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USE OF THE TOPSIS METHOD IN CONSUMERS' LUXURY ELECTRIC VEHICLE PURCHASING DECISIONS*

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Abstract

Research background: The increasing variety of electric vehicles affects users' electric vehicle purchasing preferences.
Purpose: The aim of this study is to determine the importance levels of the factors that affect consumer decisions in purchasing electric vehicles whose prices are above a certain lower limit and to rank the vehicles with the highest score.
Research methodology: TOPSIS Method, one of the multi-criteria decision-making methods, was used in the study. In the study, six different selection criteria were determined: Range (km), Charging time (min), Price (euro), Acceleration (0–100 km/h acceleration), Torque (Nm), and Power (hp). These data were obtained from the information shared by the brands on their websites, using secondary data sources. User selection was achieved by determining a lower level in the price criterion in brand and model elimination. In the implementation of the study, vehicles with a lower price limit of over 5 million lira were taken into consideration. Four different brands that meet these criteria and are currently on sale in the Türkiye market have been identified. The models evaluated among these brands are the Mercedes EQS, Porsche Taycan, BMW iX, BMW i7, and Audi E-Tron.
Results: In the selection made using the TOPSIS Method, the Mercedes EQS is in the first place in the automobile ranking, BMW iX is in the second place, BMW i7 is in the third place, Audi E-Tron is in the fourth place and Porsche Taycan is in the last place.
Novelty: The difference of this study from other studies is that luxury electric vehicles are included in the sample for the first time. In addition, charging times, torque and acceleration values have only been

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included in studies recently. Because in previous studies, criteria such as price, range and power were studied with different models and different classes of vehicles.

Keywords: Consumers' Purchasing Decisions, Topsis, Electric Vehicle, Marketing, Selection Criteria

JEL classification: C1, M30, M31, M39

Introduction

Increasing studies on sustainability and the support of the United Nations' sustainability reports and 2030 targets on a more global basis by consumers, producers, independent organizations, states, local governments, non-profit organizations, in short, all individuals, institutions and organizations have radically changed their purchasing preferences. Consumers who previously had concerns about electric vehicles' suitability for use, apart from being an environmentally friendly consumer product, have also witnessed that the demand for electric vehicles has increased rapidly, as innovators who purchase electric vehicles have witnessed the environmental, financial, social, and legal benefits they can achieve. Of course, many brands and models of vehicles that appeal to different target groups have taken their place in the world markets.

Likewise, the number of electric vehicles is increasing rapidly in the Türkiye market. According to data, the increase in the last year is expressed as 130 percent (Anadolu Agency, 2025). Thus, the number of electric vehicles in Türkiye reached 183,776 according to the data of the Turkish Statistical Institute announced on January 24, 2025, with the effect of TOGG produced in Türkiye entering the market (TUIK, 2025). The number of registered cars by fuel type between 2020 and 2024 is shown in Table 1.

Table 1. Number of Registered Cars by Fuel Type

Years	Gasoline	Diesel	LPG	Hybrid	Electric	Unknown
2020	3,201.894	5,014.356	4,810.018	33,690	2,797	36,286
2021	3,495.172	5,158.803	4,923.275	86,682	6,267	35,866
2022	3,817.104	5,261.876	5,005.563	134,662	14,552	35,595
2023	4,362.975	5,425.652	5,094.751	222,328	80,043	35,385
2024	4,908.203	5,541.441	5,172.471	391,296	183,776	35,271

Source: TUIK (2025). Erişim Tarihi: 24.01.2025.

There are a number of criteria that customers consider when choosing electric vehicles. These are; full charging time, fast charging time (Dwivedi, Sharma, 2023; Ziemba, 2020; Çoşkun, 2022), power, range, price, (Dwivedi, Sharma, 2023; Gavcar, Kara, 2020; Ziemba, 2020; Ballı et al., 2007; Çoşkun, 2022; Štilić, et al., 2022; Kaczyńska et al., 2023), security (Ziemba, 2020; Ballı et al., 2007; Güleryüz, Çokyaşar, 2021; Abdulvahitoğlu et al., 2022), luggage volume (Dwivedi, Sharma, 2023; Kaczyńska et al., 2023; Bošković et al., 2023), second-hand price, maintenance cost, MTV fee and degree of affection (Güleryüz, Çokyaşar, 2021), influence of sellers, service and promotion policies, post-purchase use, maintenance/repair status, spare parts availability, usage comparison (Abdulvahitoğlu et al., 2022), torque, horsepower and acceleration (Kaczyńska et al., 2023; Çoşkun, 2022).

Nowadays, where luxury is seen as a prestige, when we look at the vehicle purchasing preferences of consumers who have economic freedom, that is, those who are above a certain financial level, it is seen that they prefer vehicles with very high prices and the latest features. In particular, innovative consumers have purchased electric vehicles from the moment they entered the market, as they act with the mindset of being a pioneer and set out with an environmentally friendly perspective. As for 'why' a limitation was introduced in the context of electric luxury vehicles in this study, different studies have of course made rankings according to the classes of electric vehicles, but the target markets of consumers with a passion for luxury have been ignored. On the other hand, luxury electric vehicles with internal combustion engines are sold for two to three times the price. This difference arises from the taxation system applied in Türkiye. To give an example, the price of the EQS internal combustion engine S 450 model, whose current price is 8,018 thousand TL (SCT 60%), is 18,384 thousand TL (SCT 220%). The hardware features of these vehicles are almost in the same class. This is the most important reason for choosing an electric luxury vehicle. In addition, being environmentally friendly, innovative, equipped with smart systems, having a great saving advantage, being more comfortable and quiet can be listed as reasons for preference.

In this context, by examining the criteria selected and the samples studied in previous studies, it was seen that luxury electric vehicles above a certain limit had not been studied separately before and that there was a gap in the literature in this context. This deficiency was taken into consideration when determining the purpose of this study. In previous studies, passenger vehicles, light commercial vehicles and commercial taxis were discussed. In fact, the installation locations of charging stations are among the most studied topics. In this direction, the study was finalized and a sample of vehicles with a price range of 200,000 Euros (Eight million Turkish Liras) and above was created based on six different main criteria and the exchange rate during the time period in which the study was conducted.

This study, which aims to determine the importance levels of factors affecting consumers' decisions to purchase electric vehicles whose prices are above a certain lower limit and to rank the vehicles with the highest scores, consists of four parts. Following the introduction section is the literature section, where examples from previous studies are presented. In the third part of the study, the study method and the findings are explained, while the fourth part includes the results of the study.

1. Literature review

Sovacool et al. (2019) investigated users' intentions to purchase electric vehicles in their study covering all regions of China. As it is known, China ranks first in electric vehicle production and the electric vehicle market; it is also a country that ranks first in its greenhouse gas emissions. In this context, the study conducted with 805 participants discussed whether consumers' willingness to adopt electric vehicles is for pleasure or profit, what the effects of the performance features of the vehicles are on vehicle preference, how effective government incentives are, and what the perceived benefits of using electric vehicles are. As a result of the study, it was stated that it will provide a multi-dimensional gain in the long term due to its contribution to both the mitigation of climate change and energy security.

Chu et al. (2019) compared the behavior of consumers in China and Korea in their study on psychological and behavioral factors in the adoption of electric vehicles. In the comparison where geographical and cultural effects are also taken into consideration, while China represents a mature market, Korea represents an early stage. However, intense air pollution in both countries increases the demand for electric vehicles. The study was carried out on 177 users, including early adopters, from Korea, and 207 users, including the majority, from China. As a result of the study, it was concluded that small-sized electric vehicles and electric SUVs are preferred over large-sized electric vehicles and electric SUVs in both countries.

In their study, Jian and Wei (2019) evaluated the factors affecting the purchasing desire for electric vehicles in China. The research they conducted with 249 users focused on the charging structure of electric vehicles, government incentives, price, individual environmental awareness, and perceived social impact. In addition, taking into account the rational choice theory, the study tried to determine what Chinese users pay attention to when purchasing electric vehicles.

In their study, Dwivedi and Sharma (2023) ranked fifteen different brands of electric vehicles based on different criteria such as full charging time, price, fast charging time, power, range, battery capacity, maximum speed, luggage volume, acceleration, and curb weight. In the study, while criterion weights were determined with Shannon entropy, ranking was also carried out with the TOPSIS method.

In their study, Ziemba (2020) discussed the selection problem for electric vehicles that will be used by local governments and government offices in Poland. In the study, findings were obtained by combining the PROSA-C method and the Monte Carlo method, which are multi-criteria decision analyses. In the study, evaluation was made according to maximum speed, acceleration, total power, torque, load volume, load volume with folded seats, seats, battery capacity, price, range, energy consumption, charging time, fast charging time, and safety criteria. As a result of the study, the Nissan LEAF e+ was determined to be the most suitable vehicle for local governments and government offices among twelve different models of electric vehicles that were subject to the selection choice.

In their study on Chinese consumers, Huang and Qian (2018) evaluated users' preferences for electric vehicles. In the study, data were collected in the second and third lower-tier cities of China. In this context, the differences between the reasons for the preference of consumers in second-tier cities and third-tier cities were compared. Consumers in lower-level regions; the focus is on the price of the vehicle, charging stations, and subsidies. As a result of the research, it is also thought that vehicles in China are more disadvantaged than electric vehicle models in Europe.

In their study, Gavcar and Kara (2020) compared 11 different model electric vehicles based on their battery capacities, horsepower, aerodynamic coefficients, ranges, and prices. They used the Entropy and TOPSIS Methods together in their electric car selection study. As a result of the study, Tesla's XLR and Model 3 cars were found to have high performance.

Ballı et al. (2007) made the most appropriate choice among seven different electric cars in the same class in their study. In the selection study, they carried out with the Fuzzy Promethee method, based on price, fuel, performance, and safety criteria. As a result of the study, the GAIA plane was given to provide a visual analysis, and models compatible with the determined criteria were placed in this plane.

Güleryüz and Çokyaşar (2021) used the TOPSIS method in the selection of seven different model vehicles in the C segment in their study. As selection criteria: price, second-hand price, fuel consumption, 0–100 km was used. They determined the acceleration, comfort, safety, maintenance cost, MTV fee, and love rating.

In their study, Çoşkun (2022) examined consumers' electric vehicle purchasing preferences by using SD and MULTIMOORA techniques. Using the SD method, they ranked the criteria according to their importance and then ranked the alternatives using the MULTIMOORA method. While the most important criteria were torque, and charging time, the Hyundai Kona 150 kW ranked first in the vehicle ranking.

Abdulvahitoğlu et al. (2022) tried to support consumers' decision-making in choosing an electric vehicle by using the Bordo Integrated MULTIMOORA Method in their study. In this context, they separated the factors that consumers care about when choosing a car, both during and after purchase. If you are purchasing, while price, performance, sellers' influence, warranty, service, and promotion policies are discussed, post-purchase use, maintenance/ repair status, spare parts availability, service, safety, and usage comparison are taken into consideration. As a result of their study, the Mercedes EQC 400 4 MATIC was determined to be the most suitable choice.

Štilić et al. (2022) investigated the problem of the use of electric vehicles in taxi services by using multi-criteria decision-making methods. The criteria determined in the study, with the support of taxi drivers, include price, number of people that can be transported, availability of authorized services, range, and battery capacity. At the end of the study, the Volkswagen ID.3 Pro was determined to be the most suitable electric vehicle for taxi service, especially according to the battery capacity criterion.

Kaczyńska et al. (2023) carried out a study on the sustainability of electric vehicles in their study and the Comparative Analysis of the TOPSIS method with Interval Numbers. The criteria they considered in the analysis were horsepower, range, battery capacity, speed, luggage volume, 0–100 km/h acceleration time, price, fast charging time, full charging time, and unloaded weight. As a result of the study comparing the interval-based extensions of the TOPSIS method, they found that the mutual compatibility of the approaches was high.

Bošković et al. (2023) used an alternative ranking method (AROMAN) that explains a two-step normalization in electric vehicle selection in their study. The criteria they determined is in line with the opinions they received from experts: price, width, carrying capacity, battery capacity, and volume. As a result of the study, they concluded that the AROMAN method they applied to the selection problem was successful.

Więckowski et al. (2023) proposed a new and more comprehensive framework than previous studies for a sensitivity analysis based on Interval Arithmetic and Multi-Criteria Decision Analysis in electric vehicle selection. In addition, the TOPSIS method was used for absolute and interval numbers in the study.

2. Research methodology

This part of the study includes the purpose, population, sample, method, and findings of the research.

2.1. Purpose of the study

The aim of this study is to determine the importance levels of the factors that affect the decision of consumers to purchase electric vehicles whose prices are above a certain lower limit and to rank the vehicles with the highest score. The hypotheses of the study are as follows:

H1: Vehicle range significantly affects consumers' preferences for electric vehicles.

H2: Vehicle charging time significantly affects consumers' preferences for electric vehicles.

H3: Vehicle price significantly affects consumers' preferences for electric vehicles.

H4: Vehicle power significantly affects consumers' preferences for electric vehicles.

2.2. Universe and Sample of the Study

While the population of the research consists of electric vehicles offered for sale in the Turkish market, the sample of electric vehicles with a price range of 200,000 Euros (eight million Turkish Liras) and above in the exchange rate during the time period of the study was formed. Four different brands that meet these criteria and are currently offered for sale in the Türkiye market have been identified. The models evaluated among these brands are; the Mercedes EQS, Porsche Taycan, BMW iX, BMW i7, and the Audi E-Tron. The vehicles researched here are in the luxury segment of the car market. At the time the research was conducted, these vehicles were in the luxury segment of the market. However, the scope of luxury is expanding rapidly, especially with batteries of Chinese and Korean origin being introduced to luxury vehicles. Electric vehicles (BYD-KIA-VOLVO-HYUNDAI-MINI-LEXUS) entering the Turkish market are competing for a place in the luxury class with their different models. Therefore, the Turkish market varies depending on the market situation of both the producers and the government policy.

2.3. Research method, analysis, and discussion

The TOPSIS (Ranking Technique in Terms of Similarity to the Ideal Solution) Method, one of the multi-criteria decision-making methods, was used in the research. The purpose of this method is to determine the most ideal option among multi-criteria options. The method consists of 6 steps, and after the steps are applied, it is determined which of the options is more ideal (Pavic, Novoselac, 2013). The car models that constitute the sample of the study include range (km), charging time from 10% to 80% occupancy (min), price (Euro), acceleration (0–100 kmh acceleration), torque (newtonmeter, i.e. Nm), and power (hp). evaluated based on the criteria. The steps of the TOPSIS method are as follows:

Step 1. Creating the decision matrix with options and criteria.

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}$$

Step 2. After creating the decision matrix, followed creating the normalized decision matrix. The main reason for creating the normalized decision matrix in TOPSIS is to make the criteria measured n different units comparable and to ensure that the method's mathematical steps function properly.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

(i: 1, 2, …, m; number of alternatives; j: 1, 2, …, n; number of criteria)

Step 3. Creating the weighted normalized decision matrix obtained by multiplying the values in the normalized decision matrix created in Step 2 with the determined criterion weights.

$$A^+ \left\{ \left(\max_i v_{ij} \middle| j \in J \right) \right\}, \qquad \left\{ \left(\min_i v_{ij} \middle| j \in J' \right) \right\}$$

$$A^- \left\{ \left(\min_i v_{ij} \middle| j \in J \right) \right\}, \qquad \left\{ \left(\max_i v_{ij} \middle| j \in J' \right) \right\}$$

Step 4. Determination of a positive ideal (best) and negative ideal (worst) solutions according to the weighted normalized decision matrix with the following formulas.

$$S_J^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^* \right)^2} \qquad S_J^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^- \right)^2}$$

Step 5. Finding the distance to positive and negative solutions.

$$C_I^* = \frac{S_J^-}{S_I^- + S_I^*} \qquad 0 \le C_I^* \le 1$$

Step 6. Calculating the relative closeness to the ideal solution and creating the ranking.

3. Results

In order to rank with the TOPSIS Method, the web pages of electric vehicle manufacturers were scanned together with experts in the automotive field in line with the sample taken. Brands and models were determined by filtering vehicles sold in Türkiye over eight million TL, i.e. 200,000 Euros. Specified brands and models; the Mercedes EQS 580 4 Matic, Porsche Taycan Turbo S, BMW iX 50, BMW i7 M Excellence and Audi e-tron GT. The opinions of five experts in the field were consulted and they were asked to give weight scores according to predetermined criteria. One of the experts whose opinions were consulted is an advanced driving techniques expert and instructor, one is an automotive expert, one is an automotive sales consultant, and the other two are automotive sales managers. The advanced driving techniques expert and instructor whose opinion was sought was chosen because he could make the most accurate comparison of electric vehicles and internal combustion vehicles. Since driving dynamics may vary in different vehicles (internal combustion and electric), they can measure vehicle reactions more easily. That is why the expert opinion of an advanced driving techniques expert and instructor was sought. The reason for seeking the opinion of an automotive expert is that he knows both the technical equipment of different vehicles and has also tested their driving experiences. The automotive sales consultant was chosen because he is in direct contact with different types of vehicle users and can compare and measure the experiences of the vehicles he promotes/sells. Automotive sales managers were chosen because they share their training and experience with the teams they lead, providing them with a wide range of knowledge across different brands, and models.

Considering that the distance that can be reached from point A to point B with a single charge on long trips can be reached by charging twice with a low range, it has been taken into consideration that the range stated in long trips will be 20% less than the stated figures. For this reason, even +50 km is of great importance. For them, long-range was seen as the first choice.

In addition, the price criterion comes second in purchasing behavior. This is important in terms of price performance evaluation. Afterwards, the order of importance was determined as power, torque values, and charging times. In applying the method, a decision matrix containing options and criteria must first be created. In this context, the Decision Matrix is included in Table 2. The criteria for which an increase in value creates a negative effect were reverse-code in the analysis, thereby eliminating this issue.

Table 2. Decision Matrix

	Criteria					
	range (km)	charging time (min) from 10% to 80% occupancy	price (Euro)	acceleration (0–100 kmh acceleration kmh) (sec.)	torque (newtonmetre yani nm)	power (hp)
Mercedes EQS	649	31.0	212.000	4.3	855	523
Porsche Taycan	450	23.0	209.000	3.2	850	522
BMW iX	633	35.0	209.000	4,6	765	523
BMW i7	625	34.0	312.000	4.7	745	544
Audi E-Tron	488	22.5	326.000	4.1	850	530

Source: created by the author based on data taken from the brands' websites.

Criteria weights are included in Table 3.

Table 3. Criterion Weights

Range	Charging Time	Price	Acceleration	Torque	Power
0.30	0.10	0.20	0.15	0.15	0.10

Source: own elaboration.

The Weights of the criteria used in the study were prepared based on the opinion of experts. After creating the decision matrix, a normalized decision matrix was created by applying the formula shown in Step 2. The normalized decision matrix is shown in Table 4.

Table 4. Normalized Decision Matrix

	Criteria					
	range	charging time	price	acceleration	torque	power
Mercedes EQS	0.504763	0.468555	0.365775	0.456338	0.469506	0.442589
Porsche Taycan	0.349990	0.347683	0.360599	0.339600	0.466760	0.441742
BMW iX	0.492319	0.529014	0.360599	0.488175	0.420084	0.442589
BMW i7	0.486097	0.513900	0.538310	0.498788	0.409101	0.460360
Audi E-Tron	0.379544	0.340081	0.562465	0.435113	0.466760	0.448512

Source: own elaboration.

The weighted normalized decision matrix obtained as a result of multiplying the data obtained in the normalized decision matrix with the determined criterion weights is shown in Table 5.

Table 5. Weighted Normalized Decision Matrix

	Criteria					
	range	charging time	price	acceleration	torque	power
Mercedes EQS	0.151429	0.046856	0.073155	0.068451	0.070426	0.044259
Porsche Taycan	0.104997	0.034764	0.072120	0.050940	0.070014	0.044174
BMW iX	0.147696	0.052901	0.072120	0.073226	0.063013	0.044259
BMW i7	0.145829	0.051390	0.107662	0.074818	0.061365	0.046036
Audi E-Tron	0.113863	0.034008	0.112493	0.065267	0.070014	0.044851

Source: own elaboration.

The positive and negative ideal solutions obtained by applying the formula shown in Step 4 are shown in Table 6.

Table 6. Positive and Negative Ideal Solutions

	Criteria					
	range	charging time	price	acceleration	torque	power
Pozitif (A^+)	0.151429	0.052901	0.112493	0.074818	0.070426	0.046036
Negatif (A^-)	0.104997	0.034008	0.072120	0.050940	0.061365	0.044174

Source: own elaboration.

The separation measures determined by finding the distance to positive and negative ideal solutions by applying the formula shown in Step 5 are shown in Table 7.

Table 7. Discrimination Dimensions

	S^+	S^-
Mercedes EQS	0.040345	0.052065
Porsche Taycan	0.068474	0.008682
BMW iX	0.041287	0.051764
BMW i7	0.011793	0.061695
Audi E-Tron	0.043138	0.044600

Source: own elaboration.

According to Step 6, the relative closeness of the options to the ideal solution is shown in Table 8.

Table 8. Relative Closeness to the Ideal Solution

Car Model	Conclusion
Mercedes EQS	0.563412
Porsche Taycan	0.112522
BMW iX	0.556300
BMW i7	0.839524
Audi E-Tron	0.508327

Source: own elaboration.

The order of the car models whose closeness to the ideal solution is calculated and shown in Table 9.

Table 9. Car Ranking

Sequence	Car Model	Conclusion
1	BMW i7	0.839524
2	Mercedes EQS	0.563412
3	BMW iX	0.556300
4	Audi E-Tron	0.508327
5	Porsche Taycan	0.112522

Source: own elaboration.

4. Discussion and conclusion

This study, was conducted to determine the importance of factors influencing consumers’ decisions to purchase electric vehicles with prices above a certain threshold and to rank the vehicles with the highest scores, the ranking of the electric vehicles in the sample was done by using the TOPSIS method. In previous studies, Gavcar and Kara (2020) considered battery, power, aerodynamic drag coefficient, range, and price, while Ballı et al. (2007) stated that they considered price, fuel consumption, performance, and safety. Güleryüz and Çokyaşar (2021) attempted to solve the selection problem by measuring comfort, maintenance costs, MTV fees, and the degree of impact. Çoşkun (2022) considered torque and charging times as the most important criteria and continued the research using a method different from TOPSIS. In some of these studies, torque values were ignored, and torque serves to measure traction force. This is a value that accelerates the vehicle's acceleration and affects the vehicle's performance and acceleration. Indeed, as a result of this study, the BMW i7, with the highest horsepower, ranks at the top of the rankings. Furthermore, despite the same car's longer charging time (10%-80% charge) than the Porsche Taycan and Audi E-Tron, it achieves a longer range. Despite its higher price, it ranks first in terms of similarity to the ideal solution. Furthermore, the Mercedes EQS, with the highest torque, ranks second. Using the TOPSIS method, the BMW i7 ranks first, the Mercedes EQS second, the BMW iX third, the Audi E-Tron fourth, and the Porsche Taycan last. The Porsche Taycan's low score here suggests that while its high quality and luxury make it a popular choice, economic conditions and the availability of alternative models may make it less attractive. However, this does not mean that its high quality, prestige, and powerful technical features are insufficient. According to this ranking, when all criteria are considered, the BMW İ7 received the highest score, making it the first choice for eco-friendly consumers who would like to purchase a luxury electric vehicle.

To guide future studies, it is recommended for researchers interested in the subject to investigate the market impact of the increase in hybrid vehicles, which is shown in the table published by the Anadolu Agency, showing the increase in the number of vehicles according to fuel types. The increase in hybrid vehicles is due to the marketing activities of Toyota, a leader in hybrid technology, and Toyota's chairman Akio Toyoda's insistence on entering the electric vehicle market. Akio Toyoda says that as the number of electric vehicles increases, the demand for electricity and the number of grids will become more significant. It also expresses the difficulty of meeting the demand for raw materials such as Lithium and Cobalt. However, Toyota aims to be a leader in battery technology with liquid and solid electrolytes by focusing on different technologies and thinks that it will start using these batteries in 2027 (Anadolu Agency, 2025). Therefore, it can be considered as an indication that Toyota will switch from hybrid technology to electric vehicle technology in the near future. It is recommended that these be investigated in future studies.

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