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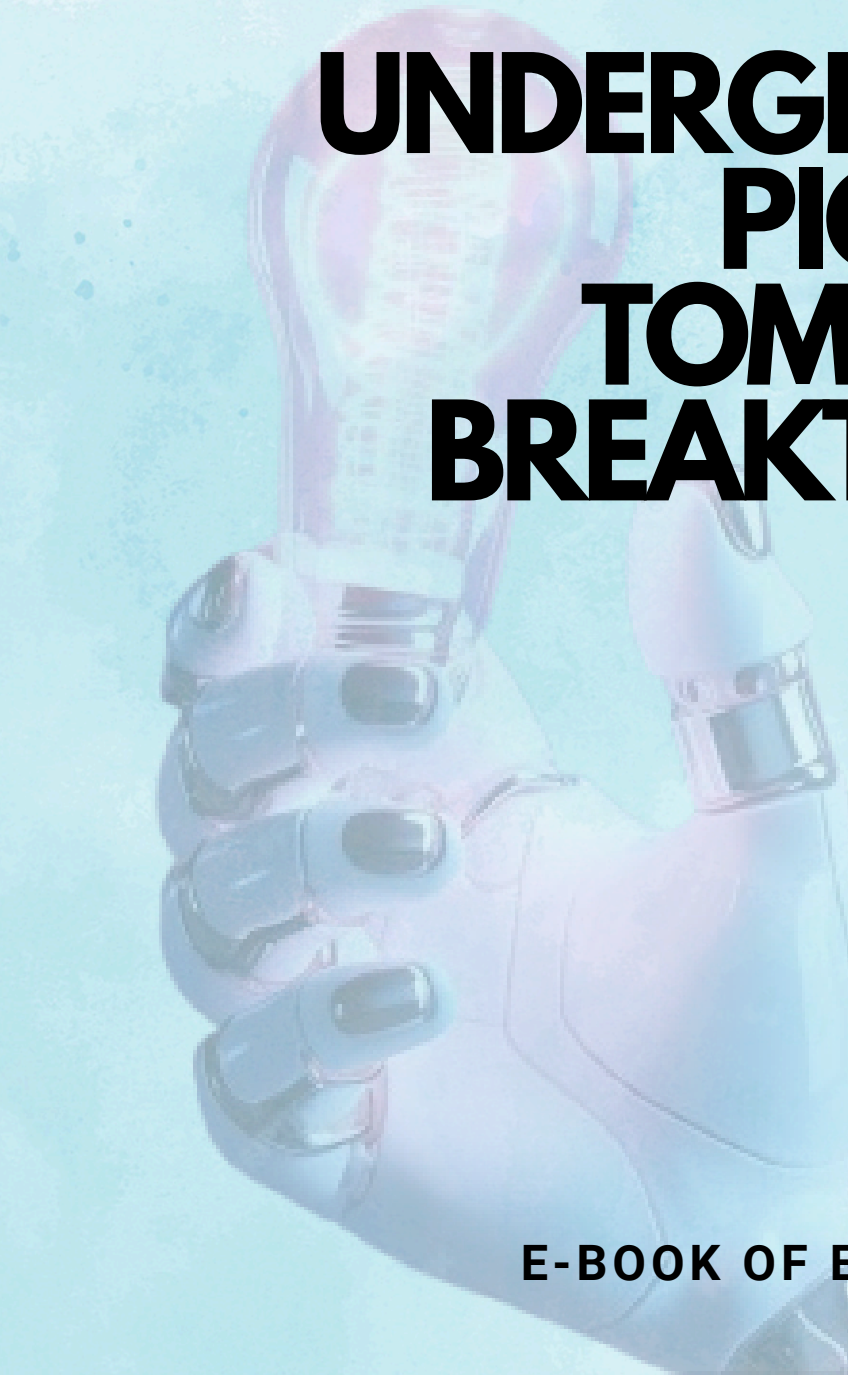

E-BOOK OF EXTENDED ABSTRACTS

COMPACT CAR SELECTION USING ANALYTIC HIERARCHY PROCESS

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ABSTRACT

Malaysian car buyers frequently encounter significant challenges in selecting the optimal compact car, primarily due to the multitude of criteria that demand careful consideration. The effectiveness of this decision-making process hinges critically on the accurate identification and prioritisation of these diverse factors. While Multi-Criteria Decision-Making Methods (MCDM) have been applied in various consumer choice scenarios, no prior research has specifically utilized the Analytic Hierarchy Process (AHP) to address the complex problem of optimal compact car selection. This study bridges this significant methodological gap by proposing and implementing a novel framework for compact car selection using AHP. Key evaluation criteria, including safety, price, fuel efficiency, performance, and brand, were identified as the primary factors influencing buyer preferences. The AHP method, renowned for its ability to structure complex decisions by breaking them down into a hierarchy, was systematically applied to rank four prominent compact car alternatives in the Malaysian market which are Perodua Myvi, Perodua Axia, Proton Iriz, and Honda City Hatchback, based on the established criteria. The findings of this research revealed that the Honda City Hatchback emerged as the most preferred compact car among the evaluated alternatives, demonstrating the robust effectiveness of AHP in solving intricate selection problems within the automotive sector. This pioneering application of AHP provides a valuable, structured approach for consumers and stakeholders in the compact car market. For future research, this AHP framework can be expanded to incorporate additional criteria and a wider range of alternatives, further enhancing its comprehensive decision-making capabilities.

Keywords: Compact car, AHP, Criteria, Alternatives, Multi-Criteria Decision Making, Analytic Hierarchy Process (AHP)

INTRODUCTION

In Malaysia, choosing the right compact car is a significant decision for many people, especially for undergraduates and young graduates (Kowang et al., 2018). However, this choice is difficult due to many similar models available and the need to weigh multiple criteria at once such as price, safety, fuel efficiency and performance (Korhonen et a1., 1992; Luqman et a1., 2015; Abu-Alkeir et al., 2020).

While other Multi Criteria Decision Making (MCDM) methods exist, this study proposes Analytic Hierarchy Process (AHP) by being the first to apply to the specific problem of selecting a compact car brand in Malaysia. The AHP developed by Thomas Saaty in the 1987s, is a powerful tool for making complex decisions. It helps to systematically translate subjective judgments into a quantifiable ranking of alternatives. This study uses the AHP to provide a clear and structured method for consumers to evaluate and select the best compact car brand that aligns with their needs and priorities.

METHODOLOGY

The AHP methodology was applied to determine the most preferred compact car in Malaysia. The methodology involves a clear, step-by-step approach to turn subjective judgments into a quantifiable ranking. First a three-level hierarchical structure was created in which the top level defined the overall goal which is to choose the most preferred compact car. The middle level is five criteria for decision-making which are safety, price, fuel efficiency, performance and brand. These five criteria are considered as the most important criteria as referring to literature. The bottom level listed the four car alternatives being considered are Myvi, Perodua Axia, Proton Iriz and Honda City hatchback. To get expert opinion, a survey was given to eight experts. Using a pairwise comparison method, they were asked to compare each criterion against the others and each car against the others using 1-9 scale to rank their relative importance. The steps in AHP are explained as follows:

Step 1: Construct a pairwise comparison matrix
Then the criterion's scale is calculated using Equation (1), where a is the scale of the first criteria, and b is the scale for the second criteria.

$$P_{ij} = \begin{cases} |a-b|+1 & \text{it is important than y} \\ \dfrac{1}{|a-b|+1} & \text{otherwise} \end{cases} \quad (1)$$

Step 2: Synthesizing the pairwise comparison.
The elements are placed inside the matrix denoted by P according to their degree.

$$P = \begin{bmatrix} 1 & c_{1,2} & \cdots & c_{1,n} \\ \dfrac{1}{c_{1,2}} & \ddots & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \dfrac{1}{c_{1,n}} & \dfrac{1}{c_{2,n}} & \cdots & 1 \end{bmatrix}$$

The normalised elements are denoted as P_j where $P_j = \sum_{i=1}^{n} P_{ij}$ and $v_{ij} = \frac{P_{ij}}{P_j}$. The process of normalisation is repeated for every row and column of the elements and placed in a new matrix as N.

$$N = \begin{bmatrix} v_{11} & \cdots & v_{1n} \\ \vdots & \ddots & \vdots \\ v_{1n} & \cdots & v_{nn} \end{bmatrix}$$

Next, the elements within the normalized matrix are summed between the other elements within the same row and it is divided by the number of elements of the matrix. The purpose of this is to find the criteria's weightage which is denoted by W. Criteria with highest weightage value is the most important criteria.

$$W_i = \frac{1}{n}\left(\sum_{i=1}^{n} v_{ij}\right)$$
$$W = [W_1, W_2, W_3, W_4, W_5] \quad (2)$$

Step 3: Perform the consistency matrix
There is one standard way of testing consistency in AHP, which is by calculating the maximum eigenvalue, The consistency matrix is considered valid if: $PW^T = NW^T$, where P is the pairwise comparison matrix and W is the weight vector. The data is considered logically consistent and reliable if the consistency ratio (CR) is less than 0.1. To find consistency ratio, the maximal latent root is denoted by ρ_{max} as Equation (3),

$$\rho_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{PW_i^T}{W_i}_{max} \quad (3)$$

Consistency indicators, CI by substitutes Equation (4),

$$CI = \frac{\rho_{max} - n}{n-1} \quad (4)$$

The Random Index (RI) is standard value to assess the consistency of judgments in AHP methods. The value of the RI depends on the number of elements being compared, denoted by n. Table 2 shows the standard ratio index.

Table 2: Standard ratio index

n	0	1	2	3	4	5	6	7	8	9	10
RI	0	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

To find the Consistency Ratio (CR), divide the CI by RI as Equation (5). The CR value must be less than 0.1 for the judgments to be considered logically consistent and acceptable.

$$CR = \frac{CI}{RI} \quad (5)$$

Step 4: Step (4-6) are performed for criteria
The construction of pairwise comparison synthesising the pairwise and consistency test are repeated for each criterion.

Step 5: Develop overall priority ranking
The collection of consistency value will be used to develop the overall priority ranking. Weightage of Alternatives:
By using the same pairwise comparison matrix method in order to calculate the weightage of alternatives based on criteria as:

$$\begin{aligned} WA_{c_1} &= \left[WA_{c_{11}}, WA_{c_{12}}, WA_{c_{13}}, WA_{c_{14}}, WA_{c_{15}}\right] \\ &\vdots \\ WA_{c4} &= \left[WA_{c_{41}}, WA_{c_{42}}, WA_{c_{43}}, WA_{c_{44}}, WA_{c_{45}}\right] \end{aligned} \quad (6)$$

The overall priority weight of the alternatives is calculated as:

$$WA_i^T = \sum_{j=1}^{n} W_{c_j} \times WA_{c_i}^T \quad (7)$$

RESULTS AND DISCUSSION

This section presents the findings from the AHP used to determine the most preferred compact car brand. Based on an average pairwise comparison metrices from eight experts, the result shows that Performance was considered the most important criterion, followed by price, fuel efficiency, safety and brand.

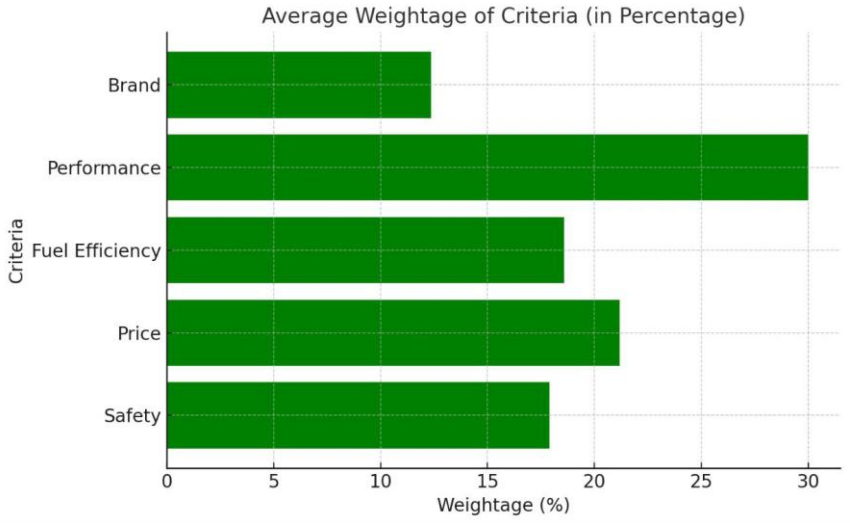

Figure 1: Percentage of Average Weightage of Criteria

Next, each car alternatives were evaluated against these criteria. The overall priority weights were then computed by multiplying the local weight of each car alternatively by the corresponding criterion's weight. The final ranking of the compact cars is presented in Table 3.

Table 3: Final Ranking of Compact Car Alternatives

Alternatives	Average weightage	Rank
Perodua Myvi	0.2436	2
Perodua Axia	0.2387	3
Proton Iriz	0.0853	4
Honda City Hatchback	0.4093	1

Based on Table 3, Honda City Hatchback is the most preferred compact car among the alternatives, with the highest preferences score. This is attributed to its strong performance and favourable ratings across other criteria. The Perodua Myvi and Perodua Axia ranked closely behind, primarily due to their affordability and fuel efficiency, which were highly valued by the experts. In contrast, Proton Iriz was the least preferred option, receiving the lowest score in this study. These findings demonstrate that the AHP is an effective and structured decision-making tool that can assist consumers in making a choice based on multiple criteria. The results also offer valuable insights for car manufacturers and marketers regarding the preferences of Malaysian consumers in the compact car market.

CONCLUSION

This study successfully demonstrates the effectiveness of applying the Analytic Hierarchy Process (AHP) to solve the complex problem of selecting a compact car. While AHP has been used in various fields, this study's key contribution is its pioneering application of this method to the specific preferences of Malaysian consumers in the compact car segment. The final rankings confirmed the model's validity, with the Honda City Hatchback emerging as the most preferred option due to its strong performance and favourable ratings across all criteria. In contrast, the Proton Iriz was identified as the least preferred alternative. The high rankings of the Perodua Myvi and Axia further highlight the importance of affordability and fuel efficiency to consumers. In conclusion, the AHP proved to be an invaluable, structured decision-making tool for consumers facing multi-criteria evaluations. The results also provide car manufacturers and marketers with crucial insights into the key preferences that drive consumer choice in the Malaysian compact car market.

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