88.6.

1. Introduction

Nowadays, along with the development and progress of the times and the demands for high mobility, four-wheeled vehicles have become essential community needs in everyday life. The types of four-wheeled vehicles that are in the market in Indonesia currently vary greatly from price and kind, such as the Toyota Agya, Avanza, Rush, and many more. Therefore, many people want to buy cars, both new and second-hand cars. For consumers who want to buy a car but have limited funds and don't want to be complicated with paying installments, purchasing a second-hand car can be the right choice. This has resulted in increased market interest in buying second-hand cars from time to time.

In purchasing a second-hand car, there are several things to consider. Consumers often ask others for guidance or suggestions to pick a second-hand car worth purchasing since they face a wide variety of car styles in the showroom or on the market. Consumers who have selected a vehicle often feel unhappy about buying the car because they don't want their car.

At present, the development of information technology is significant in supporting data production in different life situations. Through the use of technology, potential buyers can be helped to make decisions about the choice of second-hand cars that can be made more quickly and accurately. This is possible due to the sophistication of hardware technology followed by...
technological innovations and the ability to combine multiple decision-making techniques [14]–[17]. A second-hand Toyota car purchasing decision support system was developed to solve the problem of choosing a second-hand car, which will assist and make it easier for consumers to decide the second-hand car to be purchased according to their desires and their regular wishes. The Simple Additive Weighting (SAW) method is the method used in this study. This approach was selected because the SAW method was commonly used to promote decision-making [14], [18], [19].

2. Methodology
In Figure 1, the steps taken to complete this research can be seen. The analysis started to establish the context of the research problem and proceeded with the collection of data. The next step is to determine the appropriate weight and requirements. The data is then analyzed using the technique of Simple Additive Weighting (SAW). To perform calculations, this approach includes parameters and weights such that the best alternative can be obtained. The criteria used include production year, engine power, car color, and car price. In Table 1 and Table 2, the parameters for the purchasing of second-hand cars and the weight values for each criterion can be seen.

![Figure 1. Research Framework](image)

In this analysis, the data to be processed in selecting second-hand Toyota cars consists of alternative data with each criterion's value, as shown in Table 3.

| Criteria | Value |
|----------|-------|
| Production Year (C1) | Very Low: 2000-2004, Low: 2005-2009, Moderate: 2010-2013, High: 2014-2015, Very High: 2016-2018 |
| Engine Capacity (C2) | Very Low: 2000-2004, Low: 2005-2009, Moderate: 2010-2013, High: 2014-2015, Very High: 2016-2018 |
| Car Color (C3) | Another Color, Grey, Silver, White, Black |
| Car Price (C4) | 50 Million – 100 Million, 101 Million – 200 Million, 201 Million - 300 Million, 301 Million - 400 Million, 400 Million Above |

3. Result and Discussion
The data in Table 3 will then be processed using the Simple Additive Weighting (SAW) Calculation
method. Data processed in this analysis using the SAW method was second-hand car data with the values shown in table 4.

| Alternative | Car Model          | Year | Engine Capacity | Color | Value |
|-------------|--------------------|------|-----------------|-------|-------|
| A1          | Toyota Agya       | 2014 | 1200cc          | White | 98000000 |
| A2          | Toyota Avanza     | 2015 | 1200cc          | White | 138000000 |
| A3          | Toyota Rush       | 2016 | 1500cc          | Black | 190000000 |
| A4          | Toyota Kijang Innova | 2018 | 2400cc          | Silver | 300000000 |
| A5          | Toyota Fortuner   | 2019 | 2400cc          | Black | 530000000 |

4. Result and Discussion
After getting the car value data, then the weight is given, based on the level of importance of each of the required criteria as follows:

Weight Vector \( W = [30, 20, 30, 20] \)

Making a decision matrix \( X \), a match table is created as follows:

\[
X = \begin{bmatrix}
4 & 1 & 4 & 1 \\
4 & 1 & 4 & 2 \\
5 & 2 & 5 & 2 \\
5 & 4 & 3 & 3 \\
5 & 4 & 5 & 5
\end{bmatrix}
\]

After the \( X \) decision matrix has been developed, \( X \) matrix normalization is performed to measure the value of each criterion on the basis of predetermined parameters, i.e.

a. A1 (Toyota Calya)
\[
\begin{align*}
R_1 &= \frac{4}{\max(4,4,5,5,5)} = \frac{4}{5} = 0.8 \\
R_2 &= \frac{1}{\max(1,1,2,4,4)} = \frac{1}{4} = 0.25 \\
R_3 &= \frac{4}{\max(4,4,5,3,5)} = \frac{4}{5} = 0.8 \\
R_4 &= \frac{1}{\max(1,2,2,3,5)} = \frac{1}{5} = 0.2 
\end{align*}
\]

b. A2 (Toyota Avanza)
\[
\begin{align*}
R_{21} &= \frac{4}{\max(4,4,5,5,5)} = \frac{4}{5} = 0.8 \\
R_{22} &= \frac{1}{\max(1,1,2,4,4)} = \frac{1}{4} = 0.25 \\
R_{23} &= \frac{4}{\max(4,4,5,3,5)} = \frac{4}{5} = 0.8 \\
R_{24} &= \frac{2}{\max(1,2,2,3,5)} = \frac{2}{5} = 0.4 
\end{align*}
\]

c. A3 (Toyota Rush)
\[
\begin{align*}
R_{31} &= \frac{5}{\max(4,4,5,5,5)} = \frac{5}{5} = 1 \\
R_{32} &= \frac{2}{\max(1,1,2,4,4)} = \frac{2}{4} = 0.5 \\
R_{33} &= \frac{5}{\max(4,4,5,3,5)} = \frac{5}{5} = 1 \\
R_{34} &= \frac{2}{\max(1,2,2,3,5)} = \frac{2}{5} = 0.4
\end{align*}
\]
d. **A4 (Toyota Kijang Innova)**

\[
\begin{align*}
R_{41} &= \frac{5}{\max(4,5,5,5)} = \frac{5}{5} = 1 \\
R_{42} &= \frac{4}{\max(1,1,2,4,4)} = \frac{4}{4} = 1 \\
R_{43} &= \frac{3}{\max(4,4,5,3,5)} = \frac{3}{5} = 0.6 \\
R_{44} &= \frac{3}{\max(1,2,2,3,5)} = \frac{3}{5} = 0.6
\end{align*}
\]

The matrix is normalized according to the results of the following calculations:

\[
R = \begin{bmatrix}
0.8 & 0.25 & 0.8 & 0.2 \\
0.8 & 0.25 & 0.8 & 0.4 \\
1 & 0.5 & 1 & 0.4 \\
1 & 1 & 0.6 & 0.6 \\
1 & 1 & 1 & 1
\end{bmatrix}
\]

In addition, the multiplication of the matrix \( W \times R \) and the sum of the multiplication results shall be made in order to obtain the best alternative by ranking the largest value as follows:

\[
V_i = \sum_{j=1}^{n} W_j \cdot r_{ij}
\]

\begin{align*}
V_1 &= (0.8 \times 30) + (0.25 \times 20) + (0.8 \times 30) + (0.2+20) \\
&= (24 + 5 + 24 + 20.2) \\
&= 73.2 \\
V_2 &= (0.8 \times 30) + (0.25 \times 20) + (0.8 \times 30) + (0.4+20) \\
&= (24 + 5 + 24 + 20.4) \\
&= 73.4 \\
V_3 &= (1 \times 30) + (0.5 \times 20) + (1 \times 30) + (0.4+20) \\
&= (30 + 10 + 30 + 20.4) \\
&= 90.4 \\
V_4 &= (1 \times 30) + (1 \times 20) + (0.6 \times 30) + (0.6+20) \\
&= (30 + 20 + 18 + 20.6) \\
&= 88.6 \\
V_5 &= (1 \times 30) + (1 \times 20) + (1 \times 30) + (1+20) \\
&= (30 + 20 + 30 + 21) \\
&= 101
\end{align*}

The following results are obtained from the multiplication of the matrix \( W \times R \):

\[V_1 = 73.2, V_2 = 73.4, V_3 = 90.4\]
The ranking results for the Vi preference value can be seen in the graph below.

5. Conclusion
The Decision Support System (DSS) for purchasing second-hand Toyota cars is designed to make it easier for consumers to choose and assist consumers in the purchase of second-hand Toyota cars. The decision support system (DSS) for purchasing a second-hand Toyota car can be used as an option or as a guide for selecting and deciding on the purchase of a car.

The decision support system using the Simple Additive Weighting Approach is the best method to use when choosing several attributes, and the results of the study are excellent and logical. The DSS calculation results using the SAW method in this analysis were obtained from the three best second-hand car alternatives, namely Toyota Fortuner with a preference value of 101, Toyota Rush with a preference value of 90.4, and Toyota Kijang Innova with a preference value of 88.6.

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