Multi-Attribute Utility Theory Algorithm for Selection two-wheeled Vehicle, Educational Review Process

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Abstract

Motorcycles are a highly efficient and effective means of transport. Currently, the increasing number of motorcycle products allows consumers to buy the correct motorcycle and according to their wishes, requirements, and abilities. The objective is to design and use the Multi-Attribute Utility Theory (MAUT) method to choose a motorcycle product. The MAUT method has advantages, including simple calculations, leads to the ultimate value used to classify vehicles and determines the weight value of the criteria that leads to vehicle selection according to the buyer's wishes and needs. The data sources are based on the data required, namely observations and interviews with the public as motorcycle users and motorcycle dealers in the North Sumatra Region as a sample. Price, quality, design, after sales, fuel consumption and popularity are the criteria for evaluation. While Honda, Yamaha and Suzuki for motorcycles moped; sport; and matic are the alternatives used in research. The ranking results are obtained with the final value on alternative 1 = 0.8500; alternative 2 = 0.7500; and alternative 3 = 0.2250, so alternative 1 (Honda (New Vario 125 Esp CBS-ISS) is the alternative chosen as a recommendation in the selection of two-wheeled vehicles based on needs. The results of this study demonstrate that MAUT can be used as a recommendation for the public in choosing motorcycle products based on needs.

Keywords

Motorcycle, DEATH Method, As Needed, DSS, Ranking.

Introduction

Motorcycles are an effective and efficient of transportation, and the number of motorcycle products is increasing year after year. The rise in the number of motorcycle products was caused by an increase in the number of consumers who began to use motorcycles for daily activities [1]. Indonesia also has a plethora of motorcycle brands, including Honda, Suzuki, Kawasaki, and Yamaha. Because of the large number of motorcycle products available in Indonesia, many consumers have their own preferences when it comes to purchasing the right motorcycle for their wants, needs, and abilities. The development of a computing system is critical in order to facilitate the analysis process in selecting and determining the best type of two-wheeled vehicle as required. Another advantage of the study's decision support system research is how to determine the criteria and scale of assessment carried out through literature reviews and random interviews with the general public as motorcycle users and motorcycle dealers as motorcycle vehicle sellers. With these considerations in mind, the decision support system [2]–[9] is one of the system solutions that can help in recommending decision making that is quick, precise, objective, transparent, and consistent [10].

The Multi-Attribute Utility Theory (MAUT) method is one of the solutions used. The MAUT method was used because a study [11] on the selection of exemplary health workers found that the MAUT method had an accuracy rate of 86.67 percent of the test results. Furthermore, the MAUT method was chosen because it lacks a cost and benefit value in decision making, whereas several other decision support system methods, such as SAW, TOPSIS, and SMART, can be considered for use if a cost and benefit value exists [12]. This study is similar to several previous studies, including one conducted by (Arifin, 2020) [13], which resulted in a ranking on the selection of used motorcycles using the AHP and SAW methods. Then there's (Ramadhan et al., 2019) [14], which only employs the SAW method in the selection of motorcycles that result in rankings. However, this study differs from the others in terms of the assessment criteria and methods used. In this study (Arifin, 2020), two methods are used: AHP and SAW. The AHP method is used to determine priority criteria, and the SAW method is used to rank the results of the AHP method. While the following criteria are used for evaluation: year of manufacture, engine capacity, color, type, and price. Then, the differences in research conducted (Ramadhan et al., 2019) used the SAW method as a solution with assessment criteria, which included price, fuel consumption, dimension criteria, and design criteria. These factors distinguish the author's research from previously conducted studies.

Research Methodology

Data collection was carried out during the planning stage. Interviews were used to collect data. Interviews were conducted to collect data for the general public as motor vehicle users and motorcycle dealers as motor vehicle sellers, so that the output results could be used to provide reliable recommendations. The study will take place in North Sumatra. Criteria and weight data were obtained from the research data. Table 2 displays the sub-criteria values, and Table 1 displays the motorcycle product selection.

The system flow design is a design that explains the flow in the operation of the SPK in selecting the type of motorcycle product when it is used by the user. The system flow is designed according to the stages that have been carried out previously. The system flowchart can be seen in Figure 1.

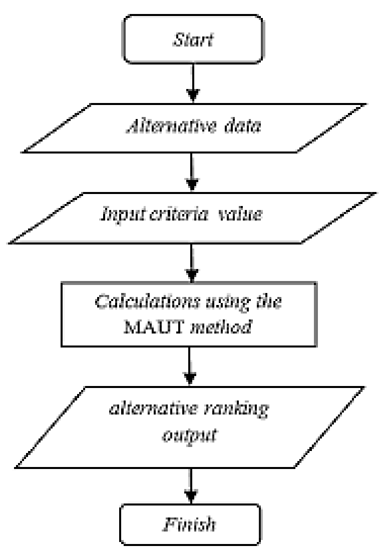

Figure 1 Flowchart system

The Multi-Attribute Utility Theory (MAUT) method requires the development of a multi-attribute utility model, which specifies the dimensions of the evaluation and decision problems [15]. The following are the steps in the MAUT process:

1. By defining the problem, you can create a decision framework.
2. Create alternatives that could solve the problem.
3. Make a list of all the factors that influence your decision.
4. Give equal weight to each factor. The weights should reflect the importance of these factors to the problem.
5. Consider the alternatives as well. Determine how satisfactory each alternative is in each aspect for each alternative.
6. The process of weighing each alternative against the existing factors in order to make a decision [16].

The method of Multi-Attribute Utility Theory translate multiple interests into numerical values in a scale of 0-1 with 0 as the worst and 1 as the best [17]. The comparison of different sizes is possible directly. You can compare apples to oranges with the right instruments. The result is a ranking of alternative assessments which describes the choices of decision makers. The calculation is as follows:

$$\mathrm{V}(x) = \sum_{i=1}^{n} w_i \,.\, v_i(x) \qquad (1)$$

variable explanation in formula (1) where V(x) is the total evaluation of alternative x; w_i is the relative weight of the I-th criteria; $v_i(x)$ is the result of the evaluation of the i-th criteria from alternative x; and I is the criterion index.

The utility functions for normalizing each alternative that are used to find the results of the x-th alternative evaluation, on a scale of 0-1 are also referred to as U (x) which can be seen in the following formula (2):

$$\mathrm{U}(x) = \frac{x - x_1^-}{x_1^+ - x_1^-} \qquad (2)$$

variable explanation in formula (2) where U(x) is the utility value of the x-th alternative; x_1^- is the worst value of the i-th criterion in alternative x; and x_1^+ is the best value of the i-th criterion in alternative x [18].

Results and Discussion

The Multi Attribute Utility Theory (MAUT) method of research on the best type of two-wheeled vehicle for needs requires several criteria that are used as a reference in decision making, as shown in Table 1 below.

Table 1 Criteria Terms

Criteria Code	Criteria	Weight Criteria
Criteria1	Price	20
Criteria2	Quality	20
Criteria3	Design	15
Criteria4	After Sales	15
Criteria5	Fuel Consumption	15
Criteria6	Popularity	15

Each criterion in Table 1 has a different weighting, with criteria codes 1 and 5 using the cost attribute type and criteria codes 2, 3, 4, and 6 using the benefit attribute type. Each criterion has a sub-criteria, and the explanation of the sub-criteria for each criterion is provided in the table below.

Table 2 Sub Criteria of Price

Price	Weight	Price range		
		Moped CC110	Moped CC 125	Matic CC110
Very expensive	4	≥ 15.1 million	≥ 17.1 million	≥ 16.1 million
Expensive	3	13.6 – 15 million	15.6 – 17 million	14.6 – 16 million
Cheap enough	2	12.1 -13.5 million	14.1 - 15.5 million	13.1 - 14.5 million
Inexpensive	1	≤ 12 million	≤ 14 million	≤ 13 million

Price	Weight	Price range		
		Matic CC 125	Matic CC150	Sport CC150
Very expensive	4	≥ 18.1 million	≥ 21 million	≥ 27 million
Expensive	3	16.6– 18 million	19.6 – 21 million	25.1 – 27 million
Cheap enough	2	15.1 - 16.5 million	18.1 - 19.5 million	23.1– 25 million
Inexpensive	1	≤ 15 million	≤ 18 million	≤ 23 million

Meanwhile, the sub-criteria of quality (Criterion2) and design (Criterion3) have values and weights, namely: very good (5); good (4); enough (3); and not good (2). While the sub-criteria of after-sales (Criteria4) have values and weights, namely: very expensive (5); expensive (4); quite cheap (3); and cheap (2). Then for the sub-criteria of fuel consumption (Criterion 5) and popularity (Criterion 6) have values and weights, namely: very high (5); height (4); enough (3); and low (2).

Tables 3 and 4 below illustrate an alternate table and example data based on the criterion and sub-criteria data used in determining the appropriate type of two-wheeled vehicle based on needs.

Table 3 Alternative Selection

No	Name	Type
1	Honda	New Vario 125 Esp CBS-ISS
2	Yamaha	All New Soul GT 125
3	Suzuki	Spin 125 NR II

Table 4 Alternative data conversion

No	Alternative	Criteria1	Criteria2	Criteria3	Criteria4	Criteria5	Criteria6
1	HONDA (New Vario 125 Esp CBS-ISS) (A1)	4	4	4	4	3	4
2	YAMAHA (All New Soul GT 125) (A2)	4	5	5	5	3	5
3	SUZUKI (Spin 125 NR II) (A3)	3	3	4	3	5	3

The process of selecting the type of two-wheeled vehicle as needed is shown in Table 4, where the dataset obtained through interviews with the general public as motorized vehicle users and motorcycle dealers as motor vehicle sellers is preprocessed and then converted into numerical (based on the sub-criteria table) form using Microsoft Excel software. The MAUT method will be used to analyze the data. The dataset (Table 4) will be normalized as follows, using equation (2) for each alternative.

HONDA (New Vario 125 Esp CBS-ISS) (A1)							
Criteria1 =	4	-	3	=	1	=	1.0000
	4	-	3		1		
Criteria2 =	4	-	3	=	1	=	1.0000
	4	-	3		1		
Criteria3 =	4	-	3	=	1	=	1.0000
	4	-	3		1		
Criteria4 =	4	-	3	=	1	=	1.0000
	4	-	3		1		
Criteria5 =	3	-	3	=	0	=	0.0000
	4	-	3		1		
Criteria6 =	4	-	3	=	1	=	1.0000
	4	-	3		1		

YAMAHA (All New Soul GT125) (A2)							
Criteria1 =	4	-	3	=	1	=	0.5000
	5	-	3		2		
Criteria2 =	5	-	3	=	2	=	1
	5	-	3		2		
Criteria3 =	5	-	3	=	2	=	1
	5	-	3		2		
Criteria4 =	5	-	3	=	2	=	1.0000
	5	-	3		2		
Criteria5 =	3	-	3	=	0	=	0
	5	-	3		2		
Criteria6 =	5	-	3	=	2	=	1.0000
	5	-	3		2		

SUZUKI (Spin 125 NR II) (A3)							
Criteria1 =	3	-	3	=	0	=	0.0000
	5	-	3		2		
Criteria2 =	3	-	3	=	0	=	0
	5	-	3		2		
Criteria3 =	4	-	3	=	1	=	0.5
	5	-	3		2		
Criteria4 =	3	-	3	=	0	=	0
	5	-	3		2		
Criteria5 =	5	-	3	=	2	=	1
	5	-	3		2		
Criteria6 =	3	-	3	=	0	=	0
	5	-	3		2		

The results of normalization of each alternative with each criterion can be seen in Table 5 below:

Table 5 Result of Normalization

Alternative	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
HONDA (New Vario 125 Esp CBS-ISS) (A1)	1.0	1.0	1.0	1.0	0.0	1.0
YAMAHA (All New Soul GT 125) (A2)	0.5	1.0	1.0	1.0	0.0	1.0
SUZUKI (Spin 125 NR II) (A3)	0.0	0.0	0.5	0.0	1.0	0.0

Calculate the evaluation value from the normalizing results using equation (1), where the evaluation value is the value used to rank the two-wheeled vehicle choices as needed.

A1 =	(1x0.2) +	(1x0.2) +	(1x0.15) +
	(1x0.15) +	(0x0.15) +	(1x0.15) =
	0.2 +	0.2 +	0.15 +
	0.15 +	0 +	0.15 = **0.85**
A2 =	(0.5x0.2) +	(1x0.2) +	(1x0.15) +
	(1x0.15) +	(0x0.15) +	(1x0.15) =
	0.1 +	0.2 +	0.15 +
	0.15 +	0 +	0.15 = **0.75**
A3 =	(0x0.2) +	(0x0.2) +	(0.5x0.15) +
	(0x0.15) +	(1x0.15) +	(0x0.15) =
	0 +	0 +	0.075 +
	0 +	0.15 +	0 = **0.225**

The results of the evaluation of each alternative can be seen in Table 6 below:

Table 6 Results of the evaluation

Alternative	**Result**	**Rank**
Honda (New Vario 125 Esp CBS-ISS) (A1)	0.8500	1
Yamaha (All New Soul GT 125) (A2)	0.7500	2
Suzuki (Spin 125 NR II) (A3)	0.2250	3

The final step in Table 6 is the ranking process. The ranking results are obtained with the final value on alternative 1 = 0.8500; alternative 2 = 0.7500; and alternative 3 = 0.2250, so alternative 1 (Honda (New Vario 125 Esp CBS-ISS) is the alternative chosen as a recommendation in the selection of two-wheeled vehicles based on needs.

Conclusion

Several implications may be derived from the findings of the research, including the development of SPK for selecting the type of two-wheeled vehicle required utilizing the Multi-Attribute Utility Theory (MAUT) technique, which can provide recommendations for picking the type of two-wheeled vehicle. The MAUT approach can be used as an alternative method for determining the type of two-wheeled vehicle system that is required. For comparison of study outcomes, this DSS can be constructed utilizing various methodologies such as SMART, TOPSIS, and SAW.

References

E.I. Putra, "Decision Support System for Choosing the Best Matic Motorcycle 'Honda 110cc' With AHP Method," *Indonesian Journal on Computer and Information Technology*, vol. 3, no. 2, pp. 3(2), 165–169, 2018.

T. Imandasari and A. P. Windarto, "Decision Support System in Recommending the Best Unit in PDAM Tirta Lihou Using the Promethee Method," *Jurnal Teknologi dan Sistem Komputer*, vol. 5, no. 4, p. 159, 2017. http://doi.org/10.14710/jtsiskom.5.4.2017.159-165.

S. Sundari, Karmila, M.N. Fadli, D. Hartama, A.P. Windarto, and A. Wanto, "Decision Support System on Selection of Lecturer Research Grant Proposals using Preferences Selection Index," *Journal of Physics: Conference Series*, vol. 1255, no. 1, pp. 1–8, 2019. http://doi.org/10.1088/1742-6596/1255/1/012006.

K. Fatmawati *et al.*, "Analysis of Promothee II Method in the Selection of the Best Formula for Infants under Three Years," *Journal of Physics: Conference Series*, vol. 1255, no. 1, 2019. http://doi.org/10.1088/1742-6596/1255/1/012009

P. Alkhairi, L.P. Purba, A. Eryzha, A.P. Windarto, and A. Wanto, "The Analysis of the ELECTREE II Algorithm in Determining the Doubts of the Community Doing Business Online," *Journal of Physics: Conference Series*, vol. 1255, no. 1, 2019. http://doi.org/10.1088/1742-6596/1255/1/012010.

W.M. Sari *et al.*, "Improving the Quality of Management with the Concept of Decision Support Systems in Determining Factors for Choosing a Cafe based on Consumers," *Journal of Physics: Conference Series*, vol. 1471, no. 1, 2020. http://doi.org/10.1088/1742-6596/1471/1/012009.

T. Imandasari, M.G. Sadewo, A.P. Windarto, A. Wanto, H.O. Lingga Wijaya, and R. Kurniawan, "Analysis of the Selection Factor of Online Transportation in the VIKOR Method in Pematangsiantar City," *Journal of Physics: Conference Series*, vol. 1255, no. 1, 2019. http://doi.org/10.1088/1742-6596/1255/1/012008

S.R. Ningsih, R. Wulansari, D. Hartama, A. P. Windarto, and A. Wanto, "Analysis of PROMETHEE II Method on Selection of Lecturer Community Service Grant Proposals," *Journal of Physics: Conference Series*, vol. 1255, no. 1, pp. 1–7, 2019. http://doi.org/10.1088/1742-6596/1255/1/012004

R. Rusdiyanto, J. Karman, A. Toyib Hidayat, A. Muli Peranginangin, F. Tambunan, and J. Hutahaean, "Analysis of Decision Support Systems on Recommended Sales of the Best Ornamental Plants by Type," *Journal of Physics: Conference Series*, vol. 1566, no. 1, 2020. http://doi.org/10.1088/1742-6596/1566/1/012047

R. Ramadiani and R. Kurniawan, "Application of Technique for Order Preference Method by Similarity to Ideal Solution (TOPSIS) Priority of KORPRI Housing Recipient," *International Journal of Engineering, Information Science and Applied Sciences (IJEIS-AS)*, vol. 1, no. 1, pp. 1–8, 2018.

A. Ramadiani, ramadiani ; Rahmah, "Decision Support System for Selection of Exemplary Health Personnel," *Jurnal Ilmiah teknologi sistem informasi*, vol. 3, no. 2, 83–88, 2019.

R. Meri, "Simple Additive Weighting (SAW) Method on The Selection of New Teacher Candidates at Integrated Islamic Elementary School," *IJISTECH (International Journal of Information System …*, vol. 4, no. 1, pp. 428–435, 2020. http://ijistech.org/ijistech/index.php/ijistech/article/view/80.

N.A. Arifin, "Decision Support System for Selection of Used Motorcycles with AHP and SAW Methods (Case Study: Sahabat Motor)," *STRING (Satuan Tulisan Riset dan Inovasi Teknologi)*, vol. 5, no. 2, p. 160, 2020. http://doi.org/10.30998/string.v5i2.7739

S. Ramadhan, L. Mazia, and E. Pujiastuti, "Decision Support System for Duck Motorcycle Selection With Simple Additive Weighting Method," *Indonesian Journal on Software Engineering (IJSE)*, vol. 4, no. 2, pp. 74–81, 2019. http://doi.org/10.31294/ijse.v4i2.5986

G. Bansal, A. Anand, and M. Agarwal, "Modeling the Impact of Remanufacturing Process in Determining Demand-Cost Trade off Using MAUT," *American Journal of Mathematical and Management Sciences*, vol. 0, no. 0, pp. 1–14, 2020. http://doi.org/10.1080/01966324.2020.1839609.

Z. Allah Bukhsh, I. Stipanovic, G. Klanker, A.O' Connor, and A.G. Doree, "Network level bridges maintenance planning using Multi-Attribute Utility Theory," *Structure and Infrastructure Engineering*, vol. 15, no. 7, pp. 872–885, 2019. http://doi.org/10.1080/15732479.2017.1414858

M. Grabisch, I. Kojadinovic, and P. Meyer, "A review of methods for capacity identification in Choquet integral based multi-attribute utility theory. Applications of the Kappalab R package," *European Journal of Operational Research*, vol. 186, no. 2, pp. 766–785, 2008, http://doi.org/10.1016/j.ejor.2007.02.025

N. Hadinata, "Implementation of the Multi Attribute Utility Theory (MAUT) Method in Decision Support Systems in Determining Credit Beneficiaries," *Jurnal Sisfokom (Sistem Informasi dan Komputer)*, vol. 7, no. 2, pp. 87–92, 2018. http://doi.org/10.32736/sisfokom.v7i2.562