Choose Motorcycles with Multi-Critical Decision Technique

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Abstract—**Motorcycles are considered indispensable items in every low- and middle-income family in Vietnam. Choosing a motorcycle to buy is very important. This research was conducted to select the best motorcycle among the available options. The number of motorcycles considered in this study is six, including Honda Wave Alpha 110, Honda Blade 110, 2021 Honda Beat CBS, Honda Wave RSX FI 110, Honda Future 125 FI, and Honda Genio. The PIPRECIA (PIvot Pairwise RElative Criteria Importance Assessment) method was used to determine the weights for the criteria. The FUCA (Faire Un Choix Adéquat) method was used to rank the alternatives in each product category. This research has identified the Honda Future 125 FI as the best among the six options mentioned above.**

Keywords—Motobike selection, PIvot Pairwise RElative Criteria Importance Assessment method, Faire Un Choix Adéquat method.

I. INTRODUCTION

Today, for every family, means of transport are considered indispensable components to serve daily life. In Vietnam, for low- and middle-income families, the means of transport mentioned is motorbikes. However, choosing to buy the most suitable motorbike is a complicated job for each customer. A question often asked is how to buy the "best" product. The concept of "best" for a product is understood that the product must have all the criteria to be considered the best. However, for each type of product, there are many different options on the market. Choosing a product based on only one or a few criteria is easy to make mistakes. That mistake is understood as buying a product that is not considered the best. To choose the best product, it is necessary to consider all its criteria. This is called multi-criteria decision making (MCDM) [1-4]. However, the authors of this study can confirm with certainty that up to now, there has not been any study applying MCDM methods to motorcycle selection. This study was conducted to fill this gap.

FUCA is a popular MCDM method used in recent times [5, 6]. This method has been used for multi-criteria decision making in various fields [7-12]. However, the application of the FUCA method to motorcycle selection has not been found in any studies. This gap is why the FUCA method was used in this study.

For items that are motorcycles, it is important to consider the opinions of buyers. PIPREICA is a method of assigning weights to criteria taking into account the decision maker's point of view. Using this method, it is possible not only to determine the weight of the criteria when considering the opinions of one person, but it is also possible to determine the weight of the criteria when considering the opinions of many people [13]. In recent times, this method has also been used to calculate the weights of criteria in a number of fields [14-18]. However, up to now, this method has not been used to determine the weights for the criteria of motorcycles. This is also the reason that it was used in this study.

II. PIPRECIA METHOD

The PIPRECIA method was used to calculate the weights of the criteria in the following order [13]:

Step 1: Select experts to ask for their opinion on the importance of the criteria.

Step 2: Each expert will determine the relative importance of the criteria s_j, starting from the second criterion, according to (1).

$$s_j = \begin{cases} > 1 \ when \ C_j > C_{j-1} \\ 1 \ when \ C_j = C_{j-1} \\ < 1 \ when \ C_j < C_{j-1} \end{cases} \quad (1)$$

Step 3: For each expert, determine the coefficient kj according to formula (2).

$$k_j = \begin{cases} 1 & j = 1 \\ 2 - s_j & j > 1 \end{cases} \quad (2)$$

Step 4: Determine the recalculated weight of the criteria according to formula (3).

$$q_j = \begin{cases} 1 & j = 1 \\ \dfrac{q_{j-1}}{k_j} & j > 1 \end{cases} \quad (3)$$

Step 5: Calculate the weight of the criteria according to the opinion of each expert according to formula (4).

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \quad (4)$$

Step 6: Calculate the weight of the criteria according to two formulas (5) and (6). Where K is the number of experts, the index r represents the rth expert.

$$w_j^* = \left(\prod_{r=1}^{K} w_j^r \right)^{1/K} \quad (5)$$

$$w_j = \frac{w_j^*}{\sum_{j=1}^{n} w_j^*} \qquad (6)$$

II. FUCA METHOD

The steps to rank alternatives according to the FUCA method include [5, 6]:

Step 1: Rank the alternatives for each criterion (r_{ij}). Suppose there are m alternatives, the worst one will be ranked m, otherwise the best one will be ranked 1.

Step 2: Calculate the score for each option according to formula (7).

$$D_i = \sum_{j=1}^{n} r_{ij} . w_j \qquad (7)$$

Step 3: Rank the alternatives according to the value of D_i. The best solution is the one with the smallest Di, and vice versa.

IV. CHOOSING A MOTORBIKE

In Table 1 are the parameters of six types of motorcycles [19]. In which the criteria have been arranged in descending order of priority based on the survey of six experts. Six types of motorcycles with corresponding product codes are Honda Wave Alpha 110 (A1), Honda Blade 110 (A2), 2021 Honda Beat CBS (A3), Honda Wave RSX FI 110 (A4), Honda Future 125 FI (A5), and Honda Genio (A6).

Table 1. Types of motorcycles [19]

No.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
A1	18.39	1.68	3.7	5500	8.44	97	769	1914	688	1075	97
A2	21.3	1.85	3.7	5500	8.65	109.1	769	1920	702	1075	98
A3	26.44	1.65	6.5	5500	9.3	110	740	1877	669	1074	89
A4	24.63	1.7	4	6000	8.7	109.1	760	1921	709	1081	100
A5	31.51	1.54	4.6	5500	10.2	110	756	1931	711	1083	105
A6	28.47	1.69	6.5	5500	9.3	110	740	1256	692	1061	89
Type	Min	Min	Max	Max	Max	Max	Max	Max	Max	Max	Max

The meaning of the criteria is as follows:
C1: is the price (dong million);
C2: is the fuel consumption (litter/100km);
C3: is the fuel tank capacity (littre);
C4: is the maximum torque (RPM);
C5: is the maximum torque (Nm);
C6: is the weight (kg);
C7: is the saddle length (mm);
C8: is the vehicle length (mm);
C9: is the vehicle width (mm);
C10: is the vehicle height (mm);
C11: is the capacity (cc).

The relative importance of the criteria was determined by a survey of experts. The results of the survey are summarized in Table 2.

Applying formulas from (2) to (6) has determined the weight of the criteria as shown in table 2.

Table 2. Expert opinion on the relative importance of s_j criteria

Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
C1						
C2	0.99	0.98	1	0.98	0.94	1.1
C3	0.99	0.97	0.98	0.99	0.99	0.99
C4	0.95	0.95	0.95	0.95	0.95	0.97
C5	0.98	0.99	0.99	0.99	0.99	0.99
C6	0.92	0.92	0.95	0.96	0.96	0.93
C7	0.98	0.98	0.98	0.98	0.98	0.98
C8	0.99	0.98	0.99	0.92	0.89	0.95
C9	0.99	0.98	0.98	0.93	0.86	0.9
C10	0.95	0.95	0.96	0.99	0.85	0.8
C11	0.94	0.99	0.99	0.98	0.85	0.88

Table 2. Weight of Criteria

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0.1043	0.1042	0.1027	0.0981	0.0970	0.0915	0.0897	0.0858	0.0810	0.0749	0.0707

Table 3. Ranking of alternatives for each criterion

No.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
A1	1	3	5.5	4	6	6	1.5	4	5	3.5	4
A2	2	6	5.5	4	5	4.5	1.5	3	3	3.5	3
A3	4	2	1.5	4	2.5	2	5.5	5	6	5	5.5
A4	3	5	4	1	4	4.5	3	2	2	2	2
A5	6	1	3	4	1	2	4	1	1	1	1
A6	5	4	1.5	4	2.5	2	5.5	6	4	6	5.5

Step 1 of the FUCA method was used to rank the alternatives against each criterion. The results are presented in Table 3.

Step 2 of the FUCA method was used to calculate the score for each option (Equation (7)), the results are summarized in Table 4. The results of the ranking of alternatives (types of motorbikes) have also been evaluated. summarized in this table.

Table 4. Score of each type of motorcycle and rank them

No.	Di	Rank
A1	3.9332245	5
A2	3.7975074	4
A3	3.7694923	3
A4	3.03685033	2
A5	2.38196607	1
A6	4.08095941	6

Looking at Table 4, the ranking order of motorcycles is as follows: A5 > A4 > A3 > A2 > A1 > A6. Therefore, the Honda Future 125 FI is the best of the six motorcycles that have been reviewed.

V. CONCLUSION

The ranking of the alternatives to determine the best option for motorcycles was first carried out in this study. Two methods including PIPRECIA and FUCA were applied to accomplish that task. Six types of motorcycles were included for consideration in this study: Honda Wave Alpha 110, Honda Blade 110, 2021 Honda Beat CBS, Honda Wave RSX FI 110, Honda Future 125 FI, and Honda Genio (A6). The ranking results of the options have shown that the Honda Future 125 FI is the best choice.

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