Proceedings of Science and Mathematics
Faculty of Science, Universiti Teknologi Malaysia
Vol. 2, 2021, page 186-192

Analysing Criteria Selection of Purchasing A Car by Using Analytic Hierarchy Process

[1]Muhammad Luqmanul Hakim Ahmad Nordin and [2]Wan Rohaizad Wan Ibrahim

[1,2]Department of Mathematical Sciences
Faculty of Science, Universiti Teknologi Malaysia,
81310 Johor Bahru, Johor, Malaysia.

e-mail: [1]luqmanul1998@graduate.utm.my 1, [2]wrohaizad@utm.my

Abstract The purpose of this research is to discuss the purchasing with selection of the best car in details. The main objective of this study is to produce an evaluation on selection of car based on few attributes and to rank the car according to users' preferences. The problem is suitable to be solved by decision-making approach. The method that has been proposed to solve this problem is by applying Analytical Hierarchy Process (AHP). At the end of the study, the result shown that Model 5 is the most preferable car according to all the criteria and sub-criteria of the model.

Keywords Criteria selection of car; Multi-Criteria Decision Making (MCDM); Analytic Hierarchy Process (AHP); Type of car model.

1 Introduction

There are several methods under MCDM which are Analytic Hierarchy Process (AHP), Technique of Order of Preference by Similarity to Ideal Solution (TOPSIS), Elimination and Choice Translating Reality (ELECTRE I), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), The Weighted Product Model (WPM) and others.

Analytic Hierarchy Process (AHP) is one of the best methods to solve the problem and helps people to find the car that fulfil their desired attributes. This method structures the decision problem in a comprehensive and rational framework to represent the overall goals and evaluate alternative solution. AHP also can be applied business organization, analysis, industrial engineering and more.

2 Literature Review

This section will be discussed about the general concept of decision-making process. First and foremost, Multi-Criteria Decision Making (MCDM) would be described. In MCDM, it consists several methods that can be used such as Analytic Hierarchy Process (AHP), Technique of Order of Preference by Similarity to Ideal Solution (TOPSIS), Elimination and Choice Translating Reality (ELECTRE I), Preference Ranking Organization Method for Enrichment of Evaluations

(PROMETHEE) and many more. In this study, our focus is only on AHP method in order to solve the problem.

2.1 Multi-Criteria Decision Making

Multi-Criteria Decision Making has been evolved throughout many years as an active research field and produced many theoretical and applied papers and books. Multi-Criteria Decision Making (MCDM) is an area of operational research in which decision-making alternatives are evaluated with regard to a set of multiple criteria [1]. Besides, MCDM may be defined as a systematic method for the study and selection of alternatives [2]. MCDM is applicable to more than one criterion or attribute that to be optimized simultaneously.

2.2 Car Criteria Selection Problem

Automotive Industries is one of the biggest industries that has been growth massively worldwide. For that reason, the automobile market has to embrace innovation that will provide better customer service as the industry becomes more competitive [3]. As for now, there are so many car companies that manufacture new cars in order to keep their customers loyal to that brand.

As the number of new cars increasing every year, it will affect on customers' decision making. There is a study mentioned that introduction of new models by car makers or modification of existing models with additional features, assisted by discount deals from retailers, loan offers from banks and rising fuel prices, pressure on the consumer when making the decision to buy a new car [4]. Therefore, by taking consideration of MCDM and implying AHP method, it will help buyer to purchase a suitable car by the car criteria selection.

2.3 Analytic Hierarchy Process (AHP)

Analysis Hierarchy Process (AHP) is one of the methods that frequently being used to solve multi-criteria decision problem. This approach is used to solve a complex decision-making problem with many attributes by modelling the unstructured problem under analysis of hierarchical elements [5]. AHP structural hierarchy will show the decision maker to understand what they have to evaluate to achieve their goal. Besides, researchers have studied that AHP has gained popularity due to its simplicity and ease with which it is possible to find very good solutions to serious hierarchical problems, consisting of important criteria and sub-criteria [6].

To determine the decision-making scale, usually we will use the scale range table which contain equally, moderately and extremely important. This table will guide the decision maker to rate their range on each criterion. The value is range from 1 to 9 and the reciprocal value is referred to non-preference value by referred to Saaty's scale.

Table 1: The Saaty's Scale

Intensity of Importance	Definition
1	Equally preferred
2	Equally to moderately preferred
3	Moderately to strongly preferred
4	Moderately to strongly preferred
5	Strongly preferred
6	Strongly to very strongly preferred
7	Very strongly preferred
8	Very to extremely strongly preferred
9	Extremely preferred

3 Methodology

This chapter will discuss about the method used in order to solve the criteria selection of purchasing a car. The algorithms of Analysis Hierarchy Process that will be used to solve the problem in this study will be explained in details.

3.1 Formulation of Model

There are many factors that customers can take into consideration when purchasing a car. The factors include the price of the car, performance of the car such as speed, noise, comfort and fuel tank. Other than that, one might be interested with the safety of the car. The car that is fully equipped with airbags, Anti-lock Braking System, body of the car and impaction rate plays a big role when choosing a car.

Other than that, the economy aspect is one of the reasons to evaluated, which tackles on aspects such as fuel cost, the warranty, equipment for the car and the spare parts. All the criteria will take effect of the price, therefore, AHP is the best method to be use to solve the problem.

3.2 Hierarchical Structure

The hierarchical structure has been constructed according to the criteria and sub-criteria.

3.3 Steps of Analytic Hierarchy Process

Step 1: Develop the structural hierarchy that contain the objective or goal at the top, criteria at the second level and for alternatives at third level.

Step 2: Develop a pair-wise comparison matrix for the criteria. The pair-wise comparison matrix as follows:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix}$$

The diagonal in the matrix A is comparing of the criteria itself and must be equal to one. The value in this pair-wise comparison is using the nine-scale questionnaire.

Step 3: Calculate the degrees for each criterion. Let W_i denotes the importance degree for the ith criterion,

$$w_{i=} \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}, i, j = 1,2, \dots, n.$$

Step 4: Checking the consistency by calculate Consistency Test.

Let C denote as n-dimensional column vector explaining the sum of the weighted values for the importance degrees of the criteria, hence

$$C = [c_i]_{nx1} = A \cdot W^T, i = 1,2, \dots, n.$$

where

$$A \cdot W^T = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{bmatrix}$$

The values of consistency can be written as vector $CV = [cv_i]_{1xn}$ and $cv_i$is defined as

$$cv_i = \frac{c_i}{w_i}, i = 1,2, \dots, n.$$

Then, evaluate the effectiveness of measurements by taking the maximal eigenvalue λ_{max} which can be calculated by

$$\lambda_{max} = \frac{\sum_{i=1}^{n} cv_i}{n}, i = 1,2, \dots, n.$$

Next, to get the Consistency Index (CI), it can be determined by

$$CI = \frac{\lambda_{max} - n}{n - 1}, i = 1,2, \dots, n.$$

where n is the number of criteria being compared. Then, carry on with finding the Consistency Ratio (CR) that can be calculated as

$$CR = \frac{CI}{RI}$$

4 Result and Discussion

4.1 Analytic Hierarchy Process (AHP)

4.1.1 Hierarchical Structure

The hierarchical structure as shown in Figure 1.

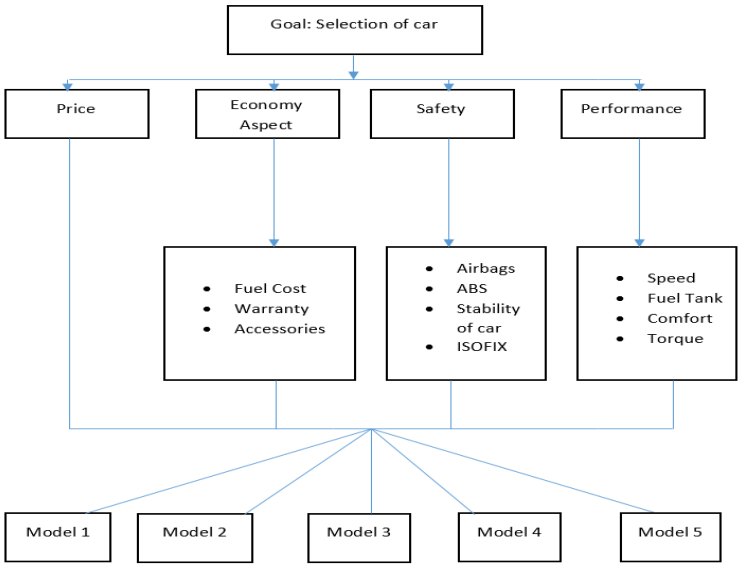

Figure 1The Hierarchical Structure

4.1.2 Development of Pair-Wise Comparison Matrix

Pair-wise comparison matrix will be developed for each of criteria and sub-criteria. The diagonal in the matrix is comparing of the criteria itself and must be equal to one. Table 2 shows the pair-wise comparison of the criteria with selecting car.

Table 2: Pair-wise Comparison Matrix of Selecting Criteria of Car

Criteria	EA	S	P	PR
EA	1.0000	6.0000	4.0000	7.0000
S	0.1667	1.0000	0.3333	2.0000
P	0.2500	3.0000	1.0000	5.0000
PR	0.1429	0.5000	0.2000	1.0000

Repeat the similar step for all the sub-criteria and continue until obtained the results.

4.2 Results and Analysis

4.2.1 Analysis Result of AHP

The calculation of the AHP method in this study is being calculated in Microsoft Excel. Microsoft Excel is one of the applications that can be used in order to solve the problem such as to construct the pair-wise comparison matrix, to find the weights of each criteria and sub-criteria, to determine the consistency and also to obtain the results and analysis. Figure 4.2 shows that the analysis of priority of each criteria and sub-criteria.

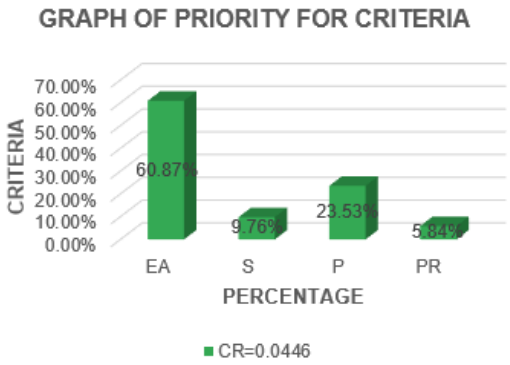

Figure 2: The Priority of Criteria

Figure 2 portrays the analysis of the four criteria which are Price (P), Economy Aspect (EA), Safety (S), and Performance (P). As we can see from the graph, the value of Consistency Ration CR is 0.0446. The highest priority of the criteria is EA with 60.87% and the lowest priority is P with 5.84%. This result shown that most of the people will be considered economy aspect as the first priority before buying a car.

Hence, from the analysis, it is proven that most of the people will choose car Model 5. The sequence of decreasing order for all the model is Model 5, Model 3, Model 4, Model 2 and Model 1.

6 Conclusion and Recommendation

6.1 Conclusion

The results show that out of five model, Model 5 is chosen as the most recommended car according to the criteria and sub-criteria. Next, most of the respondent tend to pick Model 3 as their second option. Model 4 and Model 5 ranked third and fourth respectively. Lastly, model 1 is likely to be the least preferable car because of its lack of quality in the criteria and sub-criteria. AHP method helps decision maker to be more precise identifying what they need and what they want in purchasing a car. The most important thing, decision maker will be able to achieve their goal.

6.2 Recommendation

Multi-Criteria Decision Making (MCDM) has several methods other that Analytic Hierarchy Process (AHP). Therefore, there are many other methods can be used in solving decision making problem, we may use other method such as Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) or Elimination and Choice Translating Reality (ELECTRE) to solve this problem by doing comparison. Other than that, there are lacks of something when respondent filled in the survey because they might be influenced by their friends or environment at that time. Moreover, the other software that can be used to solve AHP problem is Expert Choice 11.0.

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