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Decision Analysis on the Customer Preferences of Automobiles using AHP-TOPSIS Model

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ABSTRACT

Vehicle registration has surpassed the number of populations in Malaysia in 2021. Automobiles remain the preferred mode of transport with the top brands including Perodua, Proton, and Toyota in Malaysia. The local automotive industry is facing various challenges such as robotics and automation, sustainability, and resource scarcity in the supply chain. Therefore, this paper aims to propose a research framework for studying the consumer preferences of local car models in Malaysia using the integration of Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) models. In the first stage, AHP model is used to determine the weights of main decision criteria and sub-criteria. In the second stage, the weights of the decision alternatives are determined using TOPSIS model. In this study, the main decision criteria include design, convenience, performance, safety and economic aspect. This study shows that safety, economic aspect, and design are the top three main decision criteria in the consumer preferences of local car models. In addition, car price, engine capacity, style and aerodynamic designs are the three most influential sub-criteria affecting consumer preferences of local car models. Besides, Perodua Myvi appears as the most preferred car model based on the highest relative closeness coefficient, followed by Proton Persona, Perodua Bezza, Proton Saga, Perodua Axia and Proton Iriz. This paper contributes by providing insights to local automotive industry to improve based on the top influential criteria affecting car model selection in Malaysia.

1. Introduction

Vehicle ownership has been increasing in recent years especially in the Organisation for Economic Cooperation and Development (OECD) nations [1]. In 2021, the number of vehicles registered has surpassed the number of population in Malaysia [2]. Ton *et al.,* [3] noted that even with high quality and integrated public transport system, cars remain the top preferred mode of transport. According to Government of Malaysia [4], the top car brands in Malaysia are Perodua, Proton, and Toyota with 204,229, 102,800, and 83,086 cars registered in 2023. Based on the data from the Road Transport

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Department (JPJ) database in Malaysia, Perodua Bezza, Perodua Myvi, and Perodua Axia are the top 3 best-selling cars with 56,735, 45,014, and 44,722 cars sold in 2023 [4].

Proton Holdings Berhad was established under the National Car Project in the 1980s as the demand for vehicles soared during that period [5]. Perusahaan Otomobil Kedua Sendirian Berhad (Perodua) was launched in 1992 [6]. The factors that contributed to the development of the two national car brands during that period were fuel subsidies, limited public transportation system beside the Klang Valley, ease of obtaining car loans, and wide coverage of highway networks [5]. Perodua is currently the most preferred car brand in Malaysia with 40% market share [6]. The automotive industry, particularly the manufacturing of national cars, has great significance to the economic development of Malaysia as the automotive industry contributes significantly to the gross domestic product (GDP) and international trade [7]. However, the local automotive industry is facing several challenges such as automation and digitalization, sustainability, and supply chain disruption in automative spare parts [8–11]. Therefore, this paper intends to study the customer preferences on car models in Malaysia. This paper also intends to find out the most important factors and sub-factors that affect customer preferences in selecting a local car model in Malaysia.

Choudhury [12] performed a systematic literature review on car selection factors in India and found that fuel, economical value, car colour, safety features, engine efficiency, comfort, exterior look, interior design, and car models are the important factors in car selection. Jannah *et al.,* [6] studied the customer satisfaction of Perodua using regression analysis and found that vehicle appearance, standing charge, and resale value had significant relationships with customer satisfaction. Zakaria *et al.,* [13] compared the brand loyalty between Perodua and Proton car owners in Kota Bharu, Kelantan using statistical analysis and concluded that satisfaction, price, quality, and equity portrayed strong relationships with loyalty. Soza-Parra and Cats [14] conducted a review on the personal motives for car ownership and inferred that affective, symbolic, environmental factors, and social norms affect car ownership decisions. Melhem [15] analyzed customer satisfaction of Proton and suggested that Proton should address various interior and exterior issues in cars. Byun [16] analyzed car purchase decisions in Korea and found that warranty, fittings, and style are the top 3 sub-factors impacting car purchase decisions. Dasgupta *et al.,* [17] performed a sentiment analysis to studying car purchasing behavior during post-pandemic.

Given that the automotive industry is dynamic and baffled with issues of automation and sustainability such as safety assist, reduced carbon emissions, and lightweight construction, this paper contributes to help the automotive industry understand customers' demands and needs when purchasing and selecting a car [18]. Car selection is a multi-criteria decision making (MCDM) problem since the decision analysis involves various decision alternatives by considering multiple decision criteria. This paper aims to propose a research framework for studying the consumer preferences of local car models in Malaysia using the integration of Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) models. This paper provides insights to Proton and Perodua so that they can identify and improve the critical factors to maintain and increase their market shares. Since the numbers of car brands and models around the world, including Malaysia, are also increasing, this paper can help car designers and producers to enhance the car features and promote their brands to sustain in this competitive industry [19]. This paper also contributes to the academic field because this paper is the pioneer in proposing the conceptual framework to analyze customer preferences when selecting a local car in Malaysia using AHP-TOPSIS model.

2. Literature Review

Design is an important exterior feature of a car which affects customer preferences [16]. Customer expectations and demands normally lead to design improvements [20]. Wang and Chen [21] noted that car design is fundamental in building car brand value when cars are recognizable from afar. Distinguishable features or traits likely form the core values of a brand and brand identity [22]. Even though aesthetic features such as shape, colour, texture, style, length, and decorations such as coachline affect a car's overall design, car designers need to consider aerodynamic abilities [23,24].

Convenience refers to ease of usage which could impact consumer preferences in purchasing cars [25]. Shamsuddin *et al.,* [26] found that ergonomics design of car boots affect the convenience and experience of users while loading and unloading in Proton and Perodua cars. The infotainment services such as entertainment, connectivity, and audio systems offer opportunities in increasing convenience of car usage [27]. Interior length, width, seat posture, thermal control in the passenger compartments can also affect the passenger experience [28–30].

Meanwhile, the performance of cars is also a crucial factor that will affect customer preference in selecting a car [31]. Engines, which are normally controlled by the electronic control unit (ECU), can affect the power performance of a car [32]. Engine torque can also affect ride comfort [33]. Fuel consumption is also an important consideration because fuel consumption is determined by the car engine condition [34]. Increasing fuel efficiency can also contribute to environmental sustainability by reducing reliance on fossil fuels and carbon emissions [35,36]. Fuel efficiency can also be related to low cost per distance travelled [37].

Safety is another important criterion affecting car selection decisions. Palmås [38] noted that the design of car safety features began in the 1950s when vehicle ownership and engine capacity increased which caused a spike in traffic accidents. In the present world, safety feature is more than just having brakes, driving indicators, and door locks [38]. Based on Kaushal [31], consumers have higher tendency of purchasing cars with enhanced safety and security features even though the prices are higher. Connected and automated vehicles can also provide better detection and protection of car owners and road users [39].

Consumer preference is also based on economic aspects [31]. Price has psychological motivation towards purchasing intention of a car [40]. Tan *et al.,* [40] found that price had a significant relationship with purchase intention of cars. Zhang *et al.,* [41] also noted that fuel price and consumption could significantly affect car purchase intention in the post pandemic period. Car insurance cost can also impact consumer preference as the engine capacity often determines the cost of insurance of a car [42]. Since car insurance is a requirement in several countries including Malaysia, it often adds economic pressure on car ownership [43].

The car selection problem has been studied using MCDM models such as AHP. MCDM model is a tool which solves decision problems by prioritizing the decision alternatives based on multiple decision criteria [44-48]. Byun [16] studied the automobile purchase model selection with AHP model. The main criteria involved exterior, convenience, performance, safety, economic, dealership, and warranty. Under exterior, the sub-criteria were model, design, length, decorations, colours, and instrument cluster. Under convenience, the sub-criteria included interior width, loading, operating, fittings, visibility, and entertainment. The sub-criteria under performance included torque, speed, fuel capacity, braking system, cornering, noise, and comfort. Under safety, the sub-criteria included airbags, anti-braking system, impact, trunk, seat belt, body, and alarm system. Under economic, the sub-criteria were price, fuel, insurance, resale value, and equipment. The sub-criteria under dealership included visit, attitude, expertise, and belief. Service station, spare parts, satisfaction, and repair time are the sub-criteria under warranty. The study showed that safety, performance, economic, and exterior were important criteria of a car which affected customer preferences. Satisfaction, fittings, and designs were the top three sub-criteria.

Sakthivel *et al.,* [24] evaluated the automobile purchase model using MCDM models such as AHP and Preference Ranking Organization METHod for Enrichment Evaluation (PROMETHEE). The main criteria investigated were safety, performance, economic, exterior, dealer, convenience, warranty, and emission. The research findings showed that design and performance were important decision criteria in the selection of automobile model. Chand and Avikal [49] investigated the car selection problem in India by considering multiple criteria such as cost, brand, designs, after sales services, and fuel consumption using AHP model. This study found that brand, fuel consumption, and cost are the top three criteria affecting car selection in India. Maruti Alto K-10 (VXI AGS) was the most preferred car in the study. Roy *et al.,* [50] studied the selection of best car models using hybrid MCDM model such as AHP and PROMETHEE II models. This study used three criteria for analysis, including cost, safety, and look. Toyota emerged as the most efficient car in this study.

Turoń [51] used ELECTRE III method to select car models for car-sharing services in Poland in 2022. This study considered criteria such as rental cost, engine power, energy or fuel consumption, time for charging or refuelling, boot capacity, number of car doors, car length, European New Car Assessment Program (Euro NCAP), safety equipment, and warranty to assess 12 car variants in car segments A to D. Based on the analysis, the most important criteria were engine power, boot capacity, and rental cost. Trung *et al.,* [52] studied car selection in Vietnam using MCDM model including *R* and collaborative unbiased rank list integration (CURLI) in 2022. The twelve criteria used were cost, fuel consumption, ground clearance, weight, airbags, air conditioning, car length, car width, car height, wheelbase, multimedia system, and sunroof. This study placed cost, fuel consumption, and ground clearance as the three most important criteria. Honda City was the most optimal solution based on the results of this study.

Besides MCDM, linear regression analysis has also been done by Phuong *et al.,* [53] to explore the factors affecting the purchasing intention of cars in Ho Chi Minh, Vietnam in 2020. The eight factors studied were safety and security, quality, performance, value, income, technology, socio-cultural, and brand. The results found that brand, quality, and technology were the three contributing factors towards the purchasing intention of cars in Ho Chi Minh. Prabowol *et al.,* [54] developed a car recommendation system based on consumers' interests using collaborative filtering in 2019. This paper adopted eight parameters including brand, price, colour, transmission, engine capacity, seating capacity, fuel type, and car price. This recommendation system received high satisfaction rating from consumers which showed that these parameters were suitable criteria in evaluating consumer preferences. Scorrano *et al.,* [55] studied car choice determinants in Italy and Norway in 2023. The factors included powertrain, car segments, socio-economic characteristics, vehicle price, fuel or energy cost, and driving range. Bhuyan and Sultana [56] studied car brand selection criteria in Kamrup, Assam, India in 2024. The factors included brand image, model, price, speed, mileage and fuel efficiency, colour, car class, maintenance fees, advertisements, past experiences, resale values, interior features, after sales services, comfort, and technical specifications.

The integration of AHP-TOPSIS highlights the strengths of the respective models in which AHP offers a structured technique to determine the criteria weights while TOPSIS is simple yet reliable to complement AHP to obtain the optimum solution for the alternatives [57]. Arslan *et al.,* [58] mentioned that the precise scale of AHP can help to improve the result of TOPSIS, which helps enhance decision making [59]. According to our best understanding, there has been no study done on the customer preferences of local car models in Malaysia using the hybrid AHP-TOPSIS model. Therefore, this paper aims to propose a research framework for evaluating the consumer preferences of local car models in Malaysia using AHP-TOPSIS model. AHP-TOPSIS is a hybrid MCDM model which focuses on the pairwise comparison as well as proximity to the best ideal solution and worst ideal solution [60, 61]. AHP-TOPSIS model has been employed in various fields such as shopping mall site [60], wind turbines [61], medicine [62,63], energy [64], mobile [65] renewable energy systems [66], agricultural risk management [67], supplier selection [68], E-learning [69], key organizational capabilities [70], software development [71,72], web application [73], water treatment [74-76], flood hazards [77], course programmes [78], material [79,80], fast food restaurants [81] and low-carbon energy technology policy [82].

3. Methodology

The main objective of this paper is to propose a research framework for evaluating the customer preferences of local car models in Malaysia using AHP-TOPSIS model that consists of two stages. In the first stage (step 1 to 5), AHP model is used to determine the weights of main decision criteria and sub-criteria. In the second stage, the weights of the decision alternatives are determined using TOPSIS model (step 6 to 9) [83-89].

Step 1: Identification of main objective, main criteria, sub-criteria, and decision alternatives in a hierarchy structure. The proposed research framework is displayed in Table 1.

Table 1
Proposed research framework

Main objective - To study customer preferences on local car models	
Main Criteria	Sub-Criteria
1. Design	a. Style and aerodynamic designs
	b. Exterior length and width
	c. Decorations
	d. Colour
	e. Dashboard designs
2. Convenience	a. Interior length and width
	b. Ease of loading and unloading
	c. Operational dashboard and touchscreens
	d. Fittings
	e. 360-degree visibility
	f. Infotainment system
3. Performance	a. Engine capacity
	b. Fuel consumption
	c. Automotive noise, vibration, and harshness (NVH)
	d. Comfort
4. Safety	a. Airbags
	b. Anti-lock braking system (ABS) and vehicle stability control (VSC)
	c. Emergency trunk release
	d. ISOFIX seat belts and warning light
	e. Strong chassis, anti-collision bar, and body structure
	f. Anti-theft system
5. Economic	a. Car price
	b. Fuel
	c. Insurance cover
	d. Warranty and spare parts

Decision Alternatives:
1. Perodua Myvi
2. Perodua Axia
3. Perodua Bezza
4. Proton Saga
5. Proton Persona
6. Proton Iriz

Based on Table 1, the objective of study, which is to study the consumer preference of local car models, is in the top level of the hierarchy. In the second level, there are five main criteria, including design, convenience, performance, safety, and economic. The sub-criteria are in the third level of the hierarchy. The sub-criteria under design are style and aerodynamic design, exterior length and width, decorations, colours, and dashboard designs. Under convenience, there are interior length and width, ease of loading and unloading, operational dashboards and touchscreens, fittings, 360-degree visibility, and infotainment system. The sub-criteria under performance are engine capacity, fuel consumption, NVH, and comfort. Airbags, ABS and VSC, emergency trunk release, ISOFIX seatbelts and warning light, strong chassis, anti-collision bar, and body structure, and anti-theft system are under safety. The sub-criteria under economic aspects include car price, fuel, insurance cover, warranty and spare parts.

Step 2: Data collection using questionnaires to the target respondents. The number of respondents is 150 in this study [88,89]. The questionnaire adopts Saaty scale [90] which is shown in Table 2.

Table 2
Saaty's scale

Scale	Explanation
1	Equal preference
3	Moderate preference
5	Strong preference
7	Very strong preference
9	Extreme preference
2,4,6,8	Intermediates

Step 3: Formation of pair-wise comparison matrices with the main and sub-criteria as in Eq. (1).

$$\begin{bmatrix} 1 & c_{12} & \cdots & \cdots & c_{1n} \\ 1/c_{12} & 1 & \cdots & \vdots & c_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \vdots & \vdots & \cdots & \ddots & \vdots \\ 1/c_{1n} & \cdots & \cdots & \cdots & 1 \end{bmatrix} \tag{1}$$

where c_{ij} shows the degree of preference of criterion i to criterion j.

Step 4: Determination of the weights of the main decision criteria and sub-criteria. Normalization is carried out in the pair-wise comparison matrices. Then, the average of each row of the normalized matrices represents the weights of the main and sub-criteria.

Step 5: Checking the reliability of the results using the consistency ratio. The result is reliable if the consistency ratio does not exceed 0.10 [90] in Eq. (2).

$$CR = \frac{CI}{RI} \tag{2}$$

Where, CR denotes consistency ratio, CI denotes consistency index, RI denotes random index in Eq. (3).

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{3}$$

Where, λ_{max} is the largest eigenvalue, n is the number of criteria.

Table 3 shows the RI values with regards to the number of decision criteria [91].

Table 3
Random index

Number of decision criteria	Random index
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24

Step 6: Determination of the normalized matrices of the sub-criteria. The weights of the sub-criteria are calculated in step 4 using AHP model.

Step 7: Determination of the geometric distance between the decision alternatives and the best and worst ideal solutions respectively.

$$A_y^+ = \{\max(a_{xy})\ if\ y \in Y; \min(a_{xy})\ if\ y \in Y'\} \tag{4}$$

$$A_y^- = \{\min(a_{xy})\ if\ y \in Y; \max(a_{xy})\ if\ y \in Y'\} \tag{5}$$

$$S^+ = \sqrt{\sum_{y=1}^{k} (a_{xy} - A_y^+)^2}\,, y = 1,2,3, \dots, k \tag{6}$$

$$S^- = \sqrt{\sum_{y=1}^{k} (a_{xy} - A_y^-)^2}\,, y = 1,2,3, \dots, k \tag{7}$$

Where, A_y^+ denotes the best ideal solution, A_y^- denotes the worst ideal solution, S^+ denotes the geometric distance between the decision alternatives and A_y^+ whereas S^- denotes the geometric distance between the decision alternatives and A_y^-.

Step 8: Determination of the relative closeness coefficient (C_x). The relative closeness coefficient has a value of 0 to 1.

$$C_x = \frac{S^-}{S^+ + S^-},\ x = 1,2,3, \dots, h \tag{8}$$

Step 9: Ranking of the decision alternatives with regards to the relative closeness coefficient. The greater the relative closeness coefficient, the higher the ranking of the decision alternatives.

3. Results and Discussion

This section shows the results of the consumer preferences of local car models using AHP-TOPSIS model. Table 4 presents the weights of the main criteria. Based on Table 4, safety is the most import main criteria with a weight of 0.2254 [92]. Kassim *et al.,* [93] noted that car safety is important in Malaysia. The authorities set the lowest safety standards through the Vehicle Type Approval (VTA) processes and ASEAN New Car Assessment Program (NCAP) since Malaysia is in the World Forum for Harmonization of Vehicle Regulations. Nickkar *et al.,* [94] found that consumers are also willing to pay for cars with safety features such as 360-degree monitoring and collision avoidance systems. Jamil and Aminuddin [95] also concluded that safety was the top priority when selecting eco-friendly cars in Malaysia. Ng and Yazdanifard [96] also highlighted the importance of safety in urban car purchasing behaviors. Based on Maslow's hierarchy of needs, safety is one of the top priorities as consumers normally seek for products with greater protection and stability [97]. Moreover, according to the theory of perceived risk, consumers tend to evaluate product risks and uncertainties while making a purchase [98,99].

Table 4
Weights of main criteria

Main Criteria	Weights	Ranks
Design	0.1985	3
Convenience	0.1813	5
Performance	0.1847	4
Safety	0.2254	1
Economic	0.2101	2

Besides that, the economic aspect of a car is the second most important criteria affecting consumer preferences with a weight of 0.2101. This is also in accordance with Ng and Yazdanifard [96] where safety and economic aspect were the top 2 most important criteria in urban car selection. Supriyanto *et al.,* [97] found that economic aspect especially price has a significant relationship with car purchase decision. Fujita *et al.,* [98] also noted that consumers in the United States placed price and safety as the top 2 important criteria when considering a car. Based on the theory of planned behavior, consumers are driven by perceived behavioral control which include considering the affordability and price value of their purchase decisions [99-101]. Table 5 displays the local weights of the sub-criteria with regards to the respective main criteria.

Table 5
Local weights of sub-criteria

Main Criteria	Sub-Criteria	Weights	Ranks
Design	Style and aerodynamic designs	0.2831	1
	Exterior length and width	0.1799	4
	Decorations	0.1867	3
	Colour	0.1929	2
	Dashboard designs	0.1574	5
Convenience	Interior length and width	0.2184	1
	Ease of loading and unloading	0.1738	2
	Operational dashboard and touchscreens	0.1595	5
	Fittings	0.1613	4
	360-degree visibility	0.1659	3
	Infotainment system	0.1212	6

Performance	Engine capacity	0.3243	1
	Fuel consumption	0.2221	3
	Automotive noise, vibration, and harshness (NVH)	0.2081	4
	Comfort	0.2455	2
Safety	Airbags	0.2177	1
	Anti-lock braking system (ABS) and vehicle stability control (VSC)	0.2038	2
	Emergency trunk release	0.1463	4
	ISOFIX seat belts and warning light	0.1834	3
	Strong chassis, anti-collision bar, and body structure	0.1313	5
	Anti-theft system	0.1174	6
Economic	Car price	0.3277	1
	Fuel	0.2466	2
	Insurance cover	0.2429	3
	Warranty and spare parts	0.1828	4

Based on Table 5, the sub-criteria of style and aerodynamic designs (0.2831) is the most importance factor affecting consumer preferences under design, followed by colour (0.1929), decorations (0.1867), exterior length and width (0.1799), and dashboard designs (0.1574). Among the sub-criteria for convenience, interior length and width (0.2184) is the most important sub-criterion, followed by ease of loading and unloading (0.1738), 360-degree visibility (0.1659), fittings (0.1613), operational dashboard and touchscreens (0.1595), and infotainment system (0.1212). Under performance, engine capacity (0.3243) is the most important sub-criterion, followed by comfort (0.2455), fuel consumption (0.2221), and NVH (0.2081). Under safety, the most important sub-criterion is airbags (0.2177), followed by ABS and VSC (0.2038), ISOFIX seatbelts and warning light (0.1834), emergency trunk release (0.1463), strong chassis, anti-collision bar, and body structure (0.1313), and anti-theft system (0.1174). Under economic aspects, car price (0.3277) is the most important sub-criterion, followed by fuel (0.2466), insurance cover (0.2429), and warranty and spare parts (0.1828).

Table 6 shows the global weights of the sub-criteria. The top 5 sub-criteria are car price (0.0689), engine capacity (0.0599), style and aerodynamic designs (0.0562), fuel (0.0518), insurance cover (0.0510). Most of the important sub-criteria are under the economic factor. This is also in line with the price sensitivity theory as prices such as price, fuel, and insurance cover affect the consumer acceptance of a vehicle [102]. Consumers' price sensitivity has increased as they prefer to have better prices during the entire vehicle ownership period [102,103].

Table 6
Global weights of sub-criteria

Main Criteria	Sub-Criteria	Weights	Ranks
Design	Style and aerodynamic designs	0.0562	3
	Exterior length and width	0.0357	16
	Decorations	0.0371	15
	Colour	0.0383	14
	Dashboard designs	0.0312	19
Convenience	Interior length and width	0.0396	11
	Ease of loading and unloading	0.0315	18
	Operational dashboard and touchscreens	0.0289	23
	Fittings	0.0293	22
	360-degree visibility	0.0301	20
	Infotainment system	0.0220	25

Performance	Engine capacity	0.0599	2
	Fuel consumption	0.0410	10
	Automotive noise, vibration, and harshness (NVH)	0.0384	12
	Comfort	0.0453	8
Safety	Airbags	0.0491	6
	Anti-lock braking system (ABS) and vehicle stability control (VSC)	0.0459	7
	Emergency trunk release	0.0330	17
	ISOFIX seat belts and warning light	0.0413	9
	Strong chassis, anti-collision bar, and body structure	0.0296	21
	Anti-theft system	0.0265	24
Economic	Car price	0.0689	1
	Fuel	0.0518	4
	Insurance cover	0.0510	5
	Warranty and spare parts	0.0384	12

Figures 1 and 2 present the local car models' distance from the best ideal solution and worst ideal solution respectively.

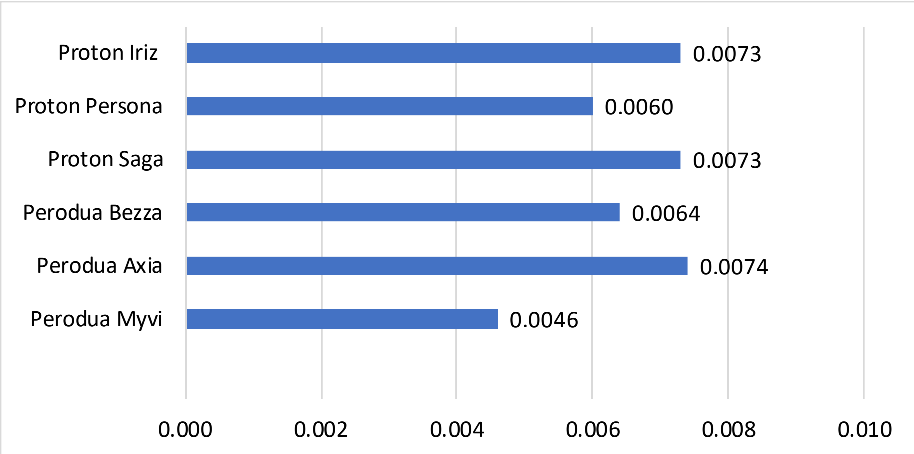

Fig. 1. Local car model's distance from the best ideal solution

As shown in Figure 1, Perodua Myvi gives the shortest distance from the best ideal solution. Therefore, Perodua Myvi is the closest to the best ideal solution, followed by Proton Persona and Perodua Bezza. Proton Iriz and Proton Saga give the same distance from the best ideal solution. Perodua Axia has the largest distance from the best ideal solution among the local car models.

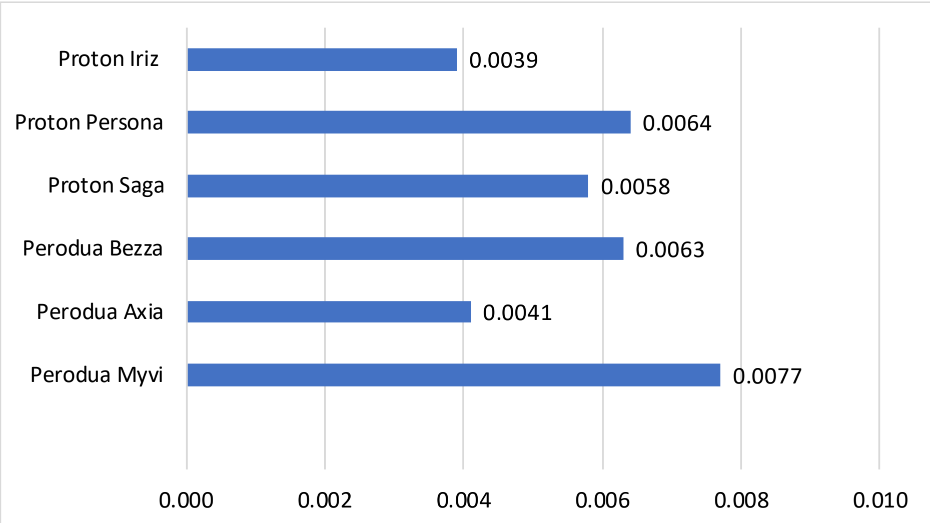

Fig. 2. Local car model's distance from the worst ideal solution

Based on Figure 2, Perodua Myvi gives the longest distance from the worst ideal solution. Therefore, Perodua Myvi is the farthest from the worst ideal solution, followed by Proton Persona, Perodua Bezza, Proton Saga, Perodua Axia and Proton Iriz.

Based on the local car model's distance from the best ideal solution as well as the worst ideal solution, the relative closeness coefficients and ranking of the local car models are determined and presented in Table 7.

Table 7
Ranking of local car models

Local Car Models	Relative Closeness Coefficient	Ranks
Perodua Myvi	0.6270	1
Perodua Axia	0.3565	5
Perodua Bezza	0.4958	3
Proton Saga	0.4411	4
Proton Persona	0.5169	2
Proton Iriz	0.3475	6

Based on Table 7, Perodua Myvi has the highest relative closeness coefficient (0.6270) because of the shortest distance with the best ideal solution (0.0046) and farthest distance to the worst ideal solution (0.0077). Therefore, Perodua Myvi is identified as the most preferred car model based on the main and sub-criteria. Proton Persona has a relative closeness coefficient of 0.5169 and is the second most preferred car model, followed by Perodua Bezza (0.4958), Proton Saga (0.4411), and Perodua Axia (0.3565). Proton Iriz is ranked last with the lowest relative closeness coefficient (0.3475) because of the closest distance to the worst ideal solution. Table 8 shows the information on the consistency ratio.

Table 8
Consistency ratio

λ_{max}	n	CI	RI	CR
5.0413	5	0.0103	1.12	0.0092

Based on Table 8, since the consistency ratio is 0.0092 or 0.92%, the results of this study is reliable [104].

There are several recommendations which can be highlighted in this study. Even though Perodua Myvi has the best overall score for consumer preferences, Perodua has to maintain the production quality and offer consistent quality control to maintain the performance of Perodua Myvi. Consistent quality control can be done by testing all the mechanical components such as suspensions and braking system. Perodua can also perform crash test to ensure greatest safety standards in Perodua's testing center by adopting sophisticated computer programs. Automated quality control systems can also be introduced in the production and assembly facilities to detect and overcome shortcomings. Perodua should also keep up with providing sleek and stylish designs for Perodua Myvi without compromising on price and comfort. Vehicle designs should also match with vehicle safety. Perodua can incorporate the use of virtual reality in their upcoming prototypes to test the designs and features of the future facelift or new model vehicles in detail so that the designers can visualize and modify the prototypes with greater precision. At the same time, Proton can consider enhancing its economic aspects for Proton Persona, particularly on car price and fuel. Proton can also use advanced composite materials to reduce the weight of the vehicles. Fuel consumption can be lowered as weight of the vehicle decreases. Eco modes can also be used to optimize fuel consumption by adjusting the engine performance. Perodua can also enhance its trunk design by adding the emergency trunk release feature for Perodua Bezza. Proton can also enhance the safety features of Proton Saga especially in terms of chassis, anti-collision bar, and body structure by reinforcing driver and passenger compartments and by adopting high strength steels.

4. Conclusions

This study adopts five main criteria which are design, convenience, performance, safety, and economic to study consumer preferences of local car models in Malaysia using AHP-TOPSIS model. This study has successfully identified the main and sub-criteria affecting consumer preferences of local car models. Safety, economic, and design are the three most important main criteria. Style and aerodynamic designs, interior length and width, engine capacity, airbags, and car price are the top concerns with regards to design, convenience, performance, safety, and economic. Above all, car price is the most important sub-criteria on consumer preferences of local car models in Malaysia. This study has successfully adopted the AHP model to compute the weights of the main and sub-criteria for consumer preferences of local car models in Malaysia and utilized the TOPSIS model to evaluate the local car models. Future study can focus on the consumer preferences of electric vehicles (EV) in Malaysia to understand consumers' concerns in purchasing greener vehicles for the better tomorrow.

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