European Transport \ Trasporti Europei (2024) Issue 99, Paper n° 3, ISSN 1825-3997

https://doi.org/10.48295/ET.2024.99.3

Investigation of The Effect of Expert's Opinions on Multi-Criteria Decision Making Techniques in Electric Vehicle Selection

Abdulkerim GÜLER[1*], Mesut POLATGİL[2]

[1]*Dr., Sivas Cumhuriyet University, aguler@cumhuriyet.edu.tr, ORCID: 0000-0003-4220-918X*
[2]*Dr., Sivas Cumhuriyet University, mesutpolatgil@cumhuriyet.edu.tr, ORCID: 0000-0002-7503-2977*

Abstract

Today, humanity is at a crucial crossroads in the transition from traditional fossil fuels to renewable energy technologies, and electric vehicles (EV) are an important facet of this shift. Buying an EV is an important decision for people. Multi-Criteria Decision Making (MCDM) techniques are suitable for such complex decisions. In this study, 44 EV models available in Turkey were evaluated across 11 different criteria. AHP and SWARA methods were used by using expert opinions to weight the criteria. Using these weights, 16 models were created using three different MCDM. The results of the study were united by using the Copeland and Borda methods. Comparing the results, the effect of getting opinions from experts in different ways on the ranking was investigated. The study reveals the best EVs model when buying an EVs. The results are expected to help consumers choose the right EV and emphasise the importance of transport.

Keywords: Electric Car, Electric Vehicle, Multicriteria Decision Making, Copeland, Borda.

1. Introduction

The automotive industry is a sector that provides economic growth throughout the world and increases its importance day by day. It has a great impact on the national and world economy in terms of both production and employment. This industry plays a serious role in economic growth with factors such as employment, production, exports, sub-industry and R&D innovation.

According to the report published by the United Nations Population Fund (UNFPA), it is estimated that the world population will reach 8.5 billion in 2030, 9.7 billion in 2050 and 10.4 billion in 2100. With the increasing population, energy is also becoming an important resource. Due to the fact that non-renewable energy sources will be depleted in time and carbon emissions, they have increasingly negative effects on the environment and people. For this reason, the interest in renewable energy sources has increased significantly in recent years. The development of vehicles working with alternative energy sources has been very important for sustainability, especially for the environment.

[*] Corresponding author: Abdulkerim GÜLER (aguler@cumhuriyet.edu.tr)

Many different alternative fuel technologies are used for vehicles. Alternative fuel vehicles can be classified in various ways. Solar Powered Vehicles: Vehicles powered by electricity produced by solar panels. Hydrogen Fuelled Vehicles: Vehicles powered by hydrogen fuel cells or internal combustion engines. Ethanol and Biodiesel Fuelled Vehicles: Vehicles that use fuels produced from biomass sources such as ethanol or biodiesel. liquefied Petroleum Gas (LPG) Vehicles: Vehicles using liquefied petroleum gas. Compressed natural gas (CNG) Vehicles: Vehicles using compressed natural gas. Electric Vehicles (EV) can also be classified within themselves: Battery EV (BEV): Vehicles powered by electric energy only and powered by batteries. Hybrid EV (HEV): Vehicles powered by both an internal combustion engine and an electric motor. Plug-in Hybrid EV (PHEV): These are vehicles that run on both electric energy and an internal combustion engine. They can be charged with an external power source. Range Extender EV (REXEV): Vehicles powered by an electric motor but also having an internal combustion engine that charges batteries (Biswas et al. 2019).

EV has taken an important place in the realization of transportation operations using clean energy. This interest has also shown itself in the automobile industry. Despite its history dating back to the 1930s, the EV has managed to enjoy just as much popularity in recent years. Today, the development of battery technology and the increase in infrastructure studies increase the number of electric vehicles.

In addition, the recent political developments in the world have increased the interest in this technology. Many European countries and the USA are developing policies to reduce their dependence on petroleum products in order to increase energy independence, reduce carbon emissions and promote sustainable transportation. Transition to EE is encouraged as part of these policies (Fayziyev et. al. 2022).

As a result of increasing awareness about environmental awareness, it has started to affect automobile preferences and the number of EV uses has increased. The EV is one of the key elements of this trend. Compared to conventional internal combustion engines, EVs emit less carbon and are less harmful to the environment. Therefore, many consumers turn to electric vehicles due to environmental awareness. In addition, hybrid vehicles are also gaining popularity as an environmentally friendly option (Danielis et. al. 2020).

Hybrid vehicles have an electric motor as well as an internal combustion engine, so they can consume less fuel and achieve lower emissions. Consumers' increasing demands for environmental awareness lead the automobile industry to more sustainable and environmentally friendly models. Many countries offer various incentives and benefits to encourage the adoption of electric cars. Some of these are free parking and privileged use of public transport corridors. In addition, some countries also offer incentives for EV owners, such as the ability to go faster on the roads and tax reductions. This encourages automobile manufacturers to offer environmentally friendly vehicles and accelerates the transformation in the industry (Fayziyev et. al., 2022).

Multi-criteria decision making (MCDM) is a method used when more than one criterion is considered in a decision-making process. These techniques are used to guide the decision maker to make the most appropriate choice among various alternatives. MCDM Techniques offer a systematic approach in making the most appropriate choice among alternatives when more than one criterion is taken into account. These techniques use various criteria and different methods to evaluate the performance of alternatives under these criteria (Feng et. al., 2021; Wątróbski et. al., 2017).

The decision-making process when buying a car is an important step for many people. In this process, it is important to consider many factors and make the right decision. Examples of factors to be considered are; budget, fuel consumption and performance, safety, brand and model, service and spare parts can be given. When purchasing a car, consumers try to choose the best alternative among brands and models by considering various criteria. These criteria may vary depending on personal preferences and needs. Each individual may have different priorities. For car selection, it is important to determine and analyse the importance levels of the criteria. MCDM methods support the decision making process by using different criteria and the order of importance of these criteria. MCDM methods are used to determine the significance level of each of these criteria. The criteria are weighted and their importance levels are determined. Later in the selection process, once the weight of each criterion has been determined, cars can be evaluated against these criteria. Each car receives a score for each criterion, and these scores can be added together to make an overall performance evaluation. This analysis process helps to objectively guide the decision-making process.

Therefore, it is an important problem that people who want to buy electric vehicles will consider which criteria and how to choose a car using these criteria. Because deciding on the car to buy requires a serious research and examination process. Indecisions and different opinions create problems for people. However, examining the cars in terms of certain criteria and analysing them with scientific methods facilitates the process. This study was carried out in order to make the decision-making process safe and easy for people who want to buy an electric car by using MCDM methods. The opinions of the experts for the criteria with the AHP and SWARA methods were taken and the effect of these opinions on the MCDM methods was investigated. In addition, the results of MCDM methods were combined with Copeland and Borda methods in the study and the results were compared.

The study was carried out on electric cars sold in Turkey as of 2023. It has been observed in the literature that similar studies have been carried out for different countries (Danielis et. al., 2020; Ziemba, 2021). This study was carried out to examine the effect of the opinions of experts obtained by AHP and SWARA methods on the selection of electric vehicles when examined with different alternative ranking methods. The study fills the gap in the literature both in terms of the vehicles sold in Turkey and in terms of examining how different expert opinions affect the results. The questions sought to be answered within the scope of the study are:

Question 1- What are the criteria that experts pay attention to when purchasing electric vehicles? How are these criteria priorities taken from experts compared to AHP AND SWARA methods?

Question 2- How much do the results change when the criteria weights obtained from the experts with the AHP and SWARA methods are used in different MCDM methods? How much do the results change when the results of different MCDM methods are combined with Copeland and Borda?

Question 3- Which EV models are the most preferred in Turkey in terms of the rankings made with different methods and the results obtained by combining these rankings?

2. Related Works

Data from 1245 Spanish citizens found that price and charging time were the most important factors influencing customers' purchase of electric vehicles (Junguara et. al., 2016). A study conducted with 969 people in Germany showed that personal needs are the most important factor in purchasing (Peters and Dütschke, 2014). Huang and Ge (2019) used theory of planned behaviour (TPB) in their study on 502 people in Beijing. They showed that customers are not affected by personal norms and non-monetary incentives. They also examined the effects of demographic variables such as gender, age and education level on purchasing. Liao et al (2019) examined the impact of vehicle types on business models. They found that electric vehicles are most preferred in car rental. Broadbent et al (2017) found that not all factors have the same degree of importance in promoting electric vehicles, citing the importance of appropriate legislation, the establishment of an adequate public charger network and the creation of an information network.

Wątróbski et. Al. (Wątróbski et. al., 2017) used 36 different alternatives, focusing mostly on urban transportation vehicles with nine criteria.

Sendek and Pyza (Sendek-Matysiak & Pyza, 2018) carried out the ranking of cars with various energy sources. As a result of the study, they found that hybrid and electric models were the best results.

Biswas et. Al. (Biswas et. al., 2019), combined in their work compromise solution (CoCoSo) and criteria importance through intercriteria Electric vehicle selection was performed using the correlation (CRITIC) method.

Gavcar and Kara (Gavcar & Kara, 2020)compared 11 different models of electric cars offered for sale in Turkey, based on certain criteria, and ranked them according to the scores obtained by Entropy and TOPSIS methods. They stated that Tesla's Model X LR and Model 3 model cars gave the best results. The power of the engine was determined as the most important criterion.

Khan et. al. (Khan et. al., 2020) stated that hybrid electric vehicles are more important for developing countries such as Pakistan. He ranked using the TOPSIS method with ten criteria and seven alternatives and found that Toyota Aqua outperformed all other alternatives.

Ecer (Ecer, 2021), A novel in his study, in which he proposed an integrated MCDM model, he listed 10 alternatives using six MCDM methods and 11 criteria. He combined the ranking results with Borda and Copeland. Price, permitted load, and energy consumption emerged as the most important criteria. As a result of the study, Tesla Model S was the best model.

Ziemba (Ziemba, 2021) used TOPSIS, SAW and NEAT F-PROMETHEE II methods with fuzzy model for EV selection in AC segments in Poland and suggested Volkswagen ID.3 Pro S and Nissan LEAF e+ models as a result of the study.

Tepe (Tepe, 2021) performed a ranking for six criteria and 10 alternatives in his study. AHP and ELECTRE methods with interval-valued spherical fuzzy (IVSF) sets method was preferred in the study. As a result of the study, he determined the battery capacity as the most important criterion.

Coşkun (Coşkun, 2022) compared five different electric vehicles with standard deviation and MULTIMOORA methods and showed that the Hyundai Kona 150 kW model gave the best results in his study. Renault ZOE took the last place. He also found that the vehicle's torque and DC charging time were the most important criteria.

Abdulvahitoğlu et. al. (Abdulvahitoglu et. al., 2022) combined different MOORA models for 11 different electric vehicles with the Borda method. In their studies, the Mercedes EQC 400 4MATIC was determined as the most suitable vehicle.

Büyükselçuk and Tozan (Büyükselçuk Çaloğlu & Tozan, 2022), in their work Electric Sports Utility Vehicles (e-SUV) models were ranked using CRITIC and EATWIOS methods, and as a result, it was concluded that the e- SUV produced by the British was the best.

Sonar and Kulkarni (Sonar & Kulkarni, 2021), analytics hierarchy process (AHP) and multi-attributive border approximation area Using the comparison (MABAC) method together, they performed a ranking for six EVs. They stated that they chose six criteria used in the literature and performed the ranking for EC sold in the market. driving range and They stated that the price criteria are the most important criteria. Hyundai Kona Electric has been identified as the best EV.

Pradhan et. al. (Pradhan et. al., 2022), quality for 6 different EVs in India Sorted using the Function Deployment (QFD) model to weight the criteria. In addition to the vehicle technical specifications, the criteria also considered other criteria that may be important to the customer. As a result of the study, Hyundai Kona was found to be the best model.

In the literature, using MCDM methods for charging station location selection for EC (Feng et. al., 2021), sensitivity of MCDM methods for EC There are also studies on performing analysis (Więckowski et. al., 2023). However, it is observed that studies generally focus on the choice of charging station location (Wang et. al., 2020).

When the literature was reviewed, it was determined that MCDM methods were used for EV, but no study was conducted on how the results might change if expert opinions were obtained with different methods. The gap in the literature will be filled by investigating the effect on both the criteria and the ranking of alternatives in the event that expert opinions are obtained by different methods.

3. Method

In the study, 44 EVs sold in Turkey were used. The reason for focusing on Turkey in this study is that the country has a critical geography at the intersection of Asia and Europe. The country is also in a critical position in terms of automotive export and import data. The 11 criteria for these vehicles are taken from the web pages of the companies that produce the vehicles. In this work used data set is given in Annex-1.

The explanation of the developed model is given in Figure 1. In total, 16 models were developed. While creating such a model, the studies in the literature where different criteria weighting and ranking methods were used and successful results were obtained were taken into consideration. For example, Lestari et al (2018) conducted a hybrid study using K-Means clustering analysis and Copeland and Borda methods. Firouzi et al (2021) proposed a hybrid study that combines the results by using different alternative ranking methods. For this reason, in our study, we propose a new hybrid model in which we can use different methods together and investigate the usability of this model in electric vehicle selection.

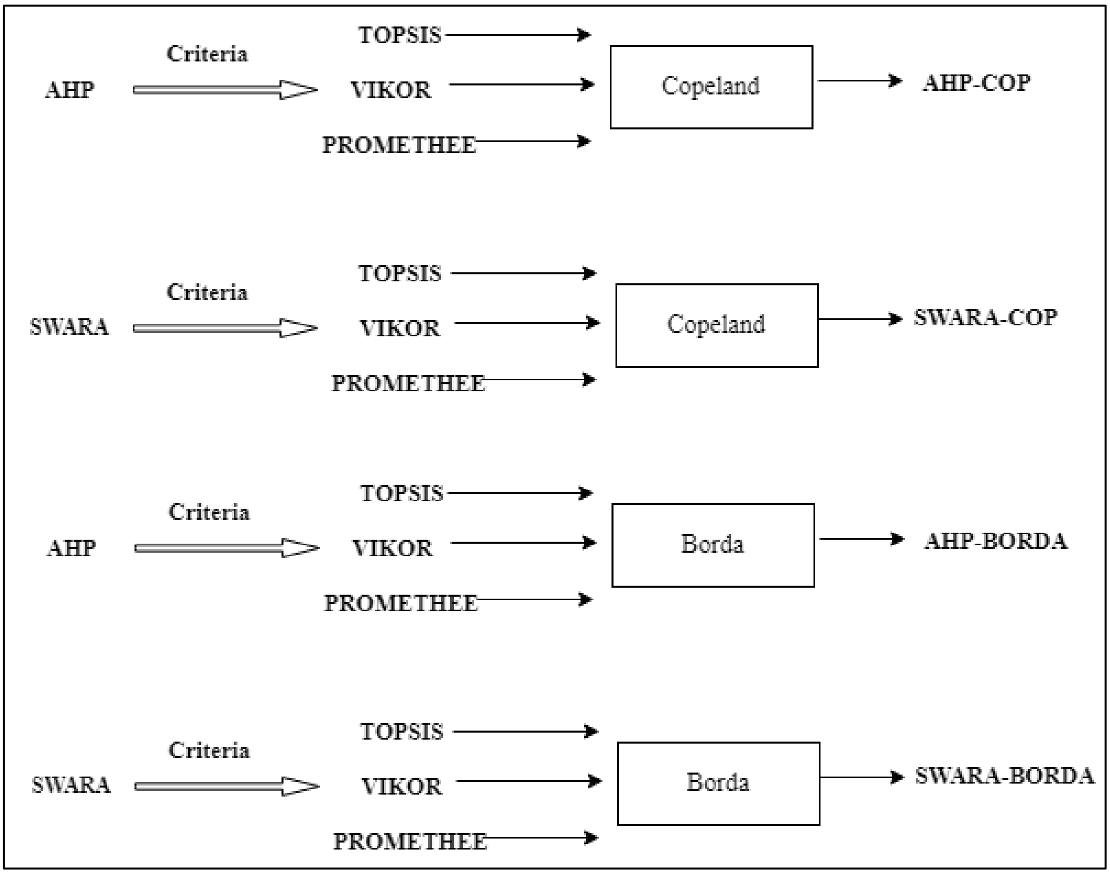

Figure 1: MCDM framework in this work.

In the study, TOPSIS, VIKOR and PROMETHEE were used as MCDM methods and AHP, SWARA as criteria weighting methods. The reason for the use of these methods is that they were widely used in analyses on MCDM in studies in Web of Science (WOS) and Scopus databases between 1977-2022 (Basílio et al., 2022). Basílio et al. (2022) showed which multi-criteria decision-making methods were used more frequently in their study.

For weighting methods, which are among the multi-criteria decision-making methods, evaluations were obtained from experts (electrical engineers, automotive engineers, etc.) in the field of electric vehicles.

In this study as seen in Figure 1, criteria weights were obtained from the experts by AHP and SWARA methods. Then, using these weights, 44 model EVs were ranked. The different rankings were combined with Copeland and Borda methods. All rankings were then compared with Spearman Rank Correlation. It is attempted to determine how the results change with different integrated multi-criteria decision-making methods and the correlation between the results and the most appropriate integrated method.

In this study, the criteria were determined based on a literature review and codes. These criteria are explained in Table 1.

Table 1: Literature review of the Criteria and codes

No.	*Criteria*	*Unit*	*Reference Literature*
1	Price (CR1)	TL	Gavcar and Kara (2020), Büyükselçuk and Tozan(2022), Çoşkun (2022), Abdulvahitoğlu et. al. (2022), Lache et. al.(2008), Milev et al. (2021), Więckowski et. al (2023).

2	Battery Capacity (CR2)	kw / hour	Gavcar and Kara (2020), Flizikowski et. al.(2020), Vrba (2003), Więckowski et. al (2023).
3	Range (CR3)	km	Gavcar and Kara (2020), Büyükselçuk and Tozan(2022), Çoşkun (2022), Abdulvahitoğlu et. al. (2022), Lundström (2014) , Więckowski et. al. (2023).
4	Engine Capacity (CR4)	HP	Gavcar and Kara (2020), Büyükselçuk and Tozan (2022), Çoşkun (2022), Dijk and Yarime (2010), Axsen et. al. (2009), Więckowski et. al. (2023).
5	Energy Usage (CR5)	kWh /100 km	Büyükselçuk and Tozan (2022), Van Vliet et. al. (2011), Sathre and Gustavsson (2021), Więckowski et. al. (2023).
6	Full Charge Time (CR6)	minutes	Büyükselçuk and Tozan (2022), Çoşkun (2022), Abdulvahitoğlu et. al. (2022), Giansoldati et. al. (2020), Horn et al. (2019), Więckowski et. al. (2023).
7	Horsepower (CR7)	kW	Gavcar and Kara (2020), Büyükselçuk and Tozan (2022), Çoşkun (2022), Dijk and Yarime (2010), Axsen et. al. (2009), Więckowski et. al. (2023).
8	Torque (CR8)	nm	Büyükselçuk and Tozan (2022), Çoşkun (2022), Kubiczek and Hadasik (2021), Grigor'ev et al. (2015), Więckowski et. al. (2023).
9	Top Speed (CR9)	km/h	Büyükselçuk and Tozan (2022), Çoşkun (2022), Helmers and Marx (2012), Kim et. al. (2014), Więckowski et. al. (2023).
10	Acceleration To 100 (CR10)	Seconds	Büyükselçuk and Tozan (2022), Coşkun (2022), Van Wee et. al. (2012), Guo and Zhang (2016), Więckowski et. al. (2023).
11	Vehicle Weight (CR11)	kg	Büyükselçuk and Tozan (2022), Van Vliet et. al.(2011), Petrovic et. al.(2015), Więckowski et. al. (2023).

In this study, EVs sold in Turkey were ranked with MCDM, and then these ranking results were combined with the Copeland and Borda Methods. Due to the varying market conditions in Turkey, the price of electric vehicles is limited to the dates between 01.07.2023 and 01.08.2023 in the study.

4. Results

4.1. Weighting criteria with AHP and SWARA Method.

The criteria were weighted according to the AHP and SWARA methods and the results are given in Table 2.

Table 2: Weights of criteria according to AHP and SWARA

AHP			*SWARA*		
Criteria	*weight Values*	*Ranking*	*Criteria*	*weight Values*	*Ranking*
CR1	0.0877	6	CR1	0.1126	4
CR2	0.11967	one	CR2	0.1531	one
CR3	0.0099	5	CR3	0.0892	6
CR4	0.1204	4	CR4	0.1159	3
CR5	0.0580	9	CR5	0.0683	9
CR6	0.0624	7	CR6	0.0716	8
CR7	0.1418	2	CR7	0.1189	2
CR8	0.1231	3	CR8	0.0957	5
CR9	0.0333	10	CR9	0.0525	10
CR10	0.0602	8	CR10	0.0722	7
CR11	0.0255	11th	CR11	0.0500	11th

According to the AHP Method, the most important criterion is the CR2 "Battery capacity". The ranking of the other criteria is as follows, in order of: CR7 "Horsepower", CR8 "Torque", CR4 "Engine Capacity", CR3 "Range", CR1 "Price", CR6 "Charging", CR10 "Acceleration", CR5 "Consumption", CR9 "Maximum Speed", and CR11 "Weight".

According to the SWARA Method, the most important criterion is the KR2 "Battery capacity". The ranking of the other criteria are as follows, in order of: CR7 "Horsepower", CR4 "Engine Capacity", CR1 "Price", CR8 "Torque", CR3 "Range", CR10 "Acceleration", CR6 "Charging", CR5 "Consumption", CR9 "Maximum Speed", and CR11 "Weight".

4.2. Combined all Ranking based on AHP criteria with Copeland and Borda Methods

The criteria weighted with AHP method and ranked by the TOPSIS, VIKOR, PROMETHEE methods, have been merged into a single ranking using the Copeland and Borda. The ranking results are shown in Table 3.

The abbreviations for the electric vehicles used in the study are specified in appendix-1.

Alternatives of electric vehicles have been ranked by TOPSIS, VIKOR, and PROMETHEE methods weighted AHP method. These rankings have been merged into a single ranking by using the Copeland method. According to this ranking, the top five positions among electric vehicles are occupied by EA26 "Porsche Taycan Turbo S Cross Turismo", EA17 "Mercedes AMG EQS 53 4MATIC+", EA29 "Porsche Taycan Turbo S", EA25 "Porsche Taycan Turbo Cross Turismo" and EA30 "Porsche Taycan Turbo" in Table 3.

The rankings have been merged into a single ranking by using the Borda method. According to this ranking, the top five positions among electric vehicles are occupied by EA17 "Mercedes AMG EQS 53 4MATIC+", EA26 "Porsche Taycan Turbo S Cross Turismo", EA29 "Porsche Taycan Turbo S", EA30 "Porsche Taycan Turbo" and EA25 "Porsche Taycan Turbo Cross Turismo" in Table 3.

Table 3: Combining of Electrics vehicles ranking which weighted with AHP Method Using Copeland and Borda Method

SN	*TOPSIS Ranking*	*VIKOR Ranking*	*PROMETHEE Ranking*	*Copeland Ranking*	*Board Ranking*
1	EA26	EA26	EA17	EA26	EA17
2	EA17	EA29	EA29	EA17	EA26
3	EA29	EA17	EA18	EA29	EA29
4	EA30	EA19	EA15	EA25	EA30
5	EA25	EA23	EA26	EA30	EA25
6	EA8	EA30	EA6	EA18	EA18
7	EA15	EA16	EA8	EA8	EA19
8	EA18	EA33	EA25	EA15	EA8
9	EA6	EA36	EA3	EA6	EA2
10	EA31	EA34	EA30	EA2	EA15
.					.
35	EA22	EA15	EA20	EA22	EA9
36	EA9	EA27	EA41	EA9	EA4
37	EA38	EA22	EA9	EA41	EA10

38	EA37	EA12	EA37	EA37	EA20
39	EA34	EA6	EA13	EA34	EA35
40	EA13	EA10	EA38	EA13	EA22
41	EA41	EA3	EA34	EA38	EA24
42	EA35	EA43	EA35	EA35	EA37
43	EA24	EA39	EA24	EA24	EA13
44	EA23	EA42	EA23	EA23	EA38

4.3. Combined all Ranking based on SWARA criteria with Copeland and Borda Methods

The criteria weighted with SWARA method and ranked by the TOPSIS, VIKOR, PROMETHEE methods, have been merged into a single ranking using the Copeland and Borda. The ranking results are shown in Table 4.

Alternatives of electric vehicles have been ranked by TOPSIS, VIKOR, and PROMETHEE methods weighted SWARA method. These rankings have been merged into a single ranking by using the Copeland method. According to this ranking, the top five positions among electric vehicles are occupied by EA26 "Porsche Taycan Turbo S Cross Turismo ", EA29 "Porsche Taycan Turbo S", EA17 "Mercedes AMG EQS 53 4MATIC+", EA25 "Porsche Taycan Turbo Cross Turismo " and EA30 "Porsche Taycan Turbo" in Table 4.

The rankings have been merged into a single ranking by using the Borda method. According to this ranking, the top five positions among electric vehicles are occupied by EA26 "Porsche Taycan Turbo S Cross Turismo", EA17 "Mercedes AMG EQS 53 4MATIC+", EA29 "Porsche Taycan Turbo S", EA30 "Porsche Taycan Turbo" and EA25 "Porsche Taycan Turbo Cross Turismo" in Table 4.

Table 4: Combining of Electrics Vehicles Ranking which weighted with SWARA Method Using Copeland and Borda Method

SN	*TOPSIS Ranking*	*VIKOR Ranking*	*PROMETHEE Ranking*	*Copeland Ranking*	*Board Ranking*
1	EA26	EA26	EA17	EA26	EA26
2	EA29	EA29	EA18	EA29	EA17
3	EA30	EA17	EA15	EA17	EA29
4	EA17	EA30	EA29	EA25	EA25
5	EA25	EA25	EA26	EA30	EA30
6	EA8	EA19	EA6	EA8	EA15
7	EA15	EA11	EA3	EA15	EA8
8	EA31	EA31	EA8	EA18	EA18
9	EA18	EA16	EA40	EA6	EA31
10	EA6	EA40	EA25	EA31	EA19
.					.
35	EA34	EA13	EA9	EA34	EA5
36	EA22	EA38	EA20	EA9	EA23
37	EA9	EA7	EA37	EA20	EA4
38	EA13	EA37	EA33	EA22	EA20

39	EA38	EA43	EA13	EA13	EA35
40	EA41	EA12	EA38	EA38	EA13
41	EA37	EA5	EA34	EA37	EA22
42	EA35	EA22	EA35	EA35	EA38
43	EA24	EA20	EA24	EA24	EA37
44	EA23	EA4	EA23	EA23	EA24

The EA26 model, namely the "Porsche Taycan Turbo S Cross Turismo", was determined as the best EV in all of the models established within the scope of the study. The technical specifications of this vehicle and the technical specifications of the EA23, the “Mini Cooper SE” model, which is in the last place in common with the models, are given in Table 5.

Table 5: Specifications for first-row and last-row EV on all models

Criteria / EV	*Porsche Taycan Turbo S Cross Turismo*	*Mini Cooper SE*
Price (TL)	12500000.00	1600000.00
Battery Capacity (kWh)	93.4	32.6
Range (km)	456	235
Engine Displacement(HP)	761	184
Consumption (kWh /100km)	29.4	16.8
Charge (min)	22.5	35
Horsepower(kW)	559	135
Torque(Nm)	1050	270
Maximum speed (km/h)	250	150
Acceleration (Sec)	4.1	7.3
Weight (kg)	2395	1440

4.4 Comparison of Copeland and Borda Method results

The criteria were weighted with the AHP and SWARA methods. Then, with these criteria, EVs were ranked by using TOPSIS, VIKOR and PROMETHEE methods. These rankings were combined with the Copeland and Borda Methods separately.

At the top five rankings of the Copeland and Borda methods, it can be observed that the rankings are nearly the same, with only a few differences in some rankings. In general, it can be stated that similar results were achieved. Moreover methods between the relationship measure Spearman Rank Correlation is used and results is given in Table 5.

When Table 5 is examined, it is seen that the ranking results of all models established within the scope of the study are in high correlation with each other. The criteria weights obtained from the experts with AHP and SWARA caused low correlation only in VIKOR methods, that is, there is a difference in the results. In the PROMETHEE method, there is a high level of correlation between the results. So the results are pretty similar. In the Copeland and Borda methods, there is a significant correlation between the ranking results, but a higher correlation was found in the Copeland method than in the Borda method.

Table 5: Spearman Rank Correlation values

Methods	*r*	*p*
AHP-TOPSIS / SWARA TOPSIS	0.993	0,000
AHP-VIKOR / SWARA-VIKOR	0.631	0,000
AHP-PROMETHEE / SWARA-PROMETHEE	0.987	0,000
AHP-COPELAND / SWARA-COPELAND	0.985	0,000
AHP-BORDA / SWARA-BORDA	0.954	0,000
AHP-COPELAND / AHP-BORDA	0.948	0,000
SWARA-COPELAND / SWARA-BORDA	0.979	0,000
AHP-COPELAND / SWARA- BOARD	0.956	0,000
SWARA-COPELAND / AHP-BORDA	0.941	0,000

5. Discussion

This study was carried out in order to make the decision-making process safe and easy for people who want to buy an electric car by using MCDM methods. The opinions of the experts for the criteria with the AHP and SWARA methods were taken and the effect of these opinions on the MCDM methods was investigated.

Question 1: What are the criteria that experts pay attention to when purchasing electric vehicles? How are these criteria priorities taken from experts compared to AHP AND SWARA methods? In terms of his question:

The first research question is what are the most important criteria in the purchase of electric vehicles. In order to find the answer to this question, 11 different criteria used in the purchase of electric vehicles have been identified in the literature. Opinions were obtained from five experts using AHP and SWARA methods. According to both AHP and SWARA methods, the most important criterion was determined as battery capacity. Battery capacity is an important value that shows how much energy it collects for the EV. This value can be said to be equivalent to the amount of fuel the tank can hold in conventional internal combustion vehicles. Therefore, the higher this value, the more energy the vehicle can store. This has a serious effect on the range that the vehicle can travel. Studies in which battery capacity is the most important criterion are found in the literature (Štilić et. al., 2022; Tepe, 2021). It is natural that the results of this study and the study using the SWARA method (Štilić et. al., 2022) are similar in terms of the same method. In addition, our study revealed that the AHP method gave similar results.

Among the criteria, horsepower and torque are the most important after battery capacity. There are also studies where the torque of the vehicle is determined as an important criterion (Coşkun, 2022; Gavcar & Kara, 2020). It shows that the experts attach importance to the traction power of the vehicle in the emergence of the vehicle's torque as an important criterion.

Although the AHP and SWARA methods found similar results as the most important criteria, there are differences in the ranking of the other criteria. It has also been determined that other criteria are primarily found in different studies in the literature (Coşkun, 2022; Ecer, 2021; Pradhan et. al., 2022). This situation may have caused the different opinions of the experts whose opinions were taken by the use of different methods. Also, some criteria weighting methods work based on data so the result may differ. In our study, there may have been differences in the results, as methods based on expert opinion were analysed and compared.

Question 2 How much do the results change when the criteria weights obtained from the experts with the AHP and SWARA methods are used in different MCDM methods?

How much do the results change when the results of different MCDM methods are combined with Copeland and Borda? In terms of his question:

It has been determined that there is a high and significant correlation between the rankings made by different methods using the criterion weights obtained with AHP and SWARA. Only the VIKOR method showed a low level of correlation in the results. This may be due to the calculation differences of the VIKOR method, which can also be seen in different studies in the literature (Opricovic & Tzeng, 2004; Papathanasiou et. al., 2016; Shekhovtsov & Sałabun, 2020). When the criteria weights are obtained by different methods, the results are similar. A similar situation was observed in the Copeland and Borda methods used to combine the results. When the different rankings are combined with Copeland and Borda using the criterion weights obtained by the AHP and SWARA methods, the results are quite similar. However, the combinations made with the Copeland method gave a higher level of correlation. This may be due to the Copeland and Borda methods combining the results differently (Lamboray, 2007; Lestari et. al., 2018; Mattei et. al., 2012). Therefore, Copeland method is more suitable especially if different MCDM methods will be used for EV and the results will be combined.

In this study, it has been shown that both AHP and SWARA methods give similar results. This shows that the results are similar even if the opinions of the experts are taken with different methods. It can be said that the results will be similar in terms of criterion weighting, even if different MCMD methods are used, especially in studies with EV.

Question 3 Which EV models are the most preferred in Turkey in terms of the rankings made with different methods and the results obtained by combining these rankings? In terms of his question:

"Porsche Taycan Turbo S Cross Turismo" as the best EV after six different analyses. It is the best vehicle in four models. Other top models were the "Mercedes AMG EQS 53 4MATIC+" and "Porsche Taycan Turbo S". "Mini Cooper SE" and "Peugeot SUV e-2008" are the vehicles with the lowest ranking. As a result of combining different methods with Copeland and Borda, "Porsche Taycan Turbo S Cross Turismo" and "Mercedes AMG EQS 53 4MATIC+" were determined as the best EV. It is thought that these vehicles can be used as a reference especially for users who want to buy EVs in Turkey.

6. Conclusion

Within the scope of the study, the criteria that the experts pay attention to in the purchase of electric vehicles were examined by AHP and SWARA methods. Five experts in Turkey were asked to rate these criteria. For weighting methods, which are among the multi-criteria decision-making methods, evaluations were obtained from experts (electrical engineers, automotive engineers, etc.) in the field of electric vehicles.

As a result of the calculations, according to the AHP Method, the most important criterion is the KR2 "Battery capacity". The ranking of the other criteria is as follows, in order of: CR7 ' Horsepower ', CR8 ' Torque ', CR4 'Engine Capacity ', CR3 ' Range ', CR1 ' Price ', CR6 ' Charging ', CR10 'Acceleration', CR5 ' Consumption ', CR9 'Maximum Speed ', and CR11 ' Weight '. According to the SWARA Method, the most important criterion is the KR2 "Battery capacity". the ranking of the other criteria are as follows , in order of: CR7 ' Horsepower ', CR4 'Engine Capacity ', CR1 ' Price ', CR8 ' Torque ', CR3 ' Range ', CR10 'Acceleration', CR6 ' Charging ', CR5 'Consumption ', CR9 'Maximum Speed ', and CR11 ' Weight '. Therefore, as a result of the study, it was determined that there was no significant change in the ranking of the criteria, although data were obtained from the experts with different methods. It has been seen that the experts pay attention to the "Battery Capacity" criterion.

The criterion weights obtained with AHP and SWARA caused low correlation in the VIKOR method, that is, there is a difference in the results. However, in all other models the results were highly correlated. In Copeland and Borda methods, the results obtained in the Copeland method gave higher correlations than the Borda method. In other words, when the data obtained from the experts with different methods are used with different methods, there may be differences in the results. In this case, it is recommended to use the Copeland method and to be careful with the VIKOR method. Because in the comparison of VIKOR method with other methods, the correlation coefficient was lower than other methods. This difference can be attributed to the VIKOR method's calculation steps.

As a result of the study, “Porsche Taycan Turbo S Cross Turismo” and “Mercedes AMG EQS 53 4MATIC+” were determined as the best EV. It is thought that these vehicles can be used as a reference especially for users who want to buy EVs in Turkey.

In addition, criteria that are important for EE can be useful for both consumers and producers. Manufacturers can concentrate on the design and production of models by considering the most important criteria. Consumers can be aware of the criteria that other people care about and use them in their choices. Countries and policy makers can also increase the use of electric vehicles by creating incentive mechanisms based on the criteria that people care about.

Future Works

Pradhan et.al. also included customer attributes in the criteria pool. As in this study, in future studies, as in the opinions of experts, customers can be asked which criteria they attach importance to. Criteria can be determined by combining the information received with expert opinions.

Sendek and Piza (2018) carried out the ranking of cars with various energy sources. As in this study, it can be included in the research not only for EV, but also for vehicles with gasoline engines. So the alternatives can be expanded.

References

Abdulvahitoglu, A., Abdulvahitoğlu, A., & Vural, D. (2022). Elektrikli Otomobil Seçiminde Çok Kriterli Karar Verme: Borda Tümleşik MULTIMOORA Yöntemi. 4th International Conference on Applied Engineering and Natural Sciences, 740–750. https://www.researchgate.net/publication/365646682

Axsen, J., Mountain, D. C., & Jaccard, M. (2009). Combining stated and revealed choice research to simulate the neighbour effect: The case of hybrid-electric vehicles. Resource and Energy Economics, 31(3), 221–238. https://doi.org/10.1016/J.RESENEECO.2009.02.001

Basílio, M. P., Pereira, V., Costa, H. G., Santos, M., & Ghosh, A. (2022). A Systematic Review of the Applications of Multi-Criteria Decision Aid Methods (1977–2022). Electronics 2022, Vol. 11, Page 1720, 11(11), 1720. https://doi.org/10.3390/ELECTRONICS11111720

Biswas, T. K., Stević, Ž., Chatterjee, P., & Yazdani, M. (2019). An Integrated Methodology for Evaluation of Electric Vehicles Under Sustainable Automotive Environment. In Advanced Multi-Criteria Decision Making for Addressing Complex Sustainability Issues (pp. 41–62). IGI Global. https://doi.org/10.4018/978-1-5225-8579-4.CH003

Büyükselçuk Çaloğlu, E., & Tozan, H. (2022). Elektrikli Araçların Performanslarının CRITIC-EATWIOS ile Değerlendirilmesi. Düzce Üniversitesi Bilim ve Teknoloji Dergisi, 10(4), 1670–1688.

Broadbent, G. H., Drozdzewski, D., & Metternicht, G. (2018). Electric vehicle adoption: An analysis of best practice and pitfalls for policy making from experiences of Europe and the US. Geography compass, 12(2), e12358.

Coşkun, I. T. (2022). Çok Kriterli Karar Verme Teknikleri ile Elektrikli Otomobil Seçimi: SDMULTIMOORA Yaklaşımı. Üçüncü Sektör Sosyal Ekonomi, 57(1). http://search/yayin/detay/1112600

Danielis, R., Rotaris, L., Giansoldati, M., & Scorrano, M. (2020). Drivers' preferences for electric cars in Italy. Evidence from a country with limited but growing electric car uptake. Transportation Research Part A: Policy and Practice, 137, 79–94. https://doi.org/10.1016/J.TRA.2020.04.004

Dijk, M., & Yarime, M. (2010). The emergence of hybrid-electric cars: Innovation path creation through co-evolution of supply and demand. Technological Forecasting and Social Change, 77(8), 1371–1390. https://doi.org/10.1016/J.TECHFORE.2010.05.001

Ecer, F. (2021). A consolidated MCDM framework for performance assessment of battery electric vehicles based on ranking strategies. RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 143. https://doi.org/10.1016/j.rser.2021.110916

Fayziyev, P.R, Ikromov I.A, Abduraximov, A.A & Dehqonov, Q.M. (2022). Timeline: History of the Electric Car, Trends and the Future Developments. Eurasian Research Bulletin, 6, 89–94. https://www.geniusjournals.org/index.php/erb/article/view/888

Feng, J., Xu, S. X., & Li, M. (2021). A novel multi-criteria decision-making method for selecting the site of an electric-vehicle charging station from a sustainable perspective. Sustainable Cities and Society, 65, 102623. https://doi.org/https://doi.org/10.1016/j.scs.2020.102623

Flizikowski, J., Tomporowski, A., Kruszelnicka, W., Piasecka, I., Mroziński, A., & Kasner, R. (2020). Electric Cars as a Future Energy Accumulation System. Renewable Energy Sources: Engineering, Technology, Innovation, 827–839. https://doi.org/10.1007/978-3-030-13888-2_80

Firouzi, S., Allahyari, M. S., Isazadeh, M., Nikkhah, A., & Van Haute, S. (2021). Hybrid multi-criteria decision-making approach to select appropriate biomass resources for biofuel production. Science of the Total Environment, 770, 144449.

Gavcar, E., & Kara, N. (2020). Elektrikli Otomobil Seçiminde Entropi ve TOPSIS Yöntemlerinin Uygulanması. The Journal of Human and Work, 7(2), 351–359.

Giansoldati, M., Monte, A., & Scorrano, M. (2020). Barriers to the adoption of electric cars: Evidence from an Italian survey. Energy Policy, 146, 111812. https://doi.org/10.1016/J.ENPOL.2020.111812

Grigor'ev, M. A., Naumovich, N. I., & Belousov, E. V. (2015). A traction electric drive for electric cars. Russian Electrical Engineering, 86(12), 731–734. https://doi.org/10.3103/S1068371215120111/METRICS

Guo, F., & Zhang, F. (2017). A study of driving cycle for electric cars on Beijing urban and suburban roads. 2016 IEEE International Conference on Power and Renewable Energy, ICPRE 2016, 319–322. https://doi.org/10.1109/ICPRE.2016.7871224

Helmers, E., & Marx, P. (2012). Electric cars: Technical characteristics and environmental impacts. Environmental Sciences Europe, 24(4), 1–15. https://doi.org/10.1186/2190-4715-24-14/FIGURES/2

Huang, X., & Ge, J. (2019). Electric vehicle development in Beijing: An analysis of consumer purchase intention. Journal of cleaner production, 216, 361-372.

Horn, M., MacLeod, J., Liu, M., Webb, J., & Motta, N. (2019). Super capacitors: A new source of power for electric cars? Economic Analysis and Policy, 61, 93–103. https://doi.org/10.1016/J.EAP.2018.08.003

Junquera, B., Moreno, B., & Álvarez, R. (2016). Analyzing consumer attitudes towards electric vehicle purchasing intentions in Spain: Technological limitations and vehicle confidence. Technological Forecasting and Social Change, 109, 6-14.

Khan, F., Ali, Y., & Khan, A. U. (2020). Sustainable hybrid electric vehicle selection in the context of a developing country. Air Quality, Atmosphere & Health, 13(4), 489–499. https://doi.org/10.1007/s11869-020-00812-y

Kim, J., Rasouli, S., & Timmermans, H. (2014). Expanding scope of hybrid choice models allowing for mixture of social influences and latent attitudes: Application to intended purchase of electric cars. Transportation Research Part A: Policy and Practice, 69, 71–85. https://doi.org/10.1016/J.TRA.2014.08.016

Kubiczek, J., & Hadasik, B. (2021). Segmentation of Passenger Electric Cars Market in Poland. World Electric Vehicle Journal 2021, Vol. 12, Page 23, 12(1), 23. https://doi.org/10.3390/WEVJ12010023

Kuchta, R., & Vrba, R. (2003). Measuring and monitoring system for electric cars. IEEE International Symposium on Diagnostics for Electric Machines, Power Electronics and Drives, SDEMPED 2003 - Proceedings, 342–344. https://doi.org/10.1109/DEMPED.2003.1234598

Lache, R., Galves, D., & Nolan, P. (2009). Electric Cars: Plugged In 2. Autos & Auto Parts, Global Market Research, 3–152. http://www.libralato.co.uk/docs/Electric Cars Plugged In 2 Deutsche Bank 2009.pdf

Lamboray, C. (2007). A comparison between the prudent order and the ranking obtained with Borda's, Copeland's, Slater's and Kemeny's rules. Mathematical Social Sciences, 54(1), 1–16.

Lestari, S., Adji, T. B., & Permanasari, A. E. (2018). Performance comparison of rank aggregation using Borda and Copeland in recommender system. 2018 International Workshop on Big Data and Information Security (IWBIS), 69–74.

Liao, F., Molin, E., Timmermans, H., & van Wee, B. (2019). Consumer preferences for business models in electric vehicle adoption. Transport Policy, 73, 12-24.

Lestari, S., Adji, T. B and Permanasari, A. E. (2018)."Performance Comparison of Rank Aggregation Using Borda and Copeland in Recommender System," 2018 International Workshop on Big Data and Information Security (IWBIS), Jakarta, Indonesia, 2018, pp. 69-74, doi: 10.1109/IWBIS.2018.8471722.

Lundström, A. (2014). Differentiated driving range: Exploring a solution to the problems with the "guess-o-meter" in electric cars. Automotive UI 2014 - 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, in Cooperation with ACM SIGCHI - Proceedings. https://doi.org/10.1145/2667317.2667347

Mattei, N., Forshee, J., & Goldsmith, J. (2012). An empirical study of voting rules and manipulation with large datasets. Proceedings of COMSOC, 59.

Milev, G., Hastings, A., & Al-Habaibeh, A. (2021). The environmental and financial implications of expanding the use of electric cars - A Case study of Scotland. Energy and Built Environment, 2(2), 204–213. https://doi.org/10.1016/J.ENBENV.2020.07.005

Opricovic, S., & Tzeng, G.-H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. European Journal of Operational Research, 156(2), 445–455.

Papathanasiou, J., Ploskas, N., Bournaris, T., & Manos, B. (2016). A decision support system for multiple criteria alternative ranking using TOPSIS and VIKOR: a case study on social sustainability in agriculture. Decision Support Systems VI-Addressing Sustainability and Societal Challenges: 2nd International Conference, ICDSST 2016, Plymouth, UK, May 23--25, 2016, Proceedings 2, 3–15.

Peters, A., & Dütschke, E. (2014). How do consumers perceive electric vehicles? A comparison of German consumer groups. Journal of Environmental Policy & Planning, 16(3), 359-377.

Petrović, D. T., Pešić, D. R., Petrović, M. M., & Mijailović, R. M. (2020). Electric cars: Are they solution to reduce CO2 emission? Thermal Science, 24(5 Part A), 2879–2889. https://doi.org/10.2298/TSCI191218103P

Pradhan, P., Shabbiruddin, & Pradhan, S. (2022). Selection of electric vehicle using integrated Fuzzy-MCDM approach with analysis on challenges faced in hilly terrain. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 44(2), 2651–2673. https://doi.org/10.1080/15567036.2022.2056665

Sathre, R., & Gustavsson, L. (2021). A lifecycle comparison of natural resource use and climate impact of biofuel and electric cars. Energy, 237, 121546. https://doi.org/10.1016/J.ENERGY.2021.121546

Sendek-Matysiak, E., & Pyza, D. (2018). The assignment of vehicle assessment based on multi criteria decision making. Archives of Transport, 48(4), 77–85. https://doi.org/10.5604/01.3001.0012.8367

Shekhovtsov, A., & Sałabun, W. (2020). A comparative case study of the VIKOR and TOPSIS rankings similarity. Procedia Computer Science, 176, 3730–3740.

Sonar, H. C., & Kulkarni, S. D. (2021). An Integrated AHP-MABAC Approach for Electric Vehicle Selection. Research in Transportation Business & Management, 41, 100665. https://doi.org/10.1016/J.RTBM.2021.100665

Štilić, A., Puška, A., \DJurić, A., & Božanić, D. (2022). Electric vehicles selection based on Brčko District Taxi service demands, a multi-criteria approach. Urban Science, 6(4), 73.

Tepe, S. (2021). The Interval-Valued Spherical Fuzzy Based Methodology and its Application to Electric Car Selection. Düzce Üniversitesi Bilim ve Teknoloji Dergisi, 9(5), 1970–1983.

Van Vliet, O., Brouwer, A. S., Kuramochi, T., Van Den Broek, M., & Faaij, A. (2011). Energy use, cost and CO2 emissions of electric cars. Journal of Power Sources, 196(4), 2298–2310. https://doi.org/10.1016/J.JPOWSOUR.2010.09.119.

Wang, R., Li, X., Xu, C., & Li, F. (2020). Study on location decision framework of electric vehicle battery swapping station: Using a hybrid MCDM method. Sustainable Cities and Society, 61, 102149. https://doi.org/https://doi.org/10.1016/j.scs.2020.102149

Wątróbski, J., Małecki, K., Kijewska, K., Iwan, S., Karczmarczyk, A., & Thompson, R. G. (2017). Multi-Criteria Analysis of Electric Vans for City Logistics. In Sustainability (Vol. 9, Issue 8). https://doi.org/10.3390/su9081453.

Więckowski, J., Wątróbski, J., Kizielewicz, B., & Sałabun, W. (2023). Complex sensitivity analysis in Multi-Criteria Decision Analysis: An application to the selection of an electric car. Journal of Cleaner Production, 390, 136051. https://doi.org/10.1016/J.JCLEPRO.2023.136051.

Ziemba, P. (2021). Selection of Electric Vehicles for the Needs of Sustainable Transport under Conditions of Uncertainty&Mdash; A Comparative Study on Fuzzy MCDA Methods. In Energies (Vol. 14, Issue 22). https://doi.org/10.3390/en14227786.

Acknowledgments

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Appendix 1 List of EVs and codes used in the study

No	Models	Codes	Price	battery capacity (kWh)	Range	Engine Power(hp)	Consumption (kWh/100km)	Charge	Engine power(kW)	Torque(Nm)	Top Speed	Acceleration	Weight
1	Audi Q8 e-tron 50 quattro	EA1	5195000,00	89	505	340	19,5	41	249	664	200	6	2510
2	Audi Q8 e-tron 55 quattro	EA2	5255000,00	106	600	408	19,9	41	300	664	200	5,6	2510
3	BMW i4 M50	EA3	4490000,00	80,7	510	544	19	31	399	795	225	3,9	2215
4	BMW iX1 xDrive30	EA4	3275000,00	64,7	440	313	16,8	29	230	494	180	5,6	2085
5	BMW iX3 2022	EA5	3500000,00	80	460	286	18,5	32	210	400	180	6,8	2185
6	BMW iX xDrive 50	EA6	6950000,00	105,2	630	523	19,8	35	384	765	200	4,6	2510
7	BMW iX xDrive 40	EA7	4975000,00	71	425	326	19,4	31	239	630	200	6,1	2365
8	BMW i7 xDrive60	EA8	9975000,00	107,8	625	544	18,4	34	399	745	240	4,7	2715
9	Hyundai Kona Elektrik 150 kW 2021	EA9	1285000,00	64	484	204	14,7	47	150	395	167	7,9	1760
10	Hyundai IONIQ 5	EA10	1995000,00	72,6	430	306	17,7	18	224	605	185	5,2	2095
11	Jaguar I-Pace EV400	EA11	3300000,00	90	470	400	27,5	45	294	696	200	4,8	2208
12	Kia EV6 Long Range GT LINE	EA12	2950000,00	77,4	506	325	17,2	18	238	605	187	5,2	2105
13	Kia Niro EV Prestige	EA13	1950000,00	64,8	463	204	15,7	43	150	255	167	7,8	1739
14	Mercedes EQE 350+	EA14	3500000,00	90	654	292	15,9	32	214	565	210	6,4	2355
15	Mercedes AMG EQE 53 4MATIC+	EA15	7500000,00	90,56	526	625	20,2	32	459	950	220	3,5	2525
16	Mercedes EQE 300+	EA16	3195000,00	89	616	245	16,7	32	180	550	210	7,3	2495
17	Mercedes AMG EQS 53 4MATIC+	EA17	7000000,00	108	580	761	21,5	31	559	1020	250	3,4	2655
18	Mercedes EQS 580 4MATIC	EA18	7425000,00	108	676	523	18,4	31	384	855	210	4,3	2585
19	Mercedes EQS 450+	EA19	6900000,00	108	780	333	15,6	31	244	568	210	6,2	2480
20	Mercedes EQB 350 4MATIC	EA20	3275000,00	66,5	419	292	18,1	32	214	520	160	6,2	2175
21	Mercedes EQC 400 4MATIC	EA21	3900000,00	80	462	408	20,8	40	300	760	180	5,1	2495
22	Mercedes EQA 350 4MATIC	EA22	2645000,00	66,5	432	292	17,5	30	214	520	160	6	2080
23	Mini Cooper SE	EA23	1600000,00	32,6	235	184	16,8	35	135	270	150	7,3	1440
24	Peugeot SUV e-2008	EA24	1625000,00	50	331	136	15,1	30	99	260	150	8,5	1548
25	Porsche Taycan Turbo Cross Turismo	EA25	10300000,00	93,4	452	680	28,7	22,5	499	850	250	3,3	2395
26	Porsche Taycan Turbo S Cross Turismo	EA26	12500000,00	93,4	456	761	29,4	22,5	559	1050	250	4,1	2395
27	Porsche Taycan 4S Cross Turismo	EA27	8000000,00	93,4	452	571	28,1	22,5	419	650	240	4,1	2320
28	Porsche Taycan 4 Cross Turismo	EA28	6900000,00	93,4	456	476	28,1	22,5	350	500	220	5,1	2320
29	Porsche Taycan Turbo S	EA29	11250000,00	93,4	416	761	28,5	22,5	559	1050	260	2,8	2370
30	Porsche Taycan Turbo	EA30	12750000,00	93,4	452	680	28	22,5	499	850	260	3,2	2380
31	Porsche Taycan 4S Plus	EA31	10250000,00	93,4	464	571	27	22,5	419	650	250	4	2295
32	Porsche Taycan 4S	EA32	9500000,00	79,2	408	530	26,2	22,5	389	640	250	4	2215
33	Porsche Taycan	EA33	8350000,00	79,2	431	408	28	22,5	300	345	230	5,4	2125
34	Renault ZOE 2022	EA34	1246900,00	52	386	135	13,5	70,0	99	245	140	9,4	1502
35	DFSK Seres 3 Elektrikli SUV	EA35	1250000,00	52,5	405	163	15,8	30	119	300	160	8,9	1690
36	Skywell ET5	EA36	1620000,00	85,97	565	204	15,9	63	150	320	150	8,2	1930
37	Subaru Solterra e-Xclusive	EA37	1409402,00	71,4	466	218	16,1	30	160	336	160	6,9	2015
38	Volvo XC40 Recharge P6	EA38	1935047,00	69	423	231	18,7	32	169	330	160	7,4	2030
39	Tesla Model Y Long Range AWD	EA39	3250000,00	81	533	396	16,9	28	291	510	217	5	1979
40	Tesla Model 3 Long Range	EA40	3450000,00	75	614	440	15,5	30	323	493	261	4,4	1844
41	Tesla Model 3 Standard Range Plus	EA41	2950000,00	54	448	296	12,6	22	217	404	225	5,6	1745
42	Tesla Model Y Performance	EA42	3550000,00	80	480	456	16,6	27	335	643	241	3,7	2003
43	Tesla Model Y Long Range AWD	EA43	3950000,00	81	533	396	16,9	27	291	510	217	5	1979
44	TOGG T10X	EA44	1215000,00	88,5	523	218	16,9	28	160	350	185	7,8	2126