Decision Support System for Electric Car Selection Recommendations Using the MOORA and TOPSIS Methods

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ABSTRACT

Electric vehicles are an environmentally friendly alternative compared to conventional motor vehicles. Electric vehicles do not produce exhaust emissions, which can help reduce air pollution in major cities. Additionally, electric vehicles are more energy-efficient compared to conventional motor vehicles. However, a large-scale transformation in the automotive sector towards electric vehicles in developing countries will be challenging as it requires stronger knowledge, awareness, and attitudinal changes towards electric-powered transportation. This study utilizes the Multi-Objective Optimization by Ratio Analysis (MOORA) and Technique for Order Performance of Similarity to Ideal Solution (TOPSIS) methods to assist in complex decision-making. The criteria used in this study include price, range, charging time, battery capacity, and additional features. The study results show that using the MOORA method, the Audi e-tron GT ranks first with a preference weight of 0.1511 while using the TOPSIS method, the Wuling Air EV ranks first with a preference weight of 0.6373.

Keywords: *Vehicle; Electric; MOORA; TOPSIS; Ranking*

INTRODUCTION

The Ministry of Energy and Mineral Resources (ESDM) reported that consumption of RON 90 fuel in Indonesia increased by 27% in 2022 compared to the previous year. This increase has caused a fuel supply shortage and raised environmental issues related to air pollution. As an alternative, electrical energy is a substitute for fuel for the future [T. Weimana, 2023]. Indonesia is still very dependent on fossil fuels, with almost 95% of its energy needs supplied by fossil fuels, of which around 50% comes from petroleum and the rest from gas and coal. Fossil fuels are non-renewable and will run out one day and hurt the environment, including greenhouse gas emissions that cause global warming and climate change [J. T. Hidayat, 2024]. Electric vehicles are a more environmentally friendly alternative to conventional motor vehicles. Electric vehicles do not produce exhaust emissions so that they can reduce air pollution in big cities. In addition, electric vehicles are more energy-efficient than conventional motor vehicles [I. Kartiko, 2024]. BEV (Battery Electric Vehicle) is the most environmentally friendly electric vehicle because it does not produce exhaust emissions. The development of electric vehicles in Indonesia, especially the BEV type, has received serious attention and support from the government, as seen from the issuance of Presidential Regulation Number 55 of 2019 concerning the acceleration of the battery-based electric motor vehicle program for road transportation, as well as the 2017–2045 National Research Master Plan which supports the use of electric vehicles as public transportation [D. D. Suranto, 2023]. Electric cars are a solution to conventional cars, whose production has dominated for the past century. Although still developing, sales of electric cars have shown a significant increase in recent years.

A decision support system (DSS) is a specific information system that assists management in making semi-structured and unstructured decisions [R. Adha, 2020]. In this case, researchers use methods that can assist in complex decision-making, namely the Multi-Objective Optimization by Ratio Analysis (MOORA) method and the Technique for Order Performance of Similarity to Ideal Solution (TOPSIS).

Previous research by Anggoro et al. (2023) entitled "Electric vehicles in the eyes of Gen Y: what factors explain their purchasing interest?" used a purposive sampling method and Structural Equation Modeling (SEM) approach. The study results showed that the more benefits consumers feel from electric vehicles, the more ease of use, public concern for the environment, and good perceptions of the price of electric vehicles will increase purchasing interest. Sukma et al. (2023), in their study entitled "The Effect of Environmental Concerns and Government Policies on The Intention to Buy Electric Cars," used a sampling method with respondents from Jabodetabek residents. The results showed that attitudes, behavioral control, environmental concerns, and government policies influenced the intention to buy an electric car, while subjective norms had a moderate influence. Pinem et al. (2020), in "Spatial-Based Industrial Location Determination Decision Support System Using the MOORA

Method," used the MOORA method with seven criteria, resulting in the determination of industrial locations with a correlation value approaching 1. Syam et al. (2023), in "Tablet PC Selection Decision Support System Using the WASPAS and MOORA Methods," used a combination of the WASPAS and MOORA methods with five criteria, proving that MOORA is very suitable in multi-criteria cases. Arofah et al. (2022), in "Decision Support System for Determining Class Promotion of Students Using the TOPSIS Method," used the TOPSIS method with six criteria, resulting in good decisions in determining class promotion of students.

The price of electric cars is generally higher than that of fuel-powered cars, forming the perception that "electric cars are expensive vehicles." As a result, many people still choose fuel-powered cars. However, a systematic evaluation shows that although the initial price of electric cars is higher, long-term cost efficiency is more profitable for their owners. Electric cars have advantages, including cheaper operating costs than conventional cars and lower battery charging costs compared to fossil fuel filling [R. Teknik et al., 2024]. However, transforming the automotive sector to electric vehicles is not easy in developing countries because it requires knowledge, awareness, and changes in attitudes towards electric-powered transportation. Therefore, a system is needed to help people choose electric vehicles according to their needs.

Based on the description above, the author is interested in researching a decision support system that helps people choose the right electric vehicle from various car brands listed.

LITERATURE REVIEW

Decision Support System

A Decision Support System (DSS) is a system that supports the work of a manager or group of managers in solving semi-structured problems by providing information or suggestions towards certain decisions. DSS is a concept in technology science designed to assist management in the decision-making process and to make each process more structured and objective. This system allows the processing of very large amounts of data with high accuracy. DSS is generally defined as a system providing problem-solving and communication capabilities for semi-structured problems. The presence of DSS is expected to help parties in need find solutions in the form of decisions [F. B. Larasati et al., 2020], [Z. Azhar et al., 2022], [N. Ndruru et al., 2020], [A. Yanda & M. Mesran, 2022].

MOORA Method

The Multi-Objective Optimization based on Ratio Analysis (MOORA) method is a multi-objective system that simultaneously optimizes two or more conflicting attributes. This method is known to have a good decision level. The MOORA approach is a process that simultaneously optimizes two or more conflicting attributes under several constraints.

MOORA offers flexibility and ease in separating subjective aspects of the evaluation process into decision-weight criteria with several decision-making attributes (Mandal, Sarkar, 2012). This method is selective because it can determine the objectives of conflicting criteria, both beneficial and disadvantageous (cost). The following are the steps for solving using the MOORA method [D. Hariyanto et al, 2021], [S. Syam et al., 2023], [M. Mesran et al., 2022].

1) Creating a Decision Matrix

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1i} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{j1} & \cdots & x_{ij} & \cdots & x_{jn} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mi} & \cdots & x_{mn} \end{bmatrix}$$

2) Creating a Normalization Matrix

$$X_{ij}^{*} = \frac{x_{ij}}{\sqrt{\left[\sum_{j=1}^{m} x_{ij}^{2}\right]}} \quad (1)$$

3) Calculating Optimization Values

$$y_j^{*} = \sum_{i=1}^{i=g} x_{ij}^{*} - \sum_{i=g+1}^{i+n} x_{ij}^{*} \quad (2)$$

TOPSIS Method

TOPSIS is one of the multi-criteria decision support methods first introduced by Yoon and Hwang (Ying-Liang, WuXing-Yan Zhu, 2011). The TOPSIS method is an assessment that is interpreted to provide each object to be evaluated for its value specifically. The main principle of the TOPSIS multi-criteria decision-making method is that the optimal alternative must be at the closest distance from the positive ideal solution and the farthest from the negative ideal solution from a geometric perspective. Based on the comparison of the relative distance, the priority arrangement of alternatives can be achieved. The TOPSIS method rules in obtaining decisions include several steps, including [A. Arofah & Respitawulan, 2022], [R. Putratama Fitri et al., 2022], [T. O. Yuneta & F. N. Aprian, 2024].

1) Forming a normalized decision matrix (R). TOPSIS requires a performance ranking of each alternative A_i on each normalized criterion C_j, namely:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{2}}} \quad (3)$$

With i = 1,2,...m, the value of m indicates the number of alternatives evaluated, and the value of x_ij indicates the rating value of the suitability of the i-th alternative with the j-th criterion.

2) Determining the weighted normalized matrix (Y). The value of each normalized data (R) is then multiplied by the weight (W) to obtain the weighted normalized decision matrix (Y)

$$y_{ij} = w_j * r_{ij} \quad (4)$$

3) Determining Positive Ideal Solution Matrix (A^+) and Negative Ideal Solution (A^-). Positive ideal solution A^+ and negative ideal solution A^- can be determined based on the normalized weight ranking (y_ij)

$$A^+ = (y_1^+, y_2^+, y_3^+, \ldots, y_n^+) \quad (5)$$

$$A^- = (y_1^-, y_2^-, y_3^-, \ldots, y_n^-)$$

4) Determining the Distance of Positive (D^+) and Negative (D^-) Ideal Solutions

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ + y_{ij}\right)^2} \quad (6)$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} + y_i^-\right)^2}$$

5) Preference Value

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (7)$$

Electric Cars

Electric cars are vehicles that use electric motors as their driving force, with power from batteries or other electricity sources. Because they do not use fossil fuels such as gasoline or diesel, these cars are more environmentally friendly because they do not produce harmful gas emissions. In addition, electric cars are known to be more efficient in energy use and have lower operating costs compared to conventional cars that use fossil fuels.

METHODS

To ensure that the results of this study are structured and produce optimal output, it is necessary to compile stages that will be applied in the process of completing this research. Some steps that must be taken in this study are as follows:

1) Analysis of problems that occur related to the selection of electric cars and solutions taken to overcome the problems that occur
2) Data collection through the official website
3) Literature studies from previous studies, journals, and books that discuss related methods are carried out to facilitate data processing based on the problems that occur [J. Hutahaean & M. Badaruddin, 2020].
4) Applying the MOORA (Multi-Objective Optimization by Ratio Analysis) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) methods
5) Conclusions obtained after calculations are carried out on the application of the method.

RESULTS

Alternatives

1) Determination Alternatives. In this study, ten different electric car alternatives were used to be assessed and analyzed. The selection of these ten alternatives aims to provide a broad and representative coverage of the various electric car options available in the market. The alternative data can be seen in Table 1 as follows:

Table 1. Alternative Data

No	Kode Alternatif	Nama Alternatif
1	A1	Hyundai Ioniq
2	A2	Tesla Model 3
3	A3	Nissan Leaf
4	A4	BMW i3
5	A5	Renault Zoe
6	A6	Wuling Air EV
7	A7	Mini Cooper SE
8	A8	Lexus UX 300e
9	A9	Audi e-tron GT
10	A10	Mercedes EQC

2) Criteria Determination. In this study, five data criteria are the main focus of the evaluation. Criteria data include purchase price, distance traveled per hour, time required to fully charge the battery, available battery capacity, and additional features offered by each electric car. The criteria data can be seen in Table 2 as follows:

Table 2. Criteria Data

No	**Kode Kriteria**	**Nama Alternatif**	**Atribut**	**Bobot**
1	C1	Harga (Rp Juta)	Cost	0.25
2	C2	Jarak Tempuh (Km)	Benefit	0.25
3	C3	Waktu Pengisian (Jam)	Cost	0.20
4	C4	Kapasitas Baterai (kWh)	Benefit	0.20
5	C5	Fitur Tambahan (skala 1 - 10)	Benefit	0.10

The next stage is to determine the sub-criteria that will be used in the exploration, which involves the process of assigning weights to each electric car model based on previously established criteria as seen in table 3 below:

Table 3. Subcriteria Data

No	**Kriteria**	**Keterangan**	**Nilai Bobot**
1	Harga (Rp Juta)	0 - 250	5
		251 - 500	4
		501 - 750	3
		751 - 1000	2
		Lebih dari 1000	1
2	Jarak Tempuh (Km)	0 - 100	1
		101 - 200	2
		201 - 300	3
		301 - 400	4

		Lebih dari 400	5
3	Waktu Pengisian (Jam)	0 - 3	5
		3 - 6	4
		6 - 9	3
		9 - 12	2
		Lebih dari 12	1
4	Kapasitas Baterai (kWh)	0 - 20	1
		21 - 40	2
		41 - 60	3
		61 - 80	4
		Lebih dari 80	5
5	Fitur Tambahan (skala 1 - 10)	1 - 2	1
		3 - 4	2
		5 - 6	3
		7 - 8	4
		9 - 10	5

The next stage is to create alternative data, complete with criteria values for each electric car model evaluated as in the following Table 4:

Table 4. Alternative Data and Criteria Values

No	Nama Alternatif	Harga (Rp Juta)	Jarak Tempuh (Km)	Waktu Pengisian (Jam)	Kapasitas Baterai (kWh)	Fitur Tambahan (skala 1 - 10)
1	Hyundai Ioniq	600	373	6.0	38.3	8
2	Tesla Model 3	1500	500	8.5	75.0	9
3	Nissan Leaf	700	311	7.5	40.0	7
4	BMW i3	1300	246	6.0	42.2	8
5	Renault Zoe	650	395	7.5	52.0	6
6	Wuling Air EV	250	300	4.0	26.5	5
7	Mini Cooper SE	1000	270	4.5	32.6	8
8	Lexus UX 300e	1200	315	5.5	54.3	9
9	Audi e-tron GT	2500	488	9.0	93.4	10
10	Mercedes EQC	1600	400	7.5	80.0	9

Application of the MOORA Method

The first step in using the MOORA method is to create a decision matrix whose criteria values have been adjusted according to pre-determined sup-criteria value rules so that a decision matrix (X) is formed as follows:

$$X = \begin{bmatrix} 3 & 4 & 4 & 2 & 4 \\ 1 & 5 & 3 & 4 & 5 \\ 3 & 4 & 3 & 2 & 4 \\ 1 & 3 & 4 & 3 & 4 \\ 3 & 4 & 3 & 3 & 3 \\ 5 & 3 & 4 & 2 & 3 \\ 2 & 3 & 4 & 2 & 4 \\ 1 & 4 & 4 & 3 & 5 \\ 1 & 5 & 3 & 5 & 5 \\ 1 & 4 & 3 & 4 & 5 \end{bmatrix}$$

The next step in the MOORA method is to create a normalization matrix, for example, the value x1.3 will be used, as in the following example:

$$r_{1,3} = \frac{x_{1,3}}{\sqrt{x_{1,3}^2 + x_{2,3}^2 + x_{3,3}^2 + x_{4,3}^2 + x_{5,3}^2 + x_{6,3}^2 + x_{7,3}^2 + x_{8,3}^2 + x_{9,3}^2 + x_{10,3}^2}}$$

$$r_{1,3} = \frac{4}{\sqrt{(16 + 9 + 9 + 16 + 9 + 16 + 16 + 16 + 9 + 9)}}$$

$$r_{1,3} = \frac{4}{\sqrt{125}}$$

$$r_{1,3} = \frac{4}{11.18033989} = 0.357770876$$

Based on the equation above, the result for the r1.3 matrix is 0.357770876. Then repeat the equation to calculate the other alternatives so that the following results are obtained:

$$r_{1,3} = \frac{x_{1,3}}{\sqrt{x_{1,3}^2 + x_{2,3}^2 + x_{3,3}^2 + x_{4,3}^2 + x_{5,3}^2 + x_{6,3}^2 + x_{7,3}^2 + x_{8,3}^2 + x_{9,3}^2 + x_{10,3}^2}}$$

$$r_{1,3} = \frac{4}{\sqrt{(16 + 9 + 9 + 16 + 9 + 16 + 16 + 16 + 9 + 9)}}$$

$$r_{1,3} = \frac{4}{\sqrt{125}}$$

$$r_{1,3} = \frac{4}{11.18033989} = 0.357770876$$

$$R = \begin{bmatrix} 0.3841 & 0.3192 & 0.3578 & 0.2000 & 0.2965 \\ 0.1280 & 0.3990 & 0.2683 & 0.4000 & 0.3706 \\ 0.3841 & 0.3192 & 0.2683 & 0.2000 & 0.2965 \\ 0.1280 & 0.2394 & 0.3578 & 0.3000 & 0.2965 \\ 0.3841 & 0.3192 & 0.2683 & 0.3000 & 0.2224 \\ 0.6402 & 0.2394 & 0.3578 & 0.2000 & 0.2224 \\ 0.2561 & 0.2394 & 0.3578 & 0.2000 & 0.2965 \\ 0.1280 & 0.3192 & 0.3578 & 0.3000 & 0.3706 \\ 0.1280 & 0.3990 & 0.2683 & 0.5000 & 0.3706 \\ 0.1280 & 0.3192 & 0.2683 & 0.4000 & 0.3706 \end{bmatrix}$$

The next step in the MOORA method is to calculate the Optimization Value (Y). As an example, here we will determine the value of y1*as follows:

$$y_1^* = \left(\left(r_{1,2(max)}^* * w_2\right) + \left(r_{1,4(max)}^* * w_4\right) + \left(r_{1,5(max)}^* * w_5\right)\right) - \left(\left(r_{1,1(min)}^* * w_1\right) + \left(r_{1,3(min)}^* * w_3\right)\right)$$

$$y_1^* = (0.0798 + 0.0400 + 0.0296) - (0.0960 + 0.0716)$$

$y_1^* = 0.1494 - 0.1676 \ = -0.0181$

So, the result for the equation y1* is -0.0181; this method is also used to determine other alternative Optimization Values (Y) so that the value obtained is as in the following matrix:

$$Y = \begin{bmatrix} -0.0181 \\ 0.1311 \\ -0.0002 \\ 0.0459 \\ 0.0124 \\ -0.1095 \\ -0.0061 \\ 0.0733 \\ 0.1511 \\ 0.1112 \end{bmatrix}$$

The final step in implementing the MOORA method is ranking according to the values we determined previously; then, the ranking results are obtained as in Table 5 below:

Table 5. Ranking Data

No	Nama Alternatif	Y	Rangking
1	Hyundai Ioniq	-0.0181	9
2	Tesla Model 3	0.1311	2
3	Nissan Leaf	-0.0002	7
4	BMW i3	0.0459	5
5	Renault Zoe	0.0124	6
6	Wuling Air EV	-0.1095	10
7	Mini Cooper SE	-0.0061	8
8	Lexus UX 300e	0.0733	4
9	Audi e-tron GT	0.1511	1
10	Mercedes EQC	0.1112	3

Implementation of TOPSIS Method

The first step in implementing the TOPSIS method is to create a decision matrix (X) by changing each criterion value according to the provisions of the sub-criteria:

$$X = \begin{bmatrix} 3 & 4 & 4 & 2 & 4 \\ 1 & 5 & 3 & 4 & 5 \\ 3 & 4 & 3 & 2 & 4 \\ 1 & 3 & 4 & 3 & 4 \\ 3 & 4 & 3 & 3 & 3 \\ 5 & 3 & 4 & 2 & 3 \\ 2 & 3 & 4 & 2 & 4 \\ 1 & 4 & 4 & 3 & 5 \\ 1 & 5 & 3 & 5 & 5 \\ 1 & 4 & 3 & 4 & 5 \end{bmatrix}$$

The first step in applying the TOPSIS method is to create a normalization matrix (R) with the equations explained previously, for example, when we will calculate x6,1 as follows:

$$r_{6,1} = \frac{x_{6,1}}{\sqrt{\left(x_{1,1}^2 + x_{2,1}^2 + x_{3,1}^2 + x_{4,1}^2 + x_{5,1}^2 + x_{6,1}^2 + x_{7,1}^2 + x_{8,1}^2 + x_{9,1}^2 + x_{10,1}^2\right)}}$$

$$r_{6,1} = \frac{5}{\sqrt{3^2 + 1^2 + 3^2 + 1^2 + 3^2 + 5^2 + 2^2 + 1^2 + 1^2 + 1^2}}$$

$$\mathrm{r}_{6,1} = \frac{5}{\sqrt{9 + 1 + 9 + 1 + 9 + 25 + 4 + 1 + 1 + 1}}$$

$$\mathrm{r}_{6,1} = \frac{5}{\sqrt{61}} = 0.64018439966448$$

So, the value for r6,1 is 0.64018439966448; this method also applies to other alternatives and their criteria until they all get results like the following.

$$\mathrm{R} = \begin{bmatrix} 0.3841 & 0.3192 & 0.3578 & 0.2000 & 0.2965 \\ 0.1280 & 0.3990 & 0.2683 & 0.4000 & 0.3706 \\ 0.3841 & 0.3192 & 0.2683 & 0.2000 & 0.2965 \\ 0.1280 & 0.2394 & 0.3578 & 0.3000 & 0.2965 \\ 0.3841 & 0.3192 & 0.2683 & 0.3000 & 0.2224 \\ 0.6402 & 0.2394 & 0.3578 & 0.2000 & 0.2224 \\ 0.2561 & 0.2394 & 0.3578 & 0.2000 & 0.2965 \\ 0.1280 & 0.3192 & 0.3578 & 0.3000 & 0.3706 \\ 0.1280 & 0.3990 & 0.2683 & 0.5000 & 0.3706 \\ 0.1280 & 0.3192 & 0.2683 & 0.4000 & 0.3706 \end{bmatrix}$$

The next step is to multiply each normalization by its criteria weight; for example, here, we are still using r6.1 as follows:

$$y_{6,1} = r_{6,1} * w_1$$

$$\mathrm{y}_{6,1} = 0.64018439966448 * 0.25$$

$$\mathrm{y}_{6,1} = 0.16004609991612$$

So, the value for y6,1 is 0.16004609991612; this method also applies to other alternatives and their criteria until they all get results like those in the following matrix.

$$\mathrm{Y} = \begin{bmatrix} 0.0960 & 0.0798 & 0.0716 & 0.0400 & 0.0296 \\ 0.0320 & 0.0998 & 0.0537 & 0.0800 & 0.0371 \\ 0.0960 & 0.0798 & 0.0537 & 0.0400 & 0.0296 \\ 0.0320 & 0.0599 & 0.0716 & 0.0600 & 0.0296 \\ 0.0960 & 0.0798 & 0.0537 & 0.0600 & 0.0222 \\ 0.1600 & 0.0599 & 0.0716 & 0.0400 & 0.0222 \\ 0.0640 & 0.0599 & 0.0716 & 0.0400 & 0.0296 \\ 0.0320 & 0.0798 & 0.0716 & 0.0600 & 0.0371 \\ 0.0320 & 0.0998 & 0.0537 & 0.1000 & 0.0471 \\ 0.0320 & 0.0798 & 0.0537 & 0.0800 & 0.0371 \end{bmatrix}$$

he next step is to find the Positive Ideal Solution value (A+), which is the largest Alternative value in its Criteria, and the Negative Ideal Solution value (A-), which is the smallest Alternative value in its criteria, as follows:

$$y_1^+ = \{0.0960, 0.0320, 0.0960, 0.0320, 0.0960, 0.1600, 0.0640, 0.0320, 0.0320, 0.0320\} = 0.1600$$

$$y_2^+ = \{0.0798, 0.0998, 0.0798, 0.0599, 0.0798, 0.0599, 0.0599, 0.0798, 0.0998, 0.0798\} = 0.0998$$

$$y_3^+ = \{0.0716, 0.0537, 0.0537, 0.0716, 0.0537, 0.0716, 0.0716, 0.0716, 0.0537, 0.0537\} = 0.0716$$

$$y_4^+ = \{0.0400, 0.0800, 0.0400, 0.0600, 0.0600, 0.0400, 0.0400, 0.0600, 0.1000, 0.0800\} = 0.1000$$

$$y_5^+ = \{0.0296, 0.0371, 0.0296, 0.0296, 0.0222, 0.0222, 0.0296, 0.0371, 0.0371, 0.0371\} = 0.0371$$

$$y_1^- = \{0.0960, 0.0320, 0.0960, 0.0320, 0.0960, 0.1600, 0.0640, 0.0320, 0.0320, 0.0320\} = 0.0320$$

$$y_2^- = \{0.0798, 0.0998, 0.0798, 0.0599, 0.0798, 0.0599, 0.0599, 0.0798, 0.0998, 0.0798\} = 0.0599$$

$$y_3^- = \{0.0716, 0.0537, 0.0537, 0.0716, 0.0537, 0.0716, 0.0716, 0.0716, 0.0537, 0.0537\} = 0.0537$$

$$y_4^- = \{0.0400, 0.0800, 0.0400, 0.0600, 0.0600, 0.0400, 0.0400, 0.0600, 0.1000, 0.0800\} = 0.0400$$

$$y_5^- = \{0.0296, 0.0371, 0.0296, 0.0296, 0.0222, 0.0222, 0.0296, 0.0371, 0.0371, 0.0371\} = 0.0222$$

The next step is to determine the Positive Ideal Solution Distance (D+) as an example as follows:

$$D_6^- = \sqrt{\left[(y_{6,1} + y_1^-)^2 + (y_{6,2} + y_2^-)^2 + (y_{6,3} + y_3^-)^2 + (y_{6,4} + y_4^-)^2 + (y_{6,5} + y_5^-)^2\right]}$$

$$= \sqrt{\left[\begin{matrix}(0.1600 - 0.0320)^2 + (0.0599 - 0.0599)^2 + (0.0716 - 0.0537)^2 + (0.0400 - 0.0400)^2 \\ +(0.0222 - 0.0222)^2\end{matrix}\right]}$$

$$= \sqrt{(0.1280^2 + 0^2 + 0.0179^2 + 0^2 + 0^2)}$$

$$= \sqrt{(0.0164 + 0 + 0.0003 + 0 + 0)}$$

$$= \sqrt{0.0167}$$

$$= 0.1293$$

Each alternative is calculated using the same method to obtain the following results:

$$D^+ = \begin{bmatrix} 0.0903 \\ 0.1308 \\ 0.0920 \\ 0.1401 \\ 0.0815 \\ 0.0736 \\ 0.1203 \\ 0.1356 \\ 0.1293 \\ 0.1323 \end{bmatrix}$$

$$D^- = \begin{bmatrix} 0.0698 \\ 0.0584 \\ 0.0675 \\ 0.0278 \\ 0.0700 \\ 0.1293 \\ 0.0374 \\ 0.0366 \\ 0.0736 \\ 0.0471 \end{bmatrix}$$

The next step is to determine the preference value, as in the following example:

$$V_6 = \frac{D_6^-}{D_6^- + D_6^+}$$

$$V_6 = \frac{0.1293}{0.1293 + 0.0736}$$

$$V_6 = 0.6373$$

From all the calculations that have been carried out, the following results were obtained:

Table 6. Ranking Data

No	Nama Alternatif	V	Rangking
1	Hyundai Ioniq	0.4360	3
2	Tesla Model 3	0.3087	6
3	Nissan Leaf	0.4230	4
4	BMW i3	0.1657	10
5	Renault Zoe	0.4621	2
6	Wuling Air EV	0.6373	1
7	Mini Cooper SE	0.2372	8
8	Lexus UX 300e	0.2124	9
9	Audi e-tron GT	0.3627	5
10	Mercedes EQC	0.2625	7

DISCUSSION

Based on the calculation of the MOORA method table with alternative data on 10 lists of car brands, the one that gets the highest value as an alternative to car number 9, with the name Audi e-tron GT, has a preference weight (0.1511), indicating that this model is considered the most optimal in the context of the criteria applied. Meanwhile, the results of the calculation of the TOPSIS method table with alternative data on 10 lists of car brands show that the alternative car number 6, with the name Wuling Air EV, has a preference weight (0.6373) getting the highest value, indicating the relative superiority of the model in the series of evaluation criteria that have been set6*.

CONCLUSION

Based on the results of the analysis and discussion that have been carried out, the decision support system, using a comparison of the MOORA method and the TOPSIS method, recommends the selection of electric cars, which produces different rankings. In the MOORA method, the Audi e-tron GT is ranked first, with a preference weight (0.1511), while in the TOPSIS method, the Wuling Air EV is ranked first, with a preference weight (0.6373). This difference shows that the two methods have different approaches to assessing and ranking electric cars based on predetermined criteria. After an in-depth comparison of the two methods, it can be concluded that both the MOORA method and the TOPSIS method have their advantages and disadvantages. The MOORA method emphasizes speed in the calculation process because it only involves three main stages, which makes it more efficient, especially in situations where time is a crucial factor in decision-making. On the other hand, the TOPSIS method, although complex in its process, is able to provide a more detailed and balanced assessment of all the criteria considered. This process allows for a more accurate measurement of the relative performance of each electric car.

REFERENCES

T. Weimana, "Pengemudian Elektrik Pada Mobil Listrik Agnijaya Weimana," vol. 10, no. 4, pp. 189–196, 2023.

J. T. Hidayat, "198-Article Text-1683-1-10-20240404," vol. 8, no. 2, pp. 132–138, 2024.

Auto2000, "Mengenal Perbedaan BEV, PHEV, HEV dan FCEV," 31 August. Accessed: Jun. 14, 2024. [Online]. Available: https://auto2000.co.id/berita-dan-tips/perbedaan-bev-phev-hev-fcev-ulasan

I. Kartiko, N. Kamaludin Al-Fatih, R. W. Fredric Jala Watu Jr, and D. Ayu Safitri, "Pengembangan Kendaraan Listrik Hemat Energi untuk Transportasi Kota yang Ramah Lingkungan," vol. 2, no. 2, pp. 222–227, 2024.

N. Nurdjanah, "Jurnal Penelitian Transportasi Darat," *Jurnal Penelitian Transportasi Darat*, vol. 20, no. 1, pp. 17–32, 2018.

D. D. Suranto, S. Anwar, M. Nuruddin, A. Rofi'i, and A. T. Zain, "Analisa Perancangan dan Pengujian Kendaraan Listrik Roda Dua dengan Variasi Pembebanan," *J-Proteksion: Jurnal Kajian Ilmiah dan Teknologi Teknik Mesin*, vol. 7, no. 2, pp. 47–53, 2023, doi: 10.32528/jp.v7i2.8927.

R. Adha, "Analisis Pembelian Mobil Listrik Menggunakan Metode Analytical Hierarchy Process (AHP) dan Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)," *Jist.Publikasiindonesia.Id*, vol. 1, no. 2, pp. 476–485, 2020, doi: 10.30865/klik.v4i1.1201.

R. Teknik *et al.*, "JURNAL ANGKA Peningkatan Kesadaran dalam Penggunaan Kendaraan Listrik di Lingkungan Universitas Negeri Semarang Melalui Kampanye Energi Bersih Sitasi," *Jurnal Angka*, vol. 1, no. 1, pp. 120–134, 2024.

A. F. Gandajati and L. P. Mahyuni, “Kendaraan listrik di mata gen y: faktor apa yang menjelaskan minat belinya?,” *Forum Ekonomi: Jurnal Ekonomi, Manajemen dan Akuntansi*, vol. 24, no. 4, pp. 717–723, 2022, doi: 10.30872/jfor.v24i4.10436.

J. Hutahaean and M. Badaruddin, “Sistem Pendukung Keputusan Pemilihan Sekolah SMK Swasta Penerima Dana Bantuan Menerapkan Metode Simple Additive Weighting (SAW),” *JURNAL MEDIA INFORMATIKA BUDIDARMA*, vol. 4, no. 2, p. 466, Apr. 2020, doi: 10.30865/mib.v4i2.2109.

F. B. Larasati *et al.*, “Penetapan Metode SMART (Simple Multi Attribute Rating Technique) Dalam Merekomendasikan Toko Roti Terbaik Kota Pematangsiantar,” *Prosiding Seminar Nasional Riset Dan Information Science (SENARIS)*, vol. 2, pp. 117–123, 2020.

Z. Azhar, N. Mulyani, J. Hutahaean, and A. Mayhaky, “Sistem Pendukung Keputusan Pemilihan E-Commerce Terbaik Menggunakan Metode MOOSRA,” *Jurnal Media Informatika Budidarma*, vol. 6, no. 4, p. 2346, 2022, doi: 10.30865/mib.v6i4.4775.

N. Ndruru, M. Mesran, F. Tinus Waruwu, and D. Putro Utomo, “Penerapan Metode MABAC Untuk Mendukung Pengambilan Keputusan Pemilihan Kepala Cabang Pada PT. Cefa Indonesia Sejahtera Lestari,” *Resolusi : Rekayasa Teknik Informatika dan Informasi*, vol. 1, no. 1, pp. 36–49, 2020, doi: 10.30865/resolusi.v1i1.11.

A. Yanda and M. Mesran, “Penentuan Penerima Bantuan Pangan Non Tunai (BPNT) Menerapkan Metode Multi Objective Optimization on the Basis of Ratio Analysis (MOORA),” *Bulletin of Informatics and Data Science*, vol. 1, no. 2, p. 38, 2022, doi: 10.61944/bids.v1i2.42.

D. Hariyanto *et al.*, “Implementasi Metode,” *jurnal Al-ilmi*, vol. 13, no. 1, pp. 110–117, 2021.

S. Syam, A. Waworuntu, A. Ayuningtyas, R. Harun, and L. Nadjamuddin, “Sistem Pendukung Keputusan Pemilihan Tablet PC Menggunakan Metode WASPAS dan MOORA,” *Building of Informatics, Technology and Science (BITS)*, vol. 4, no. 4, 2023, doi: 10.47065/bits.v4i4.3147.

M. Mesran, M.Kom, J. H. Lubis, and I. F. Rahmad, “Penerapan Metode Multi-Objective Optimization on the Basic of Ratio Analysis (MOORA) dalam Keputusan Penerimaan Siswa Baru,” *Bulletin of Informatics and Data Science*, vol. 1, no. 2, p. 73, 2022, doi: 10.61944/bids.v1i2.40.

A. Arofah and Respitawulan, “Sistem Pendukung Keputusan Penentuan Kenaikan Kelas Santri Menggunakan Metode TOPSIS,” *Jurnal Riset Matematika*, pp. 121–128, 2022, doi: 10.29313/jrm.v2i2.1194.

R. Putratama Fitri, M. Jumald, A. H. Endang, F. Syafaat, A. Z. Syaharuddin, and M. Syafaat, “Analisa Pemilihan Siswa Mekanik Terbaik Dalam Program Magang Di Perusahaan Aldi Motor Dengan Menggunakan Metode Topsis Status Artikel,” *Surabaya Jurnal Sistem Cerdas dan Rekayasa (JSCR)*, vol. 4, no. 1, pp. 2656–7504, 2022.

T. O. Yuneta and F. N. Aprian, “Analisis Prioritas Pemilihan Supplier Pembelian Bahan Baku Menggunakan Metode TOPSIS Pada UD . XYZ,” vol. 03, no. 01, 2024.