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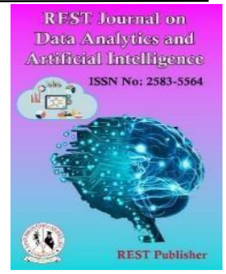

Selection Criteria and Comparative Analysis of Commercially Available Electric CARS Using the MOORA Method

***Vinod M S, Surender Kumar Shilla**
Sunrise University, Alwar, Rajasthan, India.
*Corresponding Author Email: Vinodsoudhas@gmail.com

Abstract: *The rapid development of electric vehicle (EV) technology has led to a significant transformation in the global automobile industry. With environmental concerns and rising fuel costs, consumers are increasingly drawn to electric cars as a sustainable alternative. However, choosing the right electric vehicle can be complicated due to the wide range of models, specifications, and features available. The aim of this study is to develop a comprehensive and data-driven methodology for evaluating and ranking commercially available electric cars. By using multi-criteria decision-making (MCDM) methods, this research facilitates informed decision-making for consumers, policymakers, and manufacturers in the emerging electric vehicle market. Research Significance: This study has significant value in the context of sustainable transportation and consumer choice optimization. By applying a structured approach using MCDM techniques, this research bridges the gap between technical vehicle specifications and user-centered decision-making. It empowers consumers with a transparent framework to evaluate electric vehicles based on important performance, efficiency, and cost parameters. In addition, it helps policymakers in devising incentives and strategies to promote appropriate EV models. These findings help manufacturers understand consumer preferences and thereby improve product development and market alignment. Overall, this study contributes to the rapid adoption of environmentally friendly transportation solutions. Mythology: Alternative: Nissan Leaf e+, BMW i3, Chevrolet Bolt EV, Tesla Model S, Renault ZOE, Hyundai Ioniq EV, Volkswagen e-Golf, Kia Soul EV, Smart Fortwo, Mini E. Evaluation Parameters: Battery capacity, Range, Quick charge time, Acceleration. Result: The results indicate that Volkswagen e-Golf achieved the highest rank, while Tesla Model S the lowest rank being attained. Conclusion: "The value of the dataset for Electric CAR, according to the MOORA Method, Volkswagen e-Golf achieves the highest ranking."*

Key Words: *Electric vehicles, multi-criteria decision making, AHP (Analytical Hierarchy Process), electric vehicle performance evaluation, sustainable transportation, consumer preference, electric vehicle selection criteria, environmentally friendly vehicles, vehicle ranking.*

1. INTRODUCTION

The transportation sector is undergoing significant transformation due to growing environmental concerns, energy sustainability challenges, and rapid technological advancements. At the center of this transformation is the electric vehicle (EV), which has evolved from a niche invention to a key solution in combating climate change and reducing global dependence on fossil fuels. Once dismissed as impractical or limited, electric cars are now central to global strategies aimed at achieving clean, sustainable mobility. [1] Although electric vehicles may seem like a product of the modern era, their origins date back to the 19th century. Early inventors such as Robert Anderson and Thomas Davenport experimented with battery-powered transportation, and by the early 1900s, electric vehicles were gaining popularity in urban areas for their quiet operation and ease of use—advantages over the noisy, cumbersome internal combustion engine (ICE) cars of the time. However, the advent of mass production techniques, particularly those developed by Henry Ford, and the increased availability of cheap petroleum led to the widespread dominance of ICE vehicles. [2]

FIGURE 1. Electric CAR

The renaissance of electric vehicles in the late 20th and early 21st centuries was driven by growing environmental awareness and significant advances in battery performance and technology. A key catalyst in this modern renaissance was Tesla Motors, founded in 2003. Tesla revolutionized the electric vehicle market by proving that electric cars could deliver high performance, impressive range, and cutting-edge technology. Models like the Roadster and Model S not only competed with traditional vehicles, but often outperformed them, helping to change public perception and accelerate mainstream adoption of electric vehicles.[3] A key driving force behind the global shift to electric vehicles (EVs) is their potential to significantly reduce environmental degradation. Unlike internal combustion engine (ICE) vehicles, EVs operate without tailpipe emissions, offering significant benefits in cities suffering from air quality issues. Nevertheless, a comprehensive assessment of their environmental impact must take into account the entire life cycle – from production to use and eventual disposal. Production phase: The production of electric cars, especially their batteries, incurs higher environmental costs compared to conventional vehicles. Battery production involves intensive energy use and the extraction of rare raw materials, which raises sustainability concerns.[4] Operation phase: During use, EVs emit significantly fewer greenhouse gases, especially when charged using clean, renewable energy sources such as sunlight or wind. However, when the power grid relies on fossil fuels particularly coal – the emission reduction is less pronounced, although still better than ICE vehicles in most situations. Lifecycle considerations: Responsible recycling and reuse of EV batteries is essential for sustainability. Advances in battery recycling technologies and applications such as secondary energy storage are helping to reduce the long-term environmental footprint of electric vehicles. Beyond technical and environmental aspects, psychological and social factors greatly influence the adoption of electric vehicles. Research shows that emotions such as pride in owning environmentally friendly technology or fear of environmental degradation often shape consumer preferences and choices.[5] Several psychological drivers include: Environmental awareness: Individuals with strong environmental values are more likely to purchase electric vehicles. Novelty appeal: The perception of electric vehicles as modern and innovative attracts technology enthusiasts and trend-conscious consumers. Social identity: Owning an electric vehicle can reflect a commitment to sustainability or a progressive lifestyle, reinforcing personal and social identity. Driving experience: Features such as instant acceleration, quiet operation, and smooth driving improve user satisfaction and contribute to positive adoption experiences. However, there are some behavioral barriers. Traditional reliance on gasoline vehicles, skepticism about new technologies, and reluctance to switch from familiar systems pose challenges to widespread electric vehicle integration – especially among consumers who are less motivated by environmental concerns.[6] Despite their benefits, several key barriers hinder the widespread adoption of electric vehicles: Range concerns: Persistent concerns about the limited range of electric vehicles discourage some consumers, even though modern models now offer up to 300–400 miles on a single charge. Charging infrastructure: Inadequate public charging networks, especially fast-charging options, remain a significant barrier, especially in rural or underdeveloped areas. High initial costs: Electric vehicles typically have higher purchase prices due to battery costs, although these can be offset over time through lower operating costs and government incentives. Battery Life and Recycling: Concerns about long-term battery performance and limited availability of recycling facilities may deter potential buyers. Energy Grid Readiness: The growing demand for electric vehicles demands significant improvements to the electricity grid and a shift towards cleaner power sources to ensure sustainable large-scale adoption.[7] To accelerate the transition to electric vehicles (EVs), governments around the world are implementing a variety of support policies and initiatives. These efforts are designed to overcome barriers to adoption and promote clean, sustainable transportation systems. Fiscal incentives play a key role. Many countries offer subsidies, tax breaks, and purchase incentives that reduce the upfront cost of EVs. Incentives such as lower road taxes, toll exemptions, and access to high-occupancy vehicle (HOV) or bus lanes further enhance the attractiveness of owning an electric car. [8] Regulatory measures also contribute significantly. Governments are introducing strict fuel efficiency standards and carbon emissions targets, forcing automakers to shift their production lines toward electric mobility. In addition, some regions are setting clear deadlines for phasing out internal combustion engine (ICE) vehicles. Public sector investments are equally important. Many countries are funding the development of EV charging infrastructure, supporting research into advanced battery technologies and encouraging pilot projects to test new mobility models. For example, the European Union has committed to banning the sale of ICE vehicles by 2035, while Norway's aggressive incentives have led to more than 80% of new car sales being electric. [9] Looking ahead, the future of EVs is promising. Advances in autonomous driving, smart connectivity and vehicle-to-grid (V2G) technology are placing EVs at the heart of next-generation mobility solutions. Hydrogen fuel cells, plug-in hybrids and circular economy strategies that focus on recycling and reusing components are also gaining traction. As battery costs fall and consumer awareness increases, electric vehicles are expected to become the dominant choice in global transportation. Industry analysts predict that by 2040, more than 50% of new vehicles sold globally will be electric – creating a transformative era for the automotive industry and contributing significantly to global climate goals. [10]

2. MOORA METHOD

The MOORA (Multi-Objective Optimization by Ratio Analysis) method is a widely recognized technique used in multi-criteria decision-making (MCDM) problems. The method is very useful when making decisions based on multiple conflicting criteria, and is often used in fields such as engineering, management, economics, and environmental sciences. The essence of MOORA is to provide a systematic approach to selecting the best alternative from a set of options, considering multiple criteria. The MOORA method simplifies this evaluation process by assigning weights to each criterion and then evaluating the performance of the alternatives relative to these criteria. MOORA provides a structured approach to dealing with complex decisions where objectives compete, such that improving one objective may worsen others. It is a ratio analysis method in which alternatives are ranked based on the weighted sum of the criterion values. This method ensures that the performance indicators are maximized or minimized based on the decision maker's goals. The MOORA method was developed by Dr. B.S. Haldar and his colleagues in the late 1990s. The primary goal was to improve the decision-making process for complex industrial and organizational problems, especially in cases where there are multiple conflicting objectives. Over time, the MOORA method has become popular in the decision-making community, especially for applications in engineering and management. Although the MOORA method shares similarities with other multi-criteria decision-making methods, such as the Analytic Hierarchy Process (AHP) or the Technique for Ordered Prioritization by Similarity (TOPSIS), it differs in the way it handles the decision matrix and optimizes the criteria. Constructing a Decision Matrix The first step involves constructing a decision matrix that includes all the alternatives and their associated performance values for each criterion. Let us consider a decision problem with n alternatives (A1, A2, A3..., An) and m criteria (C1, C2, C3..., Cm).

$$D = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

Normalize the Data: Standardize the data for each criterion to achieve uniformity in scale. This step is essential to prevent any single criterion from overpowering the decision-making procedure due to its larger measurement range.

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

$where\ i \epsilon [1, m]\ and\ j \in [1, n]$

In the MOORA method, each criterion is assigned a weight based on its importance relative to other criteria. The weights are usually summed to 1 and normalized. The weight of each criterion is denoted w_j, where w_j is the weight of criterion Cj. These weights reflect the relative importance or priority of each criterion in the decision-making process. In some cases, the weights may be provided by experts, or they may be derived using methods such as AHP or Analytical Network Process (ANP). Once the decision matrix is normalized and weights are assigned, the next step is to calculate a performance score for each alternative. This is done by multiplying each normalized value by the corresponding criterion weight and summarizing the results. The performance score for alternative Ai is S_i, w_j is the weight of the criterion for Cj, and y_ij is the normalized performance value of alternative Ai for Cj. The result is the weighted sum of the normalized performance of each alternative across all criteria. Finally, the alternatives are ranked based on their performance scores. The alternative with the highest score is considered the best, while the one with the lowest score is considered the worst. The ranking helps decision makers identify the most suitable option based on their preferences for various criteria. Simplicity and ease of use: The MOORA method is relatively simple to implement, requiring only basic mathematical operations. It does not involve complex calculations, making it accessible even to practitioners with little experience in optimization. Flexibility: MOORA is flexible and can handle both maximization and minimization problems. This allows it to be used in a variety of domains where objectives may vary. No pairwise comparisons required: Unlike other methods such as AHP, MOORA does not require pairwise comparisons between alternatives, which can sometimes be difficult or subjective. Transparency: The method is straightforward, making it easy to understand and interpret the results. This transparency helps explain the decision-making process to stakeholders. Applicability across domains: MOORA has been successfully used in a variety of fields, including engineering, business, environmental management, and healthcare.

3. MATERIALS

When evaluating electric vehicle (EV) models based on key parameters such as battery capacity, driving range, fast charging time, and acceleration, it is crucial to compare how each vehicle performs in these areas. This comparison helps consumers, manufacturers, and policymakers make informed decisions about which vehicle best meets their specific needs. Battery capacity plays a key role in the performance of an EV, as it determines the amount of power available and affects the vehicle's range. The Nissan Leaf e+, Hyundai Ioniq EV, and Chevrolet Bolt EV all have relatively large battery capacities, providing extended power for longer journeys. The Tesla Model S, while not equipped with the largest battery, improves its battery performance through advanced technology, achieving better range and acceleration without the need for a bulky battery. In contrast, the BMW i3 and Mini E have smaller batteries, which affects both their driving range and charging time. Range, which refers to the distance a vehicle can travel on a single charge, is another essential factor. The Tesla Model S leads the way in this area, offering a significantly longer driving range than most other models. This is due to its powerful battery and energy storage systems, making it a popular choice for long-distance trips. The Nissan Leaf e+ and Chevrolet Bolt EV offer a range of over 300 kilometers, which is suitable for most everyday use. However, smaller vehicles like the BMW i3 and Mini E offer shorter ranges, making them more suitable for city driving or short trips. Fast charging times are crucial to the practicality of an EV. The BMW i3 stands out with its fast-charging capabilities, helping users get back on the road quickly. The Hyundai Ioniq EV and Chevrolet Bolt EV also offer relatively fast charging times. On the other hand, although the Nissan Leaf e+ has a larger battery, its charging times are slower, which can be inconvenient for users with time constraints. The Smart Fortwo and Mini E have fast charging capabilities, but their smaller batteries limit their range and require frequent charging. Acceleration is another factor that contributes to the driving experience. The Tesla Model S is a great car to drive, rivaling sports cars, and is capable of reaching 0 to 100 km/h in a shorter time than many other models. The Kia Soul EV and Hyundai Ioniq EV offer good acceleration, offering a balance of speed and practicality. However, the Volkswagen e-Golf and Smart Fortwo have mediocre acceleration, which may not meet the expectations of those looking for high performance.

4. ANALYSIS AND DISSECTION

TABLE 1. Data Set

	Battery capacity	Range	Quick charge time	Acceleration
Nissan Leaf e+	62.00	382.00	90.00	7.90
BMW i3	33.20	260.00	25.00	7.30
Chevrolet Bolt EV	60.00	320.00	100.00	7.80
Tesla Model S	70.00	539.00	40.00	2.40
Renault ZOE	41.00	300.00	30.00	10.00
Hyundai Ioniq EV	100.00	311.00	54.00	9.90
Volkswagen e-Golf	35.80	201.00	60.00	9.60
Kia Soul EV	64.00	448.00	54.00	11.20
Smart Fortwo	62.00	132.00	45.00	12.70
Mini E	32.60	176.00	36.00	6.90

Table 1 provides data on the performance and efficiency of ten electric car models, highlighting key characteristics such as battery capacity (kWh), driving range (km), rapid charging time (min) and acceleration from 0 to 100 km/h (sec). The Hyundai Ioniq EV has the largest battery at 100 kWh; however, its 311 km range indicates that the battery may not be used to its full potential. On the other hand, the Tesla Model S offers the largest range at 539 km with a 70-kWh battery and has the fastest acceleration of 2.4 seconds, reflecting both high efficiency and top-level performance. Vehicles such as the Nissan Leaf e+ and Kia Soul EV also have sizeable batteries ranging from 62 to 64 kWh and offer significant ranges of 382 km and 448 km, respectively. While their acceleration and rapid charging times are average, they offer solid options for long-distance travel. The BMW i3 and Chevrolet Bolt EV, with smaller battery capacities of 33.2 kWh and 60 kWh, respectively, achieve a commendable acceleration time of under 8 seconds. Notably, the BMW i3 charges faster, in just 25 minutes. Entry-level models like the Smart Fortwo and Mini E come with shorter ranges (132 km and 176 km) and less impressive acceleration times (12.7 and 6.9 seconds), making them more suited to city use than performance-oriented driving. In short, the Tesla Model S stands out as a very well-designed vehicle, while other models cater to specific needs such as cost-effectiveness, daily commuting, or moderate performance.

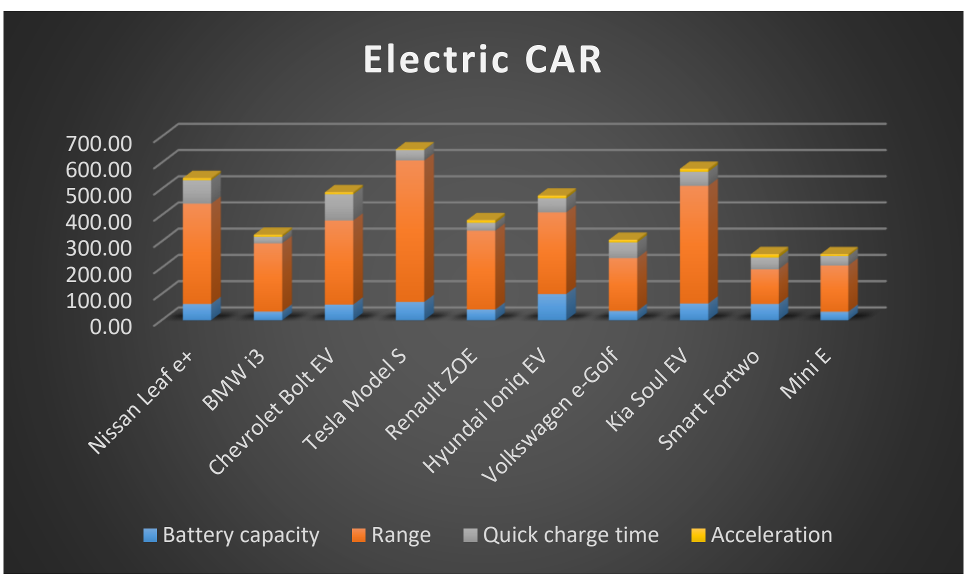

FIGURE 2. Data Set

Figure 1 presents a bar chart comparing ten electric car models based on four key performance factors: battery capacity, driving range, fast charging time, and acceleration. The bars are color-coded to distinguish each attribute, providing a clear comparative view of how each model performs on these metrics. The Tesla Model S emerges as the leading performer, with one of the tallest bars in the chart. It combines the highest range and fastest acceleration despite not having the largest battery, reflecting its advanced energy efficiency and engineering design. In contrast, the Hyundai Ioniq EV has the largest battery capacity but does not achieve a correspondingly high range, indicating possible inefficiencies or different design priorities. Models like the Kia Soul EV and Nissan Leaf e+ demonstrate a well-rounded balance between battery size and range, making them ideal for extended driving. The BMW i3 and Chevrolet Bolt EV have relatively small batteries but still deliver strong acceleration. Notably, the BMW i3 stands out for its minimal fast charging time, which shows its convenience for users who need a quick recharge. In comparison, the Smart Fortwo and Mini E appear with short bars, indicating limited range and slow acceleration. These models seem more practical for short, city-based trips rather than high-speed or long-distance use. Overall, the chart in Figure 1 highlights how different electric vehicles meet different user needs - some excel in range and speed, while others emphasize efficiency, compact design or fast charging capability.

TABLE 2. Normalized Data

	Battery capacity	Range	Quick charge time	Acceleration
Nissan Leaf e+	0.3295	0.3671	0.4883	0.2781
BMW i3	0.1764	0.2499	0.1356	0.2570
Chevrolet Bolt EV	0.3188	0.3075	0.5425	0.2746
Tesla Model S	0.3720	0.5180	0.2170	0.0845
Renault ZOE	0.2179	0.2883	0.1628	0.3521
Hyundai Ioniq EV	0.5314	0.2989	0.2930	0.3485
Volkswagen e-Golf	0.1902	0.1932	0.3255	0.3380
Kia Soul EV	0.3401	0.4306	0.2930	0.3943
Smart Fortwo	0.3295	0.1269	0.2441	0.4471
Mini E	0.1732	0.1691	0.1953	0.2429

Table 2 presents normalized data for ten electric vehicle models, focusing on four key attributes: battery capacity, driving range, fast charging time, and acceleration. Normalization scales each variable to a common range (typically 0 to 1), allowing for direct comparisons of performance across different metrics without being affected by different units or scales. Among the models, the Hyundai Ioniq EV displays the highest normalized value for battery capacity (0.5314), highlighting its relatively large battery. However, its normalized range (0.2989) is significantly lower, indicating that a larger battery does not guarantee a longer driving range. In contrast, the Tesla Model S exhibits the best normalized range (0.5180) and the lowest normalized acceleration value (0.0845). In this context, since lower acceleration values indicate faster performance, the Tesla stands out for both speed and energy efficiency. Models like the BMW i3 and Mini E score low in most categories, particularly battery size and range, indicating more limited capabilities. The Smart Fortwo also has the lowest range score (0.1269) but records a high acceleration score (0.4471), indicating slower acceleration performance. Meanwhile, the Kia Soul EV delivers a well-rounded profile with solid normalized values for both range (0.4306) and acceleration (0.3943), indicating a good balance between efficiency and performance. Overall, this normalized dataset improves the clarity of the performance comparisons. It underscores Tesla's superiority in speed and range, while highlighting that larger batteries don't always translate to extended driving range, as seen with the Hyundai – reflecting differing engineering approaches across manufacturers.

TABLE 3. Weight

Nissan Leaf e+	0.25	0.25	0.25	0.25
BMW i3	0.25	0.25	0.25	0.25
Chevrolet Bolt EV	0.25	0.25	0.25	0.25
Tesla Model S	0.25	0.25	0.25	0.25
Renault ZOE	0.25	0.25	0.25	0.25
Hyundai Ioniq EV	0.25	0.25	0.25	0.25
Volkswagen e-Golf	0.25	0.25	0.25	0.25
Kia Soul EV	0.25	0.25	0.25	0.25
Smart Fortwo	0.25	0.25	0.25	0.25
Mini E	0.25	0.25	0.25	0.25

Table 3 shows the weights assigned to each of the ten electric vehicle models across the four criteria. For each model – such as the Nissan Leaf e+, BMW i3 or Tesla Model S – the weights are distributed equally, with each criterion receiving a value of 0.25. This equal weighting indicates that all four criteria (including factors such as battery capacity, driving range, fast charging time and acceleration) are considered to be of equal importance in the decision-making process. The even distribution of weights indicates that no single criterion is given priority over the others, which supports a balanced assessment of all performance factors. This approach is beneficial when each criterion is considered equally important to the overall vehicle performance, ensuring a fair comparison across all aspects. By assigning the same weight to each criterion for each vehicle, the table creates an objective and unbiased basis for further analysis. However, in practice, this approach may not fully reflect consumer preferences or real-world priorities, as some features – such as driving range or battery capacity – may be more important to some users than others, depending on individual needs or specific use cases.

TABLE 4. Weighted normalized DM

Nissan Leaf e+	0.0824	0.0918	0.1221	0.0695
BMW i3	0.0441	0.0625	0.0339	0.0643
Chevrolet Bolt EV	0.0797	0.0769	0.1356	0.0687
Tesla Model S	0.0930	0.1295	0.0543	0.0211
Renault ZOE	0.0545	0.0721	0.0407	0.0880
Hyundai Ioniq EV	0.1329	0.0747	0.0732	0.0871
Volkswagen e-Golf	0.0476	0.0483	0.0814	0.0845
Kia Soul EV	0.0850	0.1076	0.0732	0.0986
Smart Fortwo	0.0824	0.0317	0.0610	0.1118
Mini E	0.0433	0.0423	0.0488	0.0607

Table 4 illustrates the weighted normalized decision matrix (DM) for ten electric vehicles, assessing their performance based on four key factors: battery capacity, driving range, fast charging time, and acceleration. Each value represents the vehicle's weighted and normalized score for a particular criterion, facilitating a standardized comparison. These figures are generated through a multi-criteria decision-making approach—perhaps using methods such as TOPSIS or SAW—where weights are applied based on the importance assigned to each attribute. In this matrix, higher scores generally indicate stronger performance, depending on whether the criterion benefits from a higher or lower value. Within this framework, the Tesla Model S stands out with a higher score for range (0.1295) and particularly lower values for fast charging time (0.0543) and acceleration (0.0211), which are favored due to its preference for fast charging and fast acceleration. Meanwhile, the Hyundai Ioniq EV leads in battery capacity (0.1329), but its range (0.0747) and acceleration (0.0871) figures reflect more modest results. The Kia Soul EV and Nissan Leaf e+ perform relatively well across all categories, especially range (0.1076 and 0.0918, respectively), although the Kia's higher acceleration score (0.0986) suggests slightly slower speeds. The Chevrolet Bolt EV maintains consistent but unusual scores across all parameters. The BMW i3 records its strongest number in quick charge time (0.0339), although it's underwhelming overall due to weaker performance in other categories. Vehicles like the Volkswagen e-Golf and Mini E score average across the board, indicating neither a strong nor a poor performance in any particular domain. In contrast, the Smart Fortwo, while fair in fast charging (0.0610), performs poorly in range (0.0317) and acceleration (0.1118), making it more suitable for low-demand, urban use.

TABLE 5. Assesment value

	Assesment value
Nissan Leaf e+	-0.0174
BMW i3	0.0084
Chevrolet Bolt EV	-0.0477
Tesla Model S	0.1471
Renault ZOE	-0.0022
Hyundai Ioniq EV	0.0472
Volkswagen e-Golf	-0.0700
Kia Soul EV	0.0209
Smart Fortwo	-0.0587
Mini E	-0.0240

Table 5 completes this analysis by presenting the evaluation values obtained from a comparison with a best-fit solution in a technique such as TOPSIS. These values represent a net performance score, where positive values indicate that a model is close to the optimal solution, and negative values indicate a greater deviation. In this context, the Tesla Model S clearly leads with the highest evaluation score (0.1471), reinforcing its position as the best-performing vehicle in terms of efficiency, speed, and range. It is followed by the Hyundai Ioniq EV (0.0472) and the Kia Soul EV (0.0209), which also offer well-rounded performance. On the other hand, the Volkswagen e-Golf (-0.0700), Smart Fortwo (-0.0587), and Chevrolet Bolt EV (-0.0477) all post significant benchmark scores, indicating that they are less competitive compared to the best benchmark. Although the BMW i3 shows a small positive difference (0.0084), it lags behind the leading competitors. Overall, the combined insights from the weighted normalized DM and rating values help identify the best electric vehicle performers. The Tesla stands out as the most balanced and efficient option, while models like the Hyundai Ioniq and Kia Soul meet balanced performance requirements well. Others may appeal more to urban or budget-conscious consumers, depending on their priorities.

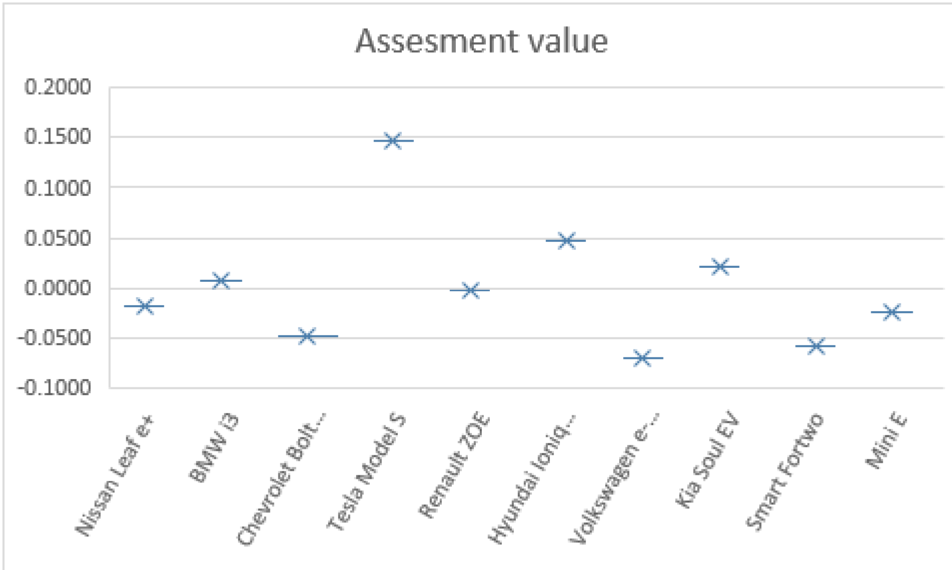

FIGURE 3. Assesment value

Figure 2 displays a scatter plot illustrating the assessment values for ten electric car models. These values are derived from a multi-criteria decision-making (MCDM) process, evaluating each car across four key performance indicators: battery capacity, driving range, quick charge time, and acceleration. The assessment value reflects how each car's performance compares to an ideal solution, with methods like TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) being used for calculation. Higher positive values indicate closer alignment with the ideal performance profile, while negative values suggest a greater deviation from the optimal solution. The Tesla Model S leads the group with the highest assessment value of approximately 0.15, solidifying its position as the top performer. This result highlights the vehicle's exceptional range, quick acceleration, and energy efficiency—all crucial attributes in electric mobility. Tesla's focus on balancing these performance factors across multiple dimensions contributes to its strong standing in this evaluation. The Hyundai Ioniq EV and Kia Soul EV also perform well, each earning positive assessment values. While the Ioniq EV has the largest normalized battery capacity, it manages to achieve a balanced performance across other parameters like range and acceleration. The Kia Soul EV, although not excelling in any one category, maintains a solid performance across the board, resulting in a respectable overall score. BMW i3 and Renault ZOE fall closer to the average, with near-zero values. The BMW i3 excels in quick charging but underperforms in range and battery capacity, whereas the Renault ZOE displays balanced performance across the board but lacks standout features. These cars may appeal to buyers with specific needs, such as city driving or affordability, but they don't offer the best overall performance. On the lower end, several models score negatively, indicating performance shortcomings relative to the ideal. The Volkswagen e-Golf and Smart Fortwo are among the lowest scorers, with assessment values around -0.07 and -0.06, respectively. These cars are weaker in key areas like range and acceleration, which are essential for long-distance travel and dynamic driving. The Chevrolet Bolt EV also has a relatively low score of around -0.05, reflecting its lack of dominance in any particular area, despite being competitive in certain metrics. Finally, the Mini E and Nissan Leaf e+ have slightly negative values, placing them just below average. While they offer acceptable range and compact designs, they lag behind the higher-performing models in terms of overall efficiency and capability.

TABLE 6. Rank

	Rank
Nissan Leaf e+	6
BMW i3	4
Chevrolet Bolt EV	8
Tesla Model S	1
Renault ZOE	5
Hyundai Ioniq EV	2
Volkswagen e-Golf	10
Kia Soul EV	3
Smart Fortwo	9
Mini E	7

Table 6 shows the rankings of ten electric car models based on their overall performance, as determined by a number of criteria. The Tesla Model S tops the list, taking 1st place and solidifying its position as the highest-performing vehicle in the dataset. Its superior performance in areas such as range, acceleration and energy efficiency contribute to this high ranking. The Hyundai Ioniq EV comes in 2nd place, benefiting from its large battery capacity and strong performance in key areas such as range and acceleration. The Kia Soul EV comes in 3rd place, offering well-rounded performance across all metrics assessed, earning a competitive overall score. The BMW i3, in 4th place, stands out for its fast-charging time and unique design. However, it lags behind in aspects such as range and battery capacity, which drags down its overall position. The Renault ZOE, in 5th place, offers balanced but exceptional performance, placing it in the middle of the rankings. At the bottom, the Volkswagen e-Golf and Smart Fortwo are ranked 10th and 9th, respectively. These models struggle in key performance areas such as range and acceleration, making them less competitive overall. The Chevrolet Bolt EV and Mini E, ranked 8th and 7th, respectively, show modest results, although they do offer some strengths in some areas. In summary, Table 6 illustrates the relative strengths and weaknesses of these vehicles, with the Tesla Model S clearly outperforming the others, followed by models that offer a balanced or exceptional mix of performance.

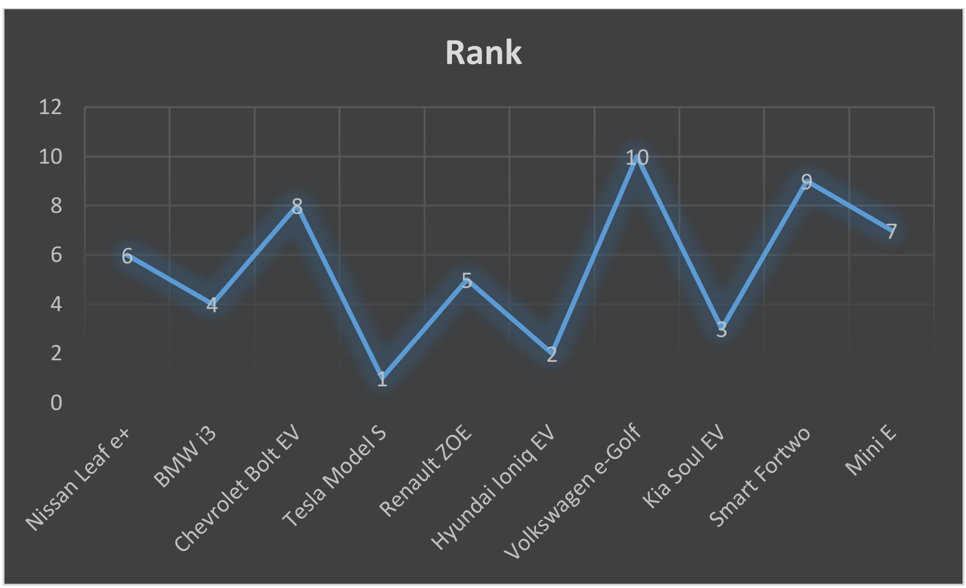

FIGURE 4. Rank

Figure 4 illustrates the overall ranking of ten commercially available electric vehicle (EV) models based on a combined assessment of the key performance criteria of battery capacity, driving range, fast charging time, and acceleration. The Tesla Model S stands out in the top ranking (rank 1), indicating its excellent performance across all selected parameters. Its fast acceleration, extended range, and robust engineering contribute to this leading position. Following Tesla, the Hyundai Ioniq EV and Kia Soul EV perform well, taking 2nd and 3rd place, respectively, due to their balance of efficient charging times, decent driving range, and favorable user experience. The BMW i3 and Renault ZOE fall into the middle range with 4th and 5th places, indicating mediocre performance compared to their top competitors.

The Nissan Leaf e+ and Mini E are slightly below average, ranking 6th and 7th, respectively, likely due to limitations in charging speed or range despite their reasonable battery capacities. At the bottom, the Chevrolet Bolt EV (ranked 8), Smart Fortwo (ranked 9), and Volkswagen e-Golf (ranked 10) show weak overall performance. These rankings may reflect trade-offs in one or more important attributes, such as slow acceleration, short range, or limited charging infrastructure compatibility, which affect their competitiveness in the current EV market.

5. CONCLUSION

The shift towards sustainable and energy-efficient transportation has increased interest in electric vehicles (EVs) globally. However, the variety of models available and the complexity of specifications can make choosing the right EV a challenge for consumers. This research aims to simplify the process by using a multi-criteria decision-making (MCDM) approach – specifically, the technique for order prioritization (TOPSIS) combined with the analytical hierarchy process (AHP) – to evaluate and rank commercially available electric cars in India. The study began by identifying important criteria for EV selection, including price, battery capacity, range, motor power, maximum speed, torque, charging time, and acceleration. AHP was used to determine the relative importance (weights) of these criteria based on expert judgment and user preferences. These weights reflect real-world priorities such as the need for a long driving range or short charging times. Then, TOPSIS was used to evaluate and rank the electric vehicles based on how close each option was to the best solution, taking into account best and worst-case performance scenarios. The combination of AHP and TOPSIS proved effective in providing a robust, consistent and transparent assessment of EV options. The results revealed that some models consistently outperformed others across multiple criteria, highlighting vehicles that are most suitable for Indian consumers seeking to balance performance, affordability and sustainability. Furthermore, this study emphasizes the versatility of MCDM techniques in automotive decision-making contexts. The proposed framework can be easily updated as new EV models are introduced or technology evolves. It is adaptable to different regional markets by revising the weights and selection criteria to reflect local preferences or conditions.

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