

The Impact of Charging Socket Location on User Experience in Electric Vehicles: An Evaluation Based on Survey Findings from the Case of Türkiye

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ABSTRACT: The rapid increase in the number of electric vehicles (EVs) has brought about new design and usage problems in terms of infrastructure and user experience. This research, using a quantitative and correlational design, aimed to determine the experiences, satisfaction levels, and suggestions of electric vehicle users in Türkiye and Europe regarding charging socket locations. Participants answered a questionnaire containing 10 questions prepared by the researchers. Data was collected via Google Forms and then analyzed using Microsoft Excel. The questionnaire, answered by 275 participants, provided a detailed analysis of vehicle brands, socket locations, problems encountered in these locations, and user preferences. According to the findings, the most common charging socket location is the right rear corner, and a significant portion of participants prefer double-sided charging ports. Furthermore, more than 75% of users stated that standardization of charging sockets among manufacturers is necessary. The data obtained indicate the importance of a user-centric approach in electric vehicle design and the necessity of standardization in terms of infrastructure compatibility.

KEYWORDS: *Electric cars, charging issues, user issues, ergonomics, standardization, charging socket placement*

I. INTRODUCTION

Globally, the automotive industry has entered a rapid transition to electric vehicles (EVs) in order to reduce its reliance on fossil fuels and control carbon emissions. Both the European Union's ban on the sale of internal combustion engine vehicles after 2035 and efforts to make urban transportation more environmentally friendly have made this transformation inevitable. [1] Türkiye has also gained significant momentum in the EV market with both domestically produced (e.g., TOGG) and imported models, in parallel with this change. The technical advancements in electric vehicles are not limited to battery technology or motor efficiency alone. Many factors directly impact the user experience, influencing usage frequency, charging behavior, and overall satisfaction. Among these factors, the location of the charging socket plays a critical role, both ergonomically and in terms of compatibility with urban charging infrastructure.

The variability in socket locations due to different design preferences of different manufacturers can cause users to encounter problems such as parking position adjustment, cable access, and station compatibility. In this context, the necessity of standardizing the charging socket location has become a subject of discussion, both for individual use and for practicality in public charging stations. Parallel to the rapid development of electric vehicle technologies, infrastructure systems that enable these vehicles to be charged efficiently are also gaining importance. Especially as the use of automatic or robotic charging systems expands, the physical location of charging sockets in vehicles becomes more critical. Recent studies in the literature emphasize that robotic systems experience real-time reliability problems in socket detection and plugging processes, and this makes the standardization of charging port locations necessary. [2] This shows that charging socket placement is a strategic design element not only in terms of user ergonomics but also in terms of the accuracy and safety level of automation systems.

This research aims to measure the satisfaction levels, problems experienced, and attitudes towards standardization of charging socket locations among electric vehicle users in Türkiye. Especially in a period of rapid development in charging infrastructure, the findings of this study will provide important guidance for both manufacturers and urban transportation policies.

II. METHOD

2.1. Research Design

This study is a descriptive research conducted using a quantitative data collection method. Its aim is to systematically reveal the experiences of electric vehicle users regarding charging socket location and to analyze the impact of these experiences on satisfaction levels and the frequency of problems encountered.

2.2. Development of the Survey Form

An online survey form has been designed to collect data. The form consists of a total of 10 questions and includes both closed-ended (multiple-choice) questions and open-ended (interpretation section) questions. The survey questions cover the following main topics:

- Vehicle make used
- Charging socket location
- Satisfaction with the current situation
- Problems related to socket location.
- Experiences at public charging stations
- Preferred socket location
- Opinion on charging socket standardization.

The survey was prepared by reviewing the literature on user experience and design ergonomics.

2.3. Sampling and Data Collection Process

The survey was widely distributed in April 2025 through social media platforms, electric vehicle user forums, and WhatsApp groups for electric vehicle users. A total of 275 electric vehicle users participated in this voluntary study. Participants came from various cities in Türkiye and Europe and owned different makes and models of electric vehicles.

Data was collected from various vehicle brands, with 28% of participants using Hyundai, 14.2% Tesla, 13.1% Renault, and 11.3% TOGG. This distribution demonstrates sufficient diversity, particularly in terms of representing the electric vehicle market in Türkiye.

2.4. Data Analysis

Data was collected via Google Forms and then analyzed using Excel with the Microsoft programming language. Descriptive statistical analyses were performed on the data, and frequencies and percentages were supported by graphs. The relationship between charging port location and satisfaction or problems experienced was examined in depth.

In addition, open-ended comments were thematically categorized, and sample user opinions were included to provide a qualitative perspective. Qualitative data were analyzed using a qualitative phenomenological design, while quantitative **data were analyzed using a quantitative relational design.**

2.5. Limitations

This research has some limitations:

- Because the survey was conducted online and on a voluntary basis, the sample was not random.
- The data is limited to Türkiye and Europe and cannot be directly generalized to overall global results.
- Some users gave inconsistent answers to the survey questions, also complaining about other problems that EA owners have encountered.
- Despite these limitations, the data obtained is valuable because it reflects the views of a significant segment of electric vehicle users in Türkiye and Europe (those who have owned an EV for 3 years or more).

III. FINDINGS

This section analyzes in detail the preferences, problems encountered, and satisfaction levels regarding charging socket location of 275 electric vehicle users who participated in the survey.

3.1. Participants' Vehicle Brands

The most common electric vehicle brands used by the participants were:

- Hyundai 28%
- Tesla 14.2%
- Renault 13.1%
- TOGG 11.3%
- BMW 9.5 %
- MG 8.7%

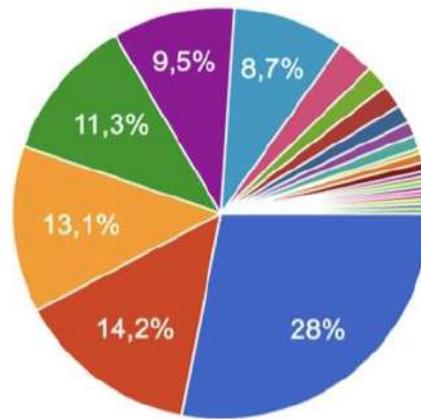


Figure 1. What brand of electric vehicle do you use?

This distribution also reflects the comparative position of domestic and foreign brands in the Turkish market.

3.2. Distribution of Charging Socket Locations

The charging port locations reported by users are as follows:

- Right rear: 91 people (33.2%)
- Left rear: 72 people (26.3%)
- Front section: 59 people (21.5%)
- Front right: 37 people (13.5%)
- Other locations (e.g. , on either side, front left, etc.): 15 people (5.5%)

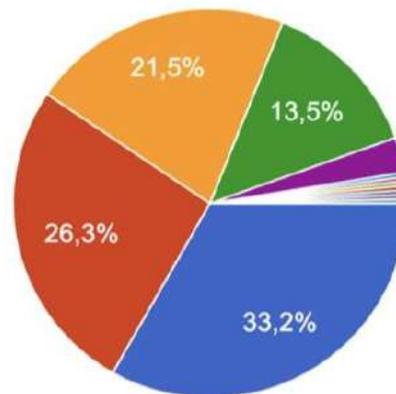


Figure 2: Where is the charging socket located in your vehicle?

As shown in the graph in Figure 2, the rear right and rear left positions have been the most commonly preferred areas **among manufacturers. This directly affects parking positions, especially at charging stations.**

3.3. User Satisfaction

Participants' satisfaction levels regarding the current charging socket location:

- “Yes, I am very satisfied” : 146 people (53.5%)
- “Partially satisfied” : 96 people (35.2%)
- “No, I’m not satisfied” or “I’m not satisfied at all” : 28 people (11.3%)

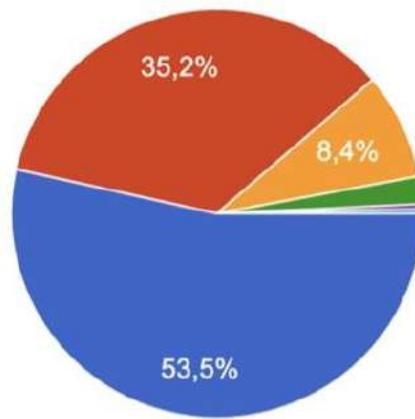


Figure 3. Are you satisfied with the current charging socket location?

These figures indicate a high level of overall satisfaction; however, nearly 47% of users reported varying degrees of dissatisfaction.

3.4. Preferred Charging Socket Location

Users were asked, "Where do you think the charging socket should be located in the car?" The most preferred locations were:

- Two-sided (on both sides): 106 people (38.8%)
- Front center (middle of the hood): 60 people (22%)
- Rear right corner: 33 people (12.1%)
- Rear left corner: 30 people (11%)

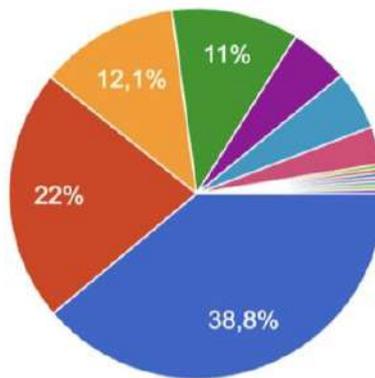


Figure 4. Where do you think the charging socket should be located in the vehicle?

This finding is quite critical because dual-sided systems are not currently found in most vehicles. Users find this option ideal in terms of ease of parking and cable access.

3.5. Problems Encountered During Charging

Users were asked about problems they experienced due to socket location, and these were indicated with multiple-choice options. The most common problems were:

- The cable wasn't long enough. (%29.3)
- Obligation to change parking position (%34.1)
- Risk of tripping over a cable. (%8.1)
- I experienced no problems: 128 people (%46.9)

3.6. Public Charging Experience

Users were asked if they experienced any issues related to socket location at public charging stations:

- No, I've never lived there: 134 people (49.3%)
- Yes, I experienced it occasionally: 93 people (34.2%)
- Yes, frequently: 12 people (4.4%)

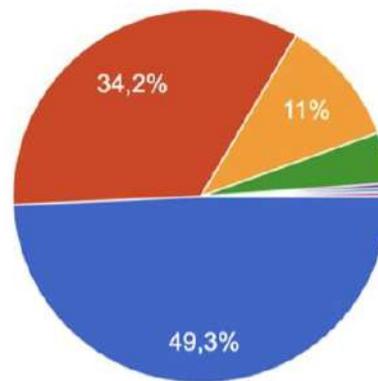


Figure 5. Did you experience any problems at public charging stations based on the charging socket location?

This situation reveals that the charging infrastructure is directly related to the placement of sockets.

3.7. Do Different Socket Locations in Different Vehicles Cause Problems?

- Sometimes there are problems: 79 people
- No, generally compatible: 72 people
- Yes, I'm having problems with charging stations: 52 people.

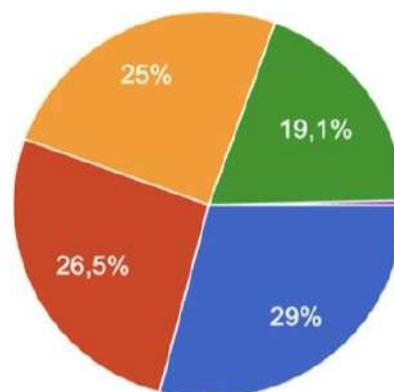


Figure 6. Does the fact that the charging socket is in different locations in different vehicles cause you a problem?

The responses to this question indicate that complex charging infrastructure can cause inconsistencies and difficulties among users.

3.8. Standardization View

Participants were asked whether the charging socket location should be standardized:

- Absolutely yes: 112 people (41%)
- Yes, that would be good: 73 people (26.7%)
- No, every brand should protect its own design: 39 people (14.3%)
- It doesn't matter: 49 people (17.9%)

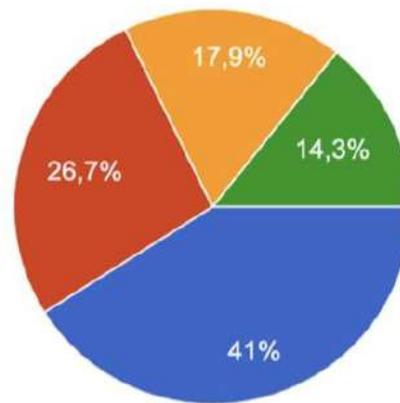


Figure 7: Do you think the location of the charging socket should be standardized for car manufacturers?

These results send a clear message to electric vehicle manufacturers: users demand greater adaptability and predictability. Standardized socket placement is among the top demands of electric vehicle users in Europe and Türkiye, according to these surveys we conducted.

IV. DISCUSSION

The results of this research reveal that electric vehicle users' experiences regarding charging socket location are multifaceted, and that this location directly affects user experience from both ergonomic and operational perspectives. The findings point to various problem areas in terms of both user satisfaction and compatibility with public infrastructure.

4.1. Socket Location and Ergonomic Fit

The location of the charging socket on a vehicle is a design decision that affects many factors during daily use. Firstly, the vehicle's parking position, cable length, cable direction, and the user's physical access to the vehicle all vary significantly depending on the socket's location. In this study, 38.8% of participants stated that they preferred a "double-sided charging socket," highlighting a need for flexibility rather than a fixed location.

This trend suggests that electric vehicle manufacturers should consider more frequently the dual-socket design – located on both the right and left sides of the vehicle – a rare example in the industry, seen in Porsche's Taycan model, which adds an extra cost but offers a highly ergonomic solution for the user. For example, while some brands like Tesla offer charging sockets only on the rear left or BMW on the rear right, some commercial vehicles prefer sockets located in the front center. Although both approaches have advantages, users find dual-sided or front-center locations more convenient in terms of ease of parking and cable access.

With the increasing prevalence of electric vehicles (EVs) today, research on robotic charging systems has also gained momentum. In particular, the location of the charging socket in EVs stands out as one of the key parameters determining the performance of these systems. In a comprehensive review study by Saputra et al. (2023), it is emphasized that one of the biggest technical obstacles faced by robotic charging systems is the positional diversity of charging ports on the vehicle. The placement of ports by different manufacturers in the front, rear, or side sections of the vehicle both reduces the success of socket detection algorithms and complicates the alignment and connection processes of the robotic arm. [2]

The article states that accuracy up to 0.6 mm was achieved, particularly in 6-degree-of-freedom (6-DOF) positioning studies, but this performance could not be consistently maintained due to variable lighting conditions and socket geometries. Furthermore, it is stated that robotic systems do not achieve sufficient reliability in real-time applications, especially in socket detection and plugging processes, and this highlights the need for standardization of charging port position. In conclusion, it is seen that port position is a critical factor not only in terms of user ergonomics but also in terms of the accuracy and safety level of automated systems. [2]

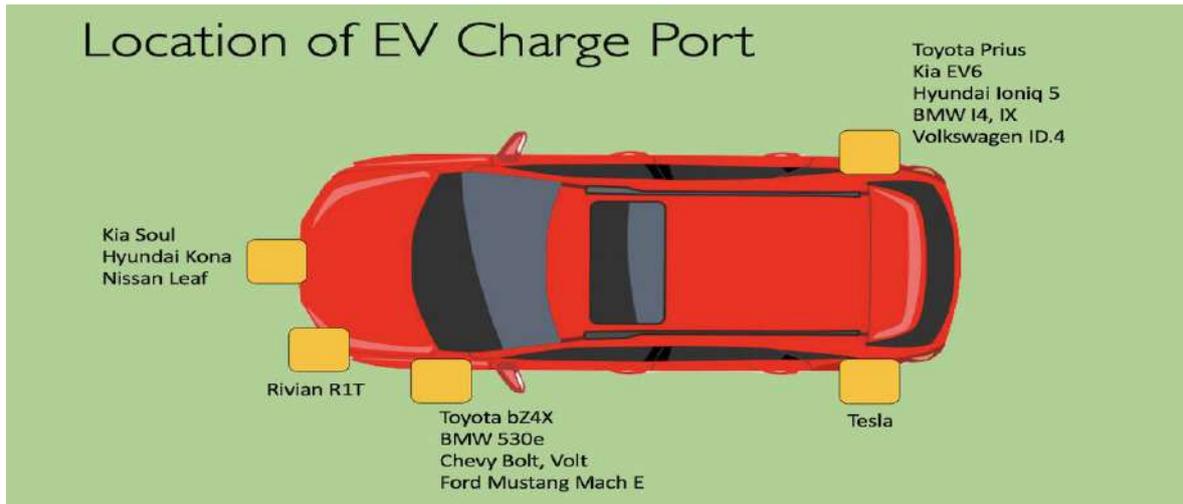


Figure 8. How to Charge Electric Cars at Home? [3]

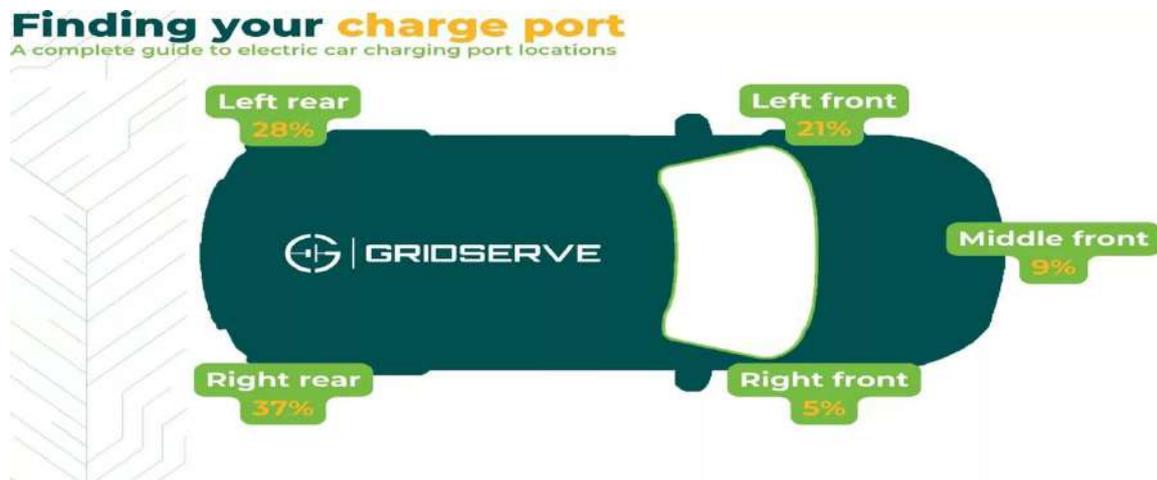


Figure 9. Supercharge Your Home: The Ultimate Guide to Charging Multiple Electric Cars [4]

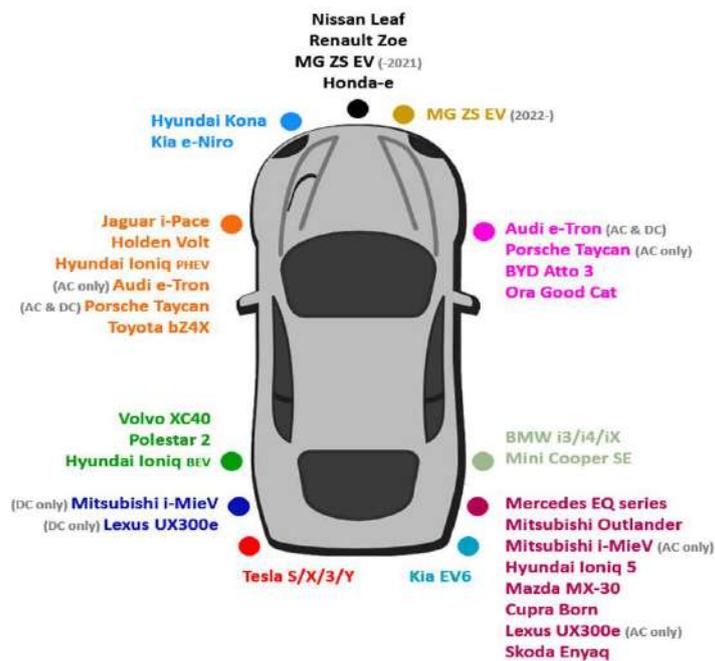


Figure 10. Where are the charging points in electric cars? [5]

Finding your charge port

A complete guide to electric car charging port locations

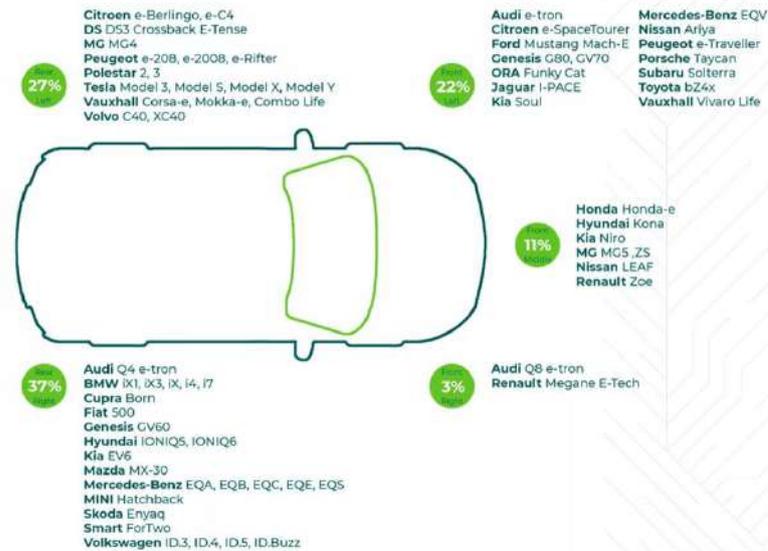


Figure 11. What should you do to avoid problems with Supercharging? [6]

4.2. Need for Standardization: Participant opinions

In the survey, over 75% of participants stated that the location of the charging socket should be standardized. This percentage indicates that the current variety is causing difficulties for users and highlights the need for an industry standard. While there is a trend towards standardization regarding AC/DC charging types (Type 2, CCS, CHADEMO, etc.), there is still no such uniformity regarding physical location. Especially in public areas, problems such as being unable to charge or the cable not reaching the charging cable are frequently encountered due to reasons such as parking arrangements, cable length, and the parking positions of other vehicles, and users have detailed these problems in the survey.

4.3. Interaction with Charging Infrastructure

According to the survey data, 34.2% of participants stated that they occasionally experienced problems at public charging stations, while 4.4% said they frequently experienced such problems (see Figure 6). Particularly with charging units that have short AC sockets, safety and accessibility risks arise, such as the cable not reaching the desired length or extending to the sidewalk if the socket's location is unsuitable. These problems affect not only individual satisfaction but also the efficient use of public infrastructure. Two different vehicle models arriving at the same charging station having sockets in completely opposite locations prolongs device usage time and reduces service efficiency.

4.4. Comparison with the Literature

While there are many studies on charging technologies in the literature, the impact of charging socket location on user experience has been addressed in a limited number of studies. The InsideEvs website, in its article titled "What's The Perfect Charge Port Location?" highlighted that the location of the charging port can affect charging times and user satisfaction; however, it did not provide comprehensive data on port compatibility with in-vehicle ergonomics. Additionally, an update article has been added to the latest version of the same publication.

"Since we first published this article in 2016, access to our survey results has disappeared, and believe it or not, these results are asked about almost every week. Therefore, we ask that you submit a response again to help us and others in our quest to find out if there is a consensus for the perfect charging spot location." [7]

Unfortunately, the expected level of participation in this study was not achieved.

There is only one review, and electric vehicle user William Carter shared his experience as follows:

"The space in the garage is usually tight. Since the driver has to get into the vehicle before taking it out of the garage, they will definitely leave enough space on the driver's side to allow for easy entry and exit when parking. Thus, the driver will automatically leave more space to plug in the charging cable on the driver's side. Even before I bought my first electric vehicle (in 2019), I always left enough space on the driver's side (and basically none on the passenger side) when I parked my vehicle in the garage. Having used EVs for years, it is

clear to me that the driver's side is the only side where the charging ports should be located. Since I always back into my garage, I prefer the charging port to be located behind the driver's side. Even if I have unlimited space in my garage, why would I want to walk to the other side of the vehicle to plug in or unplug the charging cable when parking or driving?" [7]

In this context, my research contributes to the literature by analyzing the socket location problem from a user-centered perspective using firsthand data.

4.5. Brand Preferences and Design Tradition

The survey data shows that some brands consistently prefer either the right or left rear battery socket. For example, Hyundai models frequently feature the right rear socket, while Renault prefers the front. These preferences are largely based on design tradition, battery placement, and vehicle platform.

However, this diversity creates significant complexity in terms of user experience. Particularly in public car parks or stations where many electric vehicles share charging areas, such design differences lead to operational challenges.

V. CONCLUSION AND RECOMMENDATIONS

This research aimed to reveal the experiences, problems, and design expectations of electric vehicle users in Türkiye and Europe regarding charging socket locations. Based on data obtained from 275 participants, it is understood that charging socket location is not only a technical detail but also an important ergonomic element that directly affects user experience, infrastructure compatibility, and vehicle preferences.

5.1. Key Findings

- The charging port is commonly located on the right rear or left rear.
 - 38.8% of participants prefer a dual-sided charging port, indicating a need for flexibility in design.
 - Approximately 46% of participants are not entirely satisfied with their current socket locations.
 - 41% strongly support charging socket standardization, while 35% have a positive attitude towards it.
 - Approximately 40% of users at public charging stations experience problems occasionally or frequently.
- These data reveal that socket placement has not only individual but also societal and infrastructural impacts.

5.2. Recommendations for Manufacturers

1. Dual-Sided Charging Socket Support: Especially for urban use, providing access on both the right and left sides is essential for ease of parking.
2. Integrating User Feedback into Design: User data should be actively analyzed throughout the vehicle development process.
3. User-Centered Design, Not Brand-Based: Instead of traditional socket locations, decisions should be made based on ergonomics, infrastructure, and safety.

5.3. Recommendations for Infrastructure Providers and Policymakers

1. Guidance for Standardization: A national-level set of guidelines or recommendations should be prepared regarding the location of the charging socket.
2. Cable Length and Flexibility: Instead of fixed charging stations with short cables, models offering flexible access should be more widely adopted.
3. Parking Systems for Public Charging Areas: Systems that direct vehicles based on socket locations can increase station efficiency.

5.4. Recommendations for Future Research

- Repeating this study with similar examples in different countries will provide an opportunity for comparative analysis.
- The relationship between socket location and technical parameters such as charging time, charging efficiency, and battery life should be examined.
- Multistakeholder analyses should be conducted not only with vehicle owners but also with fleet managers, corporate users, and charging station operators.

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