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## **DECIDING THE BEST VEHICLE ALTERNATIVE BY USING A MULTI CRITERIA DECISION MAKING METHODOLOGY**

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### **Abstract:**

*Multi Criteria Decision Making is one of the main topics for Industrial Engineering which is especially use for decision making and for selection process. Analytic hierarchy process (AHP) is a heuristic methodology developed for analyze and estimate decisions. This methodology is also compare tangible and intangible digitizing criteria with respect to compare their priorities between each other and also it defines order of criteria importance. In this methodology experience and knowledge of decision maker is essential. In this way, it is easy to make subjective decision which has higher qualification. With this methodology, there will be vehicle selection and application for a University which use these vehicles to carry their students from bus station to university. To be able to solve this selection, budget, importance of system and other criteria will take into consideration.*

**Keywords:** Decision Making; AHP; Vehicle Selection.

**Cite This Article:** Muhammet Enes AKPINAR, Muhammet Ensar YİĞİT, Erkan DOĞAN, and Mehmet Ali ÜSTÜNER. (2018). "DECIDING THE BEST VEHICLE ALTERNATIVE BY USING A MULTI CRITERIA DECISION MAKING METHODOLOGY." *International Journal of Engineering Technologies and Management Research*, 5(1), 108-114. DOI: 10.5281/zenodo.1171874.

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### **1. Introduction**

Multi criteria decision making (MCDM) is a tool that allows the selection of the best choice depending on the criteria applied to more than one of the alternative sets [1]. As far as its practical applications are concerned, it has a very rapid development in the field of decision analysis in terms of its theoretical development and it has a wide application area which is accepted by success with its strong logic structure and decision-making success [2]. It can be applied in multi-criteria decision making, selection, sorting and classification problems. The

decisionmakershavedifferentpurposesinthesortofproblemstobesorted.The purpose of the selection problem is to find the best alternative, to rank the worst in the ranking problem, and to separate the alternatives for the purpose in classification there will be a real case application.

Multi-criteria decision-making techniques are used when there are a lot of criteria (variables) in decision-making problems. The number of multi-criteria decision-making techniques is increasing day by day. Some of these techniques; WPM, WSM, ELECTRE, TOPSIS, PROMETHEE, ANP, SAW, VIKOR, DEMATEL, AHP, Gray Relational Analysis etc. The Analytic Hierarchy Process is more suitable for solving decision problems in real life problems, since the AHP does not reflect the human thinking style, although the aim of the AHP is to make decisions by obtaining the knowledge of the experts. Study; an application will be made for the selection of a new vehicle purchase in a system where university students are transported by ring vehicles. Alternatives for ringing in the study were selected as substitution models for MERCEDES, MAN and BMC brands. Taking into consideration the importance levels of these alternatives in terms of the evaluation criteria, the technical characteristics of the university administration will be taken into consideration in terms of the price policy of the university administration and capacity and fuel in terms of facilitating the maximum carriage of students. In the second part of the study, the definition of the problem will be given and in the third part, the application steps will be mentioned. In the fourth section, the results of the study will be transferred [3].

## 2. Problem definition

The problem is generally related to the ring systems that a university uses to carry its students to The university. The distance between the university and the locations used by the students to board the rings is about10km. Students arrive in Ulukentring area with suburban vehicles from IZBAN. The vehicles waiting to arrive here are approximately 12to15minutesaway from the campus area [4].



PIC 1: 1st RINGAREA



PIC 2: 2<sup>nd</sup> RINGAREA

The university plans to solve this problem by having the existing ring capacity and waiting time of the students with the new ring system. The university will purchase a second ring tool provided that it is the same as the ring brands that the university uses.

## 2.1. Elements of Problem

The purpose of the decision problem can be described as purchasing a new ring vehicle. The university management has set three different criteria for the new vehicle.

- Economic Life
- Passenger Capacity
- Vehicle Price

The most important criterion among these properties is undoubtedly the capacity. The maximum student carrying capacity can only be reached this way [4], [5].

- BMC150, 000\$
- MERCEDES 180,000\$
- MAN140, 000\$ calculations have been made.

Chart1. Assessment and selection of buses



Alternative1



Alternative2



Alternative3

### 3. Application Steps

The following steps will first be taken to solve the problem [6], [7], [8].

- Creating a Hierarchical Structure
- Binary Comparison Matrices and Determination of Advantages
- Calculation of eigenvector
- Calculation of Eigenvector Consistency
- Obtaining the Overall Result of Hierarchical Structure

#### 3.1. Creating a Hierarchical Structure

The goals, criteria and alternatives have been identified for the hierarchical structure as mentioned before.

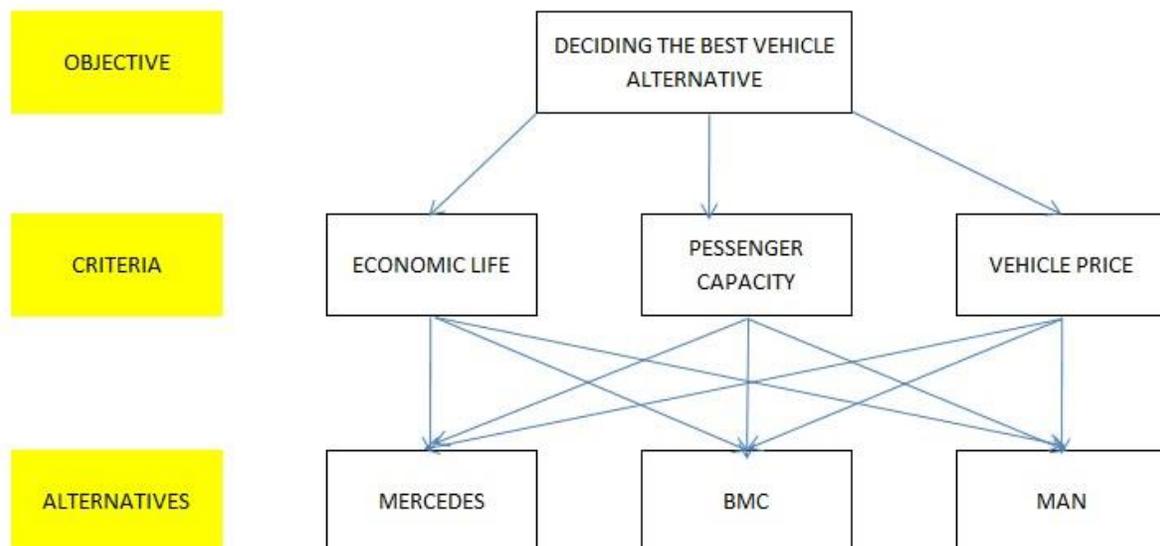


Figure1: Perform Hierarchical Display

As a criterion, the decision maker has determined the capacity, the technical feature and the price for the ring tool. According to the criteria determined for the alternatives, it is considered that one of these brands will be suitable because the vehicles of Mercedes, BMC and Man are also in use now [9], [10].

#### 3.2. Determination of Importance Ratings of Criteria

While determining the importance ratings for the decision maker, the capacity was more prominent than the other criteria. The managers of the last three years plan to reach the students without waiting for the students as soon as possible.

Table 1: Importance Rating Table

	<b>Economic Life</b>	<b>Passenger Capacity</b>	<b>Vehicle Price</b>
Economic Life	1	5	3
Passenger Capacity	1/5	1	1/5
Vehicle Price	1/3	5	1

Table 2: Comparison of Sub-Criteria with Economic Life

<b>ECONOMICLIFE</b>			
	<b>BMC</b>	<b>MERCEDES</b>	<b>MAN</b>
BMC	1	1/5	1/3
MERCEDES	5	1	3
MAN	3	1/3	1

Table 3: Comparison of Sub criteria with Vehicle Price

<b>VEHICLE PRICE</b>			
	<b>BMC</b>	<b>MERCEDES</b>	<b>MAN</b>
BMC	1	5	1/3
MERCEDES	1/5	1	1/7
MAN	3	7	1

Table 4: Comparison of Sub criteria with Passenger Capacity

<b>PASSENGER CAPACITY</b>			
	<b>BMC</b>	<b>MERCEDES</b>	<b>MAN</b>
BMC	1	3	1
MERCEDES	1/3	1	1/3
MAN	1	3	1

### 3.3. Calculations of Consistency Index

Consistency index is calculated using the following formulation.

Table 5: Calculating of Consistency Index

<b>Calculations of Consistency</b>			<b>Weight</b>
0,652	0,455	0,714	0,607
0,130	0,091	0,048	0,090
0,217	0,455	0,238	0,303

All these calculations are calculated separately for the vehicle price and passenger capacity.

Table 6: Consistency Index of Economic Life

<b>ECONOMICLIFE</b>				<b>AVARAGE</b>
	<b>BMC</b>	<b>MERCEDES</b>	<b>MAN</b>	
BMC	0,11	0,13	0,08	0,11
MERCEDES	0,56	0,65	0,69	0,63
MAN	0,33	0,22	0,23	0,26

### 3.4. Calculating Critical Ratio (CR)

Calculation of consistency index, the step in the AHP formulation is applied. Here, the importance grades and averages and matrix multiplications are made for each sub criteria. Then, for each criterion, these calculations are made and the consistency ratios of them are calculated.

$$CI = (3, 11 - 3) / ((3 - 1) * 0, 58) = 0,095$$

$$CI = (3, 09 - 3) / ((3 - 1) * 0, 58) = 0,077$$

$$CI = (3, 06 - 3) / ((3 - 1) * 0, 58) = 0,051$$

### 3.5. Obtaining Hierarchy Over All Result

In the last step, the averages of the prior significance values and the averages of the sub-criteria are calculated, and the average of these values on the general effect is calculated. The product giving the highest value of the multiplied values shows which mark must be selected.

Table7: General Result of Hierarchy

	<b>ECONOMIC LIFE</b>	<b>PESSENGER CAPACITY</b>	<b>VEHICLE PRICE</b>	<b>GENERAL EFFECT</b>
<b>AVARAGE</b>	0,61	0,09	0,3	
<b>BMC</b>	0,11	0,43	0,28	0,1898
<b>MERCEDES</b>	0,63	0,14	0,07	0,4179

## 4. Results and Discussions

A problem has been solved by using the Analytic Hierarchy Process method from many criterion decision making problems that we frequently encounter in our daily life. The problem is that a university chooses the best criteria for ring selection and chooses the most suitable ones according to these criteria.

With the method used, the criteria such as price, technical features and capacity were taken into consideration and the calculations were made in the direction of the demands of the administrators and the data obtained from the importance levels of the sub criteria. From the calculations, the AHP steps regarding the capacity, technical feature and price desired by the manager are applied to the criteria and alternatives, it was made.

In this problem, which is solved in five steps by using the AHP method, BMC, Mercedes and MAN ring vehicles are determined as Mercedes brand vehicle for decision maker.

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