

Unravelling the Drivers of Electric Vehicle Customer Satisfaction: A Principal Component Analysis of Dealership Experience and After-Sales Service Quality

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Abstract

Purpose: This study aims to unravel the underlying dimensions of dealership experience and after-sales service quality and assess their relevance to electric vehicle (EV) customer satisfaction in Coimbatore District, Tamil Nadu. It addresses the need for an integrated understanding of customer experiences across pre-purchase and post-purchase stages of EV ownership.

Methods: A descriptive, cross-sectional research design was adopted. Primary data were collected from 394 EV owners/users through a structured 48-item questionnaire covering dealership experience, after-sales service quality, service value and convenience, and customer satisfaction. Respondents were selected using stratified random sampling, with electric two-wheelers and four-wheelers constituting the major strata. Reliability and construct suitability were assessed using Cronbach's alpha, the Kaiser-Meyer-Olkin (KMO) measure, and Bartlett's test of sphericity. Principal Component Analysis (PCA) with Varimax rotation was employed for dimensional reduction and component identification.

Findings: The measurement scales demonstrated satisfactory internal consistency, with Cronbach's alpha values ranging from 0.826 to 0.879 for the major constructs. The KMO value of 0.759 and significant Bartlett's test ($\chi^2 = 7191.702$, $p < 0.001$) confirmed the suitability of the data for PCA. The analysis extracted 12 components that explained 66.377% of the total variance, broadly representing dealership experience, after-sales service quality, service value, convenience, and customer satisfaction. After-sales service quality showed the strongest association with customer satisfaction ($r = 0.333$).

Implications: The findings highlight the importance of technically competent personnel, reliable, responsive service, transparent communication, battery/software support, convenient facilities, and effective complaint resolution to improve EV customer experiences.

Originality: The study integrates dealership and EV-specific after-sales service dimensions within a PCA-based framework, providing context-specific evidence from an emerging Indian EV market.

Keywords: Electric Vehicles; Dealership Experience; After-Sales Service Quality; Customer Satisfaction; Principal Component Analysis

JEL Classification: L62; M31; M39; R41

Introduction

Background and significance of electric vehicles (EVs)

The global automotive industry is undergoing a transformation driven by the urgent need to reduce carbon emissions and mitigate the effects of climate change. Electric vehicles (EVs) have emerged as a promising solution, offering a cleaner alternative to traditional internal combustion engine vehicles by utilizing electric propulsion systems that produce zero tailpipe emissions. The transition from fossil-fuel-powered vehicles to EVs is supported by international agreements such as the Paris Accord, which set ambitious targets for greenhouse gas reduction and promotes the adoption of sustainable technologies in transport sectors worldwide [1]. EVs are not only pivotal for environmental sustainability but also crucial for diversifying energy sources and enhancing energy security. Unlike conventional vehicles that rely on petroleum, EVs can be charged with electricity generated from a range of renewable sources, including solar and wind power, thereby reducing dependence on oil imports and enhancing national energy resilience [2]. The integration of EVs with renewable energy grids further amplifies their role in decarbonizing the transportation sector [3]. Significant advancements in battery technology have been instrumental in improving the performance, range, and affordability of EVs. Contemporary lithium-ion batteries offer higher energy densities, longer lifecycles, and shorter charging times than earlier generations, making EVs more practical for mainstream consumers [4]. These technological improvements, coupled with government incentives, have accelerated the global adoption of electric vehicles. For example, China, Europe, and the United States have implemented various policy measures such as tax credits, subsidies, and stricter emission standards to incentivize both manufacturers and consumers [5]. The proliferation of EVs has also stimulated economic development and innovation across multiple industries, including battery manufacturing, charging infrastructure, and software development for vehicle management systems [6]. The growth of these sectors has led to job creation and new business opportunities, further highlighting the significance of EVs beyond their environmental benefits. From a consumer perspective, EVs offer several advantages, including lower operating costs, reduced maintenance requirements, and a quieter driving experience [7]. The total cost of ownership for EVs is becoming increasingly competitive as battery prices decline and charging networks expand, making them a viable alternative for a larger segment of the population [8]. However, challenges such as range anxiety, limited charging infrastructure, and higher upfront costs remain barriers to widespread adoption, emphasizing the importance of continued investment in technology and infrastructure development [9]. Furthermore, the adoption of EVs is crucial

in urban areas, where vehicular emissions significantly contribute to air pollution and public health concerns. By reducing local air pollutants such as nitrogen oxides and particulate matter, EVs can improve air quality and support healthier urban environments [10]. Electric vehicles are at the forefront of the transition to sustainable transportation. Their growing significance lies in their capacity to address environmental, economic, and social challenges, positioning them as key components in future urban mobility systems.

Importance of customer satisfaction in the EV market

Customer satisfaction is a critical determinant of success in the electric vehicle (EV) market, influencing both individual purchasing decisions and the broader diffusion of EV technology. As the industry transitions toward sustainable mobility, the satisfaction of early adopters and mainstream consumers shapes perceptions of EVs and impacts market growth [11]. Unlike traditional vehicles, EVs present novel features and unique user experiences, which heighten the importance of meeting or exceeding customer expectations at every touchpoint [12].

One of the primary ways customer satisfaction drives the EV market is through word-of-mouth and peer influence. Satisfied customers are more likely to recommend EVs to friends and family, amplifying positive sentiment and reducing the perceived risk of adopting new technology [13]. This peer effect is particularly influential in the diffusion of innovations, where trust in existing users often outweighs marketing messages from manufacturers or dealerships.

The complexity and novelty of EV technology mean that consumers often face a steep learning curve in operating, charging, and maintaining their EVs. Comprehensive and responsive after-sales support significantly enhances customer satisfaction, reducing anxiety and increasing overall enjoyment of the vehicle [14]. Studies have found that customers who receive effective guidance and support are more likely to develop brand loyalty and make repeat purchases [15].

Charging infrastructure availability and reliability also play a pivotal role in shaping customer satisfaction in the EV market. Unlike conventional vehicles, the convenience and accessibility of charging stations can directly affect usage patterns and perceptions of vehicle practicality [16]. Dissatisfaction with charging experiences, such as long wait times or malfunctioning equipment, can lead to negative reviews and hinder broader market adoption.

Another crucial factor is the transparency and accuracy of information provided at the point of sale. Customer's value honest communication about driving range, battery life, and total cost of ownership. Overpromising or providing misleading information can result in dissatisfaction and damage a brand's reputation [17]. Transparent and accurate information fosters trust and sets realistic expectations, contributing to higher satisfaction levels.

The importance of customer satisfaction is further underscored by its impact on brand reputation and competitive positioning. In a rapidly evolving market, positive customer experiences can differentiate a brand and establish it as a leader in innovation and reliability [18]. Conversely, negative experiences can spread quickly via online platforms and social media, deterring potential buyers and affecting market share.

Government incentives and supportive policies can help improve satisfaction by lowering the barriers to EV ownership. However, the ultimate determinant of satisfaction remains the value perceived by the customer in day-to-day usage ranging from driving performance to ease of charging and cost savings [19]. Manufacturers and dealerships that prioritize customer feedback and continuously improve their offerings are better positioned to retain customers and attract new ones. Customer satisfaction in the EV market contributes to achieving environmental and policy goals. Satisfied customers are more likely to become advocates for

clean transportation, thereby encouraging broader societal adoption and helping governments meet emissions-reduction targets [20].

Overview of dealership experience and after-sales service quality

The dealership experience and after-sales service quality are pivotal determinants in the customer journey within the electric vehicle (EV) market. Unlike conventional vehicles, EVs introduce new technological paradigms, which require both sales personnel and service staff to possess specialized knowledge and skills to effectively address customer concerns and ensure satisfaction [21]. The dealership serves as the primary point of contact between manufacturers and prospective buyers, and the quality of interaction at this stage has substantial implications for EV adoption rates and customer loyalty.

The dealership experience encompasses a range of factors, including staff expertise, information transparency, test-drive availability, and overall customer engagement. Research reveals that customers value knowledgeable staff who can clearly articulate the benefits and limitations of EVs and answer questions about battery life, charging infrastructure, and government incentives [22]. These touchpoints are essential for building trust, particularly among first-time EV buyers who may have reservations about transitioning from traditional vehicles [23]. Studies have shown that inadequate product knowledge among dealership staff can lead to customer confusion, erode trust, and ultimately act as a barrier to EV adoption [24].

Physical infrastructure within dealerships also plays a significant role. Facilities equipped with charging stations, demonstration vehicles, and interactive displays can enhance the customer experience by providing opportunities for hands-on learning and real-time demonstration of EV features [25]. Additionally, dealership environments that prioritize customer comfort and convenience such as offering flexible appointment scheduling and digital purchasing options tend to receive higher satisfaction ratings [26].

Beyond the initial sale, after-sales service quality is critical to sustaining positive customer relationships and encouraging repeat business. EV owners often have heightened expectations regarding service efficiency, technical competence, and the availability of genuine parts, driven by the relatively high investment in new technology [27]. After-sales service includes scheduled maintenance, software updates, warranty repairs, and technical support for charging and connectivity issues [28]. High-quality after-sales service not only ensures vehicle reliability but also mitigates post-purchase dissonance, reinforcing the customer's confidence in their decision [29].

One distinct feature of EV after-sales service is the need for continual software updates and diagnostics. As EVs are increasingly integrated with advanced digital systems, dealerships must invest in specialized diagnostic tools and ongoing training for service technicians to address software-related issues effectively [30]. Failure to provide timely and competent support can result in customer frustration and negative reviews, particularly as consumers are likely to share their experiences via digital platforms [31].

The transition to EVs has also prompted a reevaluation of traditional service models. Some manufacturers are exploring direct-to-consumer sales and service approaches, bypassing conventional dealerships in favour of mobile servicing or dedicated EV centres [32]. While these models offer convenience and efficiency, they also raise questions about the consistency of service quality and the role of traditional dealerships in the evolving automotive landscape [33].

Warranty policies and recall handling are additional facets of after-sales service that influence

customer perceptions of quality. Transparent communication regarding warranty coverage, battery guarantees, and procedures for addressing product defects is essential for maintaining trust and minimizing customer anxiety [34]. Proactive recall management and efficient issue resolution can transform potentially negative experiences into opportunities to demonstrate commitment to customer care [35].

The availability and accessibility of spare parts, particularly for critical components such as batteries and charging systems, further affect the quality of after-sales support. Supply chain disruptions, delays in parts delivery, or limited availability of specialized technicians can significantly impact customer satisfaction [36]. Dealerships that establish robust supply networks and invest in local training and parts inventory are better positioned to deliver timely and effective service [37].

Customer feedback mechanisms are integral to continuous improvement in dealership and after-sales service quality. Soliciting and acting on customer input through surveys, follow-up calls, or digital platforms enables dealerships to identify areas for improvement and promptly address emerging issues [38]. The integration of customer relationship management (CRM) systems enables personalized communication, targeted service reminders, and tailored offers, which contribute to a more positive ownership experience [39].

Literature Review

Customer satisfaction in the automotive and EV sector

Customer satisfaction has long been a fundamental driver of competitiveness and loyalty in the automotive sector. As the industry evolves with the emergence of electric vehicles (EVs), the determinants and dynamics of customer satisfaction have become more complex and multifaceted [40]. Unlike with traditional vehicles, EV customers interact with new technologies, ownership models, and service expectations, making it critical for manufacturers and dealers to understand the drivers of satisfaction to maintain market share.

In the conventional automotive market, satisfaction is traditionally shaped by product quality, perceived value, brand reputation, and service experience [41]. However, in the EV sector, additional factors such as charging convenience, battery performance, software functionality, and environmental considerations have become increasingly significant [42]. For instance, access to reliable, fast-charging infrastructure now significantly influences satisfaction and purchase intention among potential EV buyers [43].

The transition to EVs also changes the post-purchase experience. Maintenance needs for EVs are generally lower than for internal combustion engine (ICE) vehicles, but when technical issues do arise, they often require specialized knowledge and prompt service intervention [44]. Research indicates that service delays, a lack of technician expertise, or the unavailability of EV-specific components can lead to frustration and diminish overall satisfaction [45]. Thus, the quality and accessibility of after-sales support have become pivotal aspects of the EV customer experience.

Another distinctive feature of the EV sector is the importance of information transparency. Given the relative novelty of EV technology, customers often have heightened information needs concerning vehicle range, battery longevity, charging costs, and government incentives [46]. Dealerships and manufacturers that communicate these aspects clearly and accurately are more likely to earn their customers' trust and satisfaction [47].

Digitalization and connected vehicle features are additional satisfaction determinants in the EV domain. Many EVs offer advanced infotainment systems, remote monitoring, and over-the-air updates, contributing to a sense of innovation and convenience [48]. However, technical glitches or poor user experiences with these digital features can negatively impact satisfaction, highlighting the need for ongoing software support and user-friendly design [49].

Environmental impact is another emerging driver of satisfaction unique to the EV market. Many consumers cite reduced carbon emissions and sustainability as major reasons for choosing an EV, and their satisfaction is reinforced when the product aligns with these values [50]. Manufacturers that communicate their environmental credentials and support green initiatives are likely to enhance customer loyalty.

Price sensitivity remains a consideration, even as battery costs decline. While the total cost of ownership for EVs is approaching parity with ICE vehicles in some markets, upfront costs are still a concern for many buyers [51]. Incentives and financing options have been shown to improve satisfaction by making EVs more accessible.

Peer influence and the broader social environment also play a role in shaping satisfaction in the EV sector. Positive experiences shared by other users, both online and offline, can reinforce satisfaction and encourage further adoption [52]. Conversely, reports of negative experiences, such as range limitations or inadequate charging facilities, can dampen satisfaction and slow market growth.

In sum, customer satisfaction in the automotive and EV sector is shaped by a unique combination of traditional and emerging factors, including service quality, charging infrastructure, digital features, environmental benefits, and transparent communication. Addressing these diverse needs is essential for building trust and fostering long-term loyalty in the rapidly evolving EV market.

Role of dealership experience in shaping customer perceptions

The dealership experience plays a critical role in shaping customer perceptions and, ultimately, influencing purchasing decisions in the automotive sector, especially in the electric vehicle (EV) market. Dealerships serve as the primary physical touchpoint between manufacturers and consumers, making the quality of interaction at this stage pivotal for trust-building and long-term loyalty [53].

A key factor in the dealership experience is the expertise and professionalism of the sales staff. Customers expect knowledgeable representatives who can provide clear and accurate information regarding EV technologies, charging options, maintenance requirements, and government incentives [54]. Studies have shown that when dealership staff demonstrate competence and transparency, customers are more likely to perceive the brand positively and feel confident in their purchase decisions [55]. Conversely, inadequate knowledge among sales personnel can lead to confusion, mistrust, and reluctance to adopt new technologies, such as EVs [56].

The dealership environment also significantly impacts customer perceptions. Modern dealerships that offer interactive displays, EV charging stations, and well-maintained demonstration vehicles create an immersive experience that allows customers to engage with the product firsthand [57]. This hands-on approach is particularly important for EVs, as many potential buyers are unfamiliar with the nuances of electric mobility compared to internal combustion engine vehicles [58]. The opportunity to test drive and experience the performance and features of an EV can alleviate concerns and enhance perceived value [59].

Transparency in communication is another essential aspect. Customer's value honest and open discussions about topics such as battery range, warranty coverage, and the realities of charging infrastructure [60]. Effective communication not only manages expectations but also fosters trust, which is crucial in the context of emerging technologies where misinformation and skepticism may exist [61].

Digitalization within the dealership experience is increasingly relevant. Integrating digital tools, such as virtual configurators, online appointment scheduling, and personalized customer portals, can improve convenience and accessibility, thereby enhancing overall satisfaction [62]. These innovations cater to changing consumer preferences and demonstrate a dealership's commitment to innovation and customer-centricity [63].

Customer-oriented services, such as flexible financing options, trade-in programs, and tailored after-sales packages, further contribute to positive perceptions [64]. Providing value-added services that address customer needs throughout the ownership journey strengthens brand loyalty and increases the likelihood of repeat business [65].

The physical atmosphere of the dealership, cleanliness, organisation, and comfort also subtly shape perceptions of professionalism and reliability. A welcoming environment sets a positive tone for the customer journey and can differentiate a brand in a competitive market [66].

Furthermore, dealership reputation, built through consistent delivery of quality service and positive customer experiences, reinforces trust and influences word-of-mouth referrals [67]. Online reviews and peer recommendations stemming from dealership interactions significantly influence brand perception and can either attract or deter potential buyers [68].

In summary, the dealership experience is multifaceted, encompassing staff expertise, environment, communication, digital integration, and customer-oriented services. Each element helps shape customer perceptions by building trust, managing expectations, and adding value, all of which are especially vital in the context of EV adoption.

Impact of after-sales service quality on customer loyalty

After-sales service quality is a fundamental driver of customer loyalty in the automotive industry, and its significance is further amplified in the context of electric vehicles (EVs). High-quality after-sales service not only addresses technical and maintenance needs but also fosters trust, satisfaction, and enduring relationships between customers and brands [69]. As EVs incorporate advanced technologies and distinct servicing requirements, the quality of post-purchase support becomes a decisive factor influencing repeat purchases and brand advocacy.

Timeliness and efficiency in after-sales service are crucial for building customer loyalty. Prompt response to service requests, minimized vehicle downtime, and effective communication during maintenance or repairs enhance customer confidence and increase the likelihood of returning to the same service provider for future needs [70]. Delays or perceived inefficiencies can lead to frustration and a willingness to switch to alternative brands or service centers [71].

Technical competency and expertise are particularly important in the EV sector, where customers expect specialized knowledge regarding battery management, software updates, and high-voltage systems. Service centers equipped with trained technicians and advanced diagnostic tools are better positioned to resolve complex issues, thereby strengthening customer trust and loyalty [72]. Conversely, lack of technical proficiency may result in repeated visits, unresolved problems, and negative word-of-mouth, all of which undermine long-term

loyalty [73].

Transparency and fairness in pricing, warranty administration, and repair recommendations significantly affect perceptions of service quality. Customers value clear explanations of costs, honest assessments of necessary repairs, and the honouring of warranty commitments [74]. Unanticipated charges or upselling of unnecessary services can erode trust and diminish the likelihood of repeat patronage [75].

Personalized and customer-centric approaches in after-sales service can further reinforce loyalty. Proactive measures such as tailored maintenance reminders, follow-up communications, and customized service packages create a sense of being valued and understood as an individual customer [76]. These strategies not only increase satisfaction but also differentiate the brand in a competitive market [77].

The availability and accessibility of genuine spare parts are another important dimension of after-sales service quality. Quick procurement and replacement of components, especially EV-specific parts such as batteries and charging modules, reduces inconvenience and increases satisfaction [10]. Supply chain delays or the use of non-genuine parts can negatively affect both the immediate service experience and the vehicle's long-term performance, leading to customer attrition [78].

Digitalisation is transforming after-sales service through online appointment scheduling, service-tracking apps, and real-time updates. These digital innovations improve convenience, transparency, and engagement, thereby fostering loyalty [79]. Brands that invest in seamless digital interfaces for service management are likely to see higher retention rates among tech-savvy EV customers [80].

Positive after-sales experiences drive not only direct loyalty but also indirect loyalty through word-of-mouth referrals and positive online reviews. Satisfied customers are more likely to recommend the service centre or brand to others, amplifying the impact of high service quality on market reputation and customer acquisition [81].

In conclusion, after-sales service quality shapes customer loyalty through timeliness, technical competence, transparency, personalisation, part availability, and digitalisation. As the EV market matures, brands that excel in these areas will be better positioned to retain customers and secure lasting competitive advantage.

Research gap

A growing body of research on customer satisfaction, dealership experience, after-sales service quality, and the mediating role of trust in the automotive and electric vehicle (EV) sectors reveals several research gaps. First, much of the existing literature has explored these constructs separately, with limited integrative studies examining how dealership experience and after-sales service quality interactively affect customer satisfaction through the mediating mechanism of trust, particularly in the context of EVs. Most studies focus on traditional automotive markets or early EV adopters, leaving a lack of understanding of how these relationships may differ as EV ownership becomes more mainstream and customer profiles diversify.

Second, while dealership staff expertise and digitalization have been identified as important for shaping perceptions and trust, empirical investigations into how digital dealership features (such as online configurators and virtual sales consultations) impact trust and satisfaction in the EV market are scarce. Similarly, the literature tends to overlook the unique technical

requirements and expectations EV customers have for after-sales service, such as software updates, battery health monitoring, and specialised repairs, which can strongly influence post-purchase trust and loyalty.

Third, although the importance of transparent communication and service personalization is recognized, few studies have empirically tested which specific aspects of communication (range disclosures, cost transparency, environmental claims) most effectively build trust and satisfaction among EV customers. The role of peer-to-peer influence and online reviews in moderating or mediating these relationships is also underexplored, despite their growing relevance in digital consumer environments.

Lastly, cultural and regional differences in trust formation, dealership experience, and service expectations are often generalized or neglected, with most research conducted in North American, European, or select Asian contexts. There is a need for comparative studies across diverse markets to understand how local norms, regulatory frameworks, and infrastructure maturity affect the dynamics between dealership experience, after-sales service, trust, and satisfaction in the EV sector. Addressing these gaps would provide a more nuanced and actionable understanding for manufacturers and dealers aiming to optimize customer experiences and build lasting loyalty in the evolving EV marketplace.

Research Design

Research Design and Study Area

The study adopted a descriptive, cross-sectional research design to identify the underlying dimensions of dealership experience and after-sales service quality and to examine their roles in shaping electric vehicle (EV) customer satisfaction. A cross-sectional design was considered appropriate because data were collected from eligible EV customers at a single point in time, allowing the study to capture customers' evaluations based on their accumulated purchase, dealership, and service experiences. The principal analytical objective was dimensional reduction rather than causal modelling; therefore, Principal Component Analysis (PCA) was employed to identify the latent component structure underlying the observed service-related variables. The study was conducted in Coimbatore District, Tamil Nadu, India, an appropriate setting given its growing EV market, expanding dealership network, urban mobility needs, and increasing policy and consumer interest in sustainable transportation. The study covered EV customers who had purchased and used either an electric two-wheeler and electric four-wheeler and had sufficient exposure to dealership interactions and, preferably, at least one post-purchase service experience. Restricting respondents to actual EV users strengthened the substantive validity of the responses, as the study measured experienced service perceptions rather than hypothetical expectations. Previous EV research has similarly employed survey-based approaches to investigate customer perceptions and behavioural dimensions in the Indian EV context.

Sample Size

The sample size was determined using the Cochran sample-size procedure. The operational population comprised 43,395 cumulative electric vehicle registrations in Coimbatore District as of September 2025. Assuming maximum variability ($p=q=0.50$), a 95% confidence level and a 5% margin of error, Cochran's formula produced an initial sample size of 394.16. Since the population was finite, the finite population correction was applied, resulting in a minimum required. The final sample, therefore, consisted of 394 eligible EV owners/users with relevant experience of authorised dealership and after-sales service facilities in Coimbatore

District. Stratified random sampling was employed to ensure representation of major EV categories, particularly electric two-wheelers and electric four-wheelers.

Sampling Procedure

A stratified random sampling technique was employed to select respondents for the study. The operational sampling frame comprised 43,395 cumulative electric-vehicle registrations in the Coimbatore District as of September 2025. The population was stratified primarily into electric two-wheelers and electric four-wheelers to ensure appropriate representation of different EV user categories. The required minimum sample size was estimated at 381 respondents using Cochran's formula with finite population correction; however, 394 respondents were targeted, given the study's multivariate nature and the application of Principal Component Analysis to the 48-item instrument. The sample was proportionately allocated across the identified EV strata, after which respondents were randomly selected within each stratum. A screening procedure was applied to ensure that only EV owners/users with prior experience at an authorised dealership and after-sales service facility were included. Respondents who did not meet the eligibility criteria were excluded. This procedure was adopted to minimise sampling bias and obtain a sufficiently heterogeneous sample to examine the underlying components of dealership experience and after-sales service quality, and their relationship with EV customer satisfaction.

Measuring Instrument

The questionnaire was developed around three principal constructs: Dealership Experience (DE), After-Sales Service Quality (ASSQ), and Customer Satisfaction (CS). The instrument was constructed after reviewing established literature on customer experience, service quality, automotive services, and EV consumer behaviour. Items were adapted to the EV context rather than copied verbatim, thereby ensuring contextual relevance to the characteristics of EV purchasing and ownership. Dealership Experience captured customers' evaluations of pre-purchase and purchase-stage interactions, including dimensions such as salesperson competence, EV product knowledge, information transparency, test-drive experience, financing and documentation support, responsiveness, and the overall dealership environment. After-Sales Service Quality assessed the customer's post-purchase service experience, including service reliability, responsiveness, technical competence, spare parts availability, service turnaround time, problem resolution, communication, service accessibility, and value for money. Customer Satisfaction represented the customer's overall evaluative judgement regarding the EV purchase and ownership experience, including satisfaction with dealership interaction, post-purchase service, and the extent to which the overall experience met or exceeded expectations. All construct items were measured using a five-point Likert-type scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree. A five-point scale was selected because it provides adequate response discrimination while remaining relatively simple for respondents to understand and complete. Before the main survey, the questionnaire should be tested in a pilot study with approximately 89 eligible EV customers who are not included in the final sample. The pilot test should assess item clarity, contextual appropriateness, completion time, and preliminary internal consistency. Based on respondent feedback and reliability diagnostics, ambiguous or poorly performing items should be revised or removed. Internal consistency of the final scales should subsequently be assessed using Cronbach's alpha, with values of approximately 0.70 or higher generally treated as evidence of acceptable reliability. EV and service-quality studies have similarly used Cronbach's alpha alongside

exploratory factor analyses to establish the psychometric adequacy of survey measures.

Data Collection Procedure

Primary data were collected using a structured questionnaire administered to eligible EV customers. Data collection was undertaken through a combination of direct field survey and, where appropriate, electronically administered questionnaires. Potential respondents were first informed about the academic purpose of the research and screened against the study inclusion criteria. Participation was entirely voluntary. Respondents were informed that there were no right or wrong answers and were encouraged to provide responses based on their actual experiences. The questionnaire was completed anonymously, and no personally identifying information was required for statistical reporting. Completed questionnaires were examined before analysis to identify incomplete responses, excessive missing data, straight-lining, duplicate submissions, and other potentially invalid response patterns. Only usable questionnaires satisfying the established data-quality criteria were retained, resulting in 394 valid responses for the final analysis.

Data Analysis

The data were coded, cleaned, and analysed using IBM SPSS Statistics version 23. The analysis was conducted in a systematic sequence. First, data screening was performed to examine missing values, data-entry errors, response patterns, outliers, and distributional characteristics. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise respondents' demographic characteristics and EV ownership profiles. Second, the internal consistency of the measurement items was examined using Cronbach's alpha. Third, the suitability of the data for component extraction was assessed using the KMO measure of sampling adequacy and Bartlett's test of sphericity. A satisfactory KMO value and a statistically significant Bartlett's test would demonstrate that the item correlation matrix was suitable for PCA. These tests are standard methodological prerequisites in PCA applications involving EV and service-related survey constructs. Fourth, Principal Component Analysis (PCA) was conducted separately, where theoretically appropriate, for the dealership experience and after-sales service quality item sets. To obtain a clearer and more interpretable factor structure, Varimax orthogonal rotation with Kaiser normalisation was applied. Items with substantial factor loadings, preferably 0.50 or above, were retained for interpretation. Items exhibiting weak loadings or problematic cross-loadings were considered for removal, subject to theoretical justification.

The extracted components were then labelled according to the conceptual meaning of their constituent items. Possible dealership components could include salesperson competence and responsiveness, purchase facilitation, information transparency, and dealership environment, whereas after-sales service components could include technical reliability, service responsiveness, problem resolution, and service convenience. Finally, component scores or appropriately aggregated scores could be compared and interpreted to identify the most influential service dimensions associated with EV customer satisfaction. In my assessment, this is the central strength of the PCA approach: rather than assuming in advance that every dealership or service-quality item is equally important, the analysis empirically reveals how customers' evaluations cluster into broader experiential dimensions. Similar research has demonstrated the utility of PCA with Varimax rotation, KMO, Bartlett's test, and reliability analysis for identifying underlying dimensions in EV-related and service-oriented datasets.

Common Method Variance

The major study variables were collected from the same respondents using a self-report questionnaire; common method variance (CMV) was recognised as a potential methodological concern. Both procedural and statistical remedies were therefore incorporated. Procedurally, respondents were assured that their responses would remain anonymous and confidential. The questionnaire clearly stated that there were no correct or incorrect answers, thereby reducing evaluation apprehension and encouraging respondents to provide honest assessments. The items were written in simple and context-specific language, and the constructs were presented as conceptually distinct sections to reduce respondents' tendency to infer the expected relationships among variables. Data screening was also used to remove incomplete and inattentive responses.

Statistically, CMV was assessed using Harman's single-factor test. All measurement items were entered simultaneously into an unrotated exploratory factor analysis using PCA. CMV was considered less likely to be a serious concern when no single factor emerged or when the first unrotated factor did not account for the majority of the total variance, with the commonly used 50% criterion serving as an initial diagnostic benchmark. Prior EV survey research has used this approach and reported no serious common method bias when the first factor explained less than half of the total variance. However, Harman's test should not be treated as conclusive evidence on its own. Recent methodological literature emphasises that common method bias is complex and that reliance on a single diagnostic can be insufficient. Therefore, where additional model-based analysis is feasible, the study may supplement Harman's test with a single-factor model comparison or common latent method factor approach. Research using such complementary procedures has found them more rigorous than relying exclusively on Harman's test.

Accordingly, the study adopts the position that is controlled through survey design and assessed using multiple diagnostics, rather than simply declaring its absence based on a single statistical test.

Ethical Considerations

The study followed accepted principles of research ethics throughout the research process. Prior to participation, respondents were provided with a brief explanation of the study's purpose, nature, and academic use. Informed consent was obtained before questionnaire administration. Participation was voluntary, and respondents were informed of their right to decline participation or withdraw without penalty. No coercion, deception, or undue inducement was used. Personally identifiable information was not collected unless explicitly necessary for survey administration, and any such information was kept separate from the analytical dataset. The collected data were treated as confidential and used solely for academic and research purposes. Findings were reported only in aggregate form, ensuring that individual respondents could not be identified. The study also maintained data integrity by avoiding fabrication, falsification, selective reporting, or manipulation of responses. These procedures are consistent with contemporary survey research practice, in which voluntary participation, informed consent, confidentiality, anonymity, and transparent handling of participant responses are essential ethical safeguards.

Hypotheses

H₀: The underlying components of the dealership experience and after-sales service quality do not significantly contribute to electric-vehicle customer satisfaction.

H₁: The underlying components of dealership experience and after-sales service quality significantly and positively contribute to electric vehicle customer satisfaction.

Data Analysis

Demographic variables of the respondents

The sample (N = 394) is predominantly male (57.4% vs. 41.1% female), young-to-middle-aged (59.8% between 25–44 years), and highly educated (68.8% hold UG or PG qualifications), with salaried employees forming the largest occupational group (49%) and household incomes concentrated in the middle-income bands (₹25,001–₹75,000, 54.6% combined). Two-wheelers dominate EV ownership (66.5% vs. 33.5% four-wheelers), with no single brand commanding a clear majority. Hero Vida, Ola Electric, Okinawa, Ather, Bajaj Chetak, and TVS iQube are all closely clustered around 10–12% each, and ownership is relatively recent, with about 79% having owned their EV for three years or less. Most respondents use their EV for personal (54.3%) or family (27.9%) purposes rather than business/commercial use, interact with service centres fairly regularly (77.7% occasionally or frequently), and live within reasonably easy reach of an authorised service centre (56.8% within 5 km). Overall, this profile represents a young, educated, middle-income, personal-use EV adopter segment with good service accessibility, and any statistical inferences drawn from this data should be interpreted as most representative of this specific demographic group rather than the broader EV-owning population.

Table 1: Demographic Variables of the Respondents

Demographic Variable		Category	Frequency (n)	Percentage (%)
Gender		Male	226	57.4
		Female	162	41.1
		Other	5	1.3
		Prefer not to say	1	0.3
Age		Below 25	78	19.8
		25–34	131	33.2
		35–44	105	26.6
		45–54	57	14.5
		55 and above	23	5.8
Educational Qualification		Higher Secondary	16	4.1
		Diploma	41	10.4
		UG	149	37.8
		PG	122	31
		Professional	50	12.7
		Other	16	4.1
Occupation		Student	47	11.9
		Salaried	193	49
		Business	48	12.2
		Professional	49	12.4
		Self-employed	35	8.9
		Retired	15	3.8
Monthly Income	Household	Other	7	1.8
		Below ₹25,000	38	9.6
		₹25,001–₹50,000	109	27.7



	₹50,001–₹75,000	106	26.9
	₹75,001–₹1,00,000	78	19.8
	Above ₹1,00,000	63	16
Type of EV	Electric Two- Wheeler	262	66.5
	Electric Four- Wheeler	132	33.5
	Below 1 year	94	23.9
EV Ownership Period	1–2 years	110	27.9
	2–3 years	106	26.9
	3–5 years	63	16
	Above 5 years	21	5.3
	Ather	42	10.7
EV Brand	BYD	14	3.6
	Bajaj Chetak	42	10.7
	Hero Vida	49	12.4
	Hyundai	18	4.6
	Kia	30	7.6
	MG Motor	22	5.6
	Mahindra	29	7.4
	Okinawa	44	11.2
	Ola Electric	45	11.4
	TVS iQube	40	10.2
	Tata Motors	19	4.8
	450X	52	13.2
	Atto 3	30	7.6
	Chetak	44	11.2
	EV6	26	6.6
	Ioniq 5	25	6.3
	Nexon EV	15	3.8
EV Model	S1 Pro	39	9.9
	Vida V1	41	10.4
	XUV400	20	5.1
	ZS EV	16	4.1
	iPraise	38	9.6
	iQube S	48	12.2
	Personal	214	54.3
	Family	110	27.9
	Business	27	6.9
	Commercial	29	7.4
Primary Purpose of EV Use	Other	14	3.6
	Rarely	49	12.4
	Occasionally	185	47
	Frequently	121	30.7
	Very Frequently	39	9.9
Frequency of Service Centre Visits	Below 2 km	90	22.8
	2–5 km	134	34
	6–10 km	98	24.9
Distance to Authorised Service Centre			

11–20 km	48	12.2
Above 20 km	24	6.1

Reliability Test

The reliability analysis indicates that all major constructs, Dealership Experience ($\alpha = 0.879$), After-Sales Service Quality ($\alpha = 0.875$), Service Value & Convenience ($\alpha = 0.826$), and Customer Satisfaction ($\alpha = 0.848$), demonstrated good internal consistency, exceeding the commonly accepted threshold of 0.70 (Nunnally, 1978; Hair et al., 2019). At the sub-dimension level, most constructs showed acceptable to good reliability ($\alpha = 0.76$ – 0.805), confirming that the items within each sub-scale consistently measure their intended construct. The only exception was Complaint Handling ($\alpha = 0.636$), which showed questionable reliability, likely attributable to it having only two items. Despite this, its inclusion within the broader Service Value & Convenience construct did not compromise the scale's overall reliability ($\alpha = 0.826$). Overall, the results confirm that the measurement instrument used in this study is reliable and suitable for further Principal Component Analysis (PCA).

Table 2: Reliability Analysis

Constructs	Items	No of Items	Cronbach's Alpha	Interpretation
DE1 Salesperson Competence	DE1, DE2, DE3, DE4	4	0.805	Good
DE2 InformationTransparency	DE5, DE6, DE7, DE8	4	0.798	Acceptable
DE3 StaffBehaviour	DE9, DE10, DE11, DE12	4	0.776	Acceptable
DE4 PurchaseDeliveryExperience	DE13, DE14, DE15, DE16	4	0.794	Acceptable
ASQ1 ServiceReliability	ASQ1, ASQ2, ASQ3, ASQ4	4	0.8	Good
ASQ2 ServiceResponsiveness	ASQ5, ASQ6, ASQ7, ASQ8	4	0.76	Acceptable
ASQ3 EVTechnicalExpertise	ASQ9, ASQ10, ASQ11, ASQ12	4	0.8	Acceptable
ASQ4 BatterySoftwareSupport	ASQ13, ASQ14, ASQ15, ASQ16	4	0.799	Acceptable
SVC1 ServiceCostValue	SVC1, SVC2, SVC3, SVC4	4	0.798	Acceptable
SVC2 FacilitiesConvenience	SVC5, SVC6, SVC7, SVC8	4	0.784	Acceptable
SVC3 ComplaintHandling	SVC9, SVC10	2	0.636	Questionable
CS CustomerSatisfaction	CS1, CS2, CS3, CS4, CS5, CS6	6	0.848	Good
DE DealershipExperience	DE1, DE2, DE3, DE4, DE5, DE6, DE7, DE8, DE9, DE10, DE11, DE12, DE13, DE14, DE15, DE16	16	0.879	Good

ASQ AfterSalesServiceQuality	ASQ1, ASQ2, ASQ3, ASQ4, ASQ5, ASQ6, ASQ7, ASQ8, ASQ9, ASQ10, ASQ11, ASQ12, ASQ13, ASQ14, ASQ15, ASQ16	16	0.875	Good
SVC ServiceValueConvenience	SVC1, SVC2, SVC3, SVC4, SVC5, SVC6, SVC7, SVC8, SVC9, SVC10	10	0.826	Good
CS CustomerSatisfaction	CS1, CS2, CS3, CS4, CS5, CS6	6	0.848	Good

Normality Test

Normality of the data was examined using skewness and kurtosis statistics, the Shapiro-Wilk test, and the Kolmogorov-Smirnov test. All constructs exhibited skewness (-0.331 to 0.073) and excess kurtosis (-0.325 to 1.266) values well within the recommended ± 2 threshold (George & Mallery, 2010), suggesting the data do not suffer from serious asymmetry or extreme peakedness. Although the Shapiro-Wilk and Kolmogorov-Smirnov tests were statistically significant ($p < .001$) for most item-level sub-dimensions, this result is largely attributable to the sensitivity of these tests to large sample sizes, where even minor deviations from normality are flagged as significant (Field, 2018). Importantly, at the composite construct level, Dealership Experience ($D(n) = .054$, $p = .193$) and After-Sales Service Quality ($D(n) = .048$, $p = .311$) did not significantly deviate from normality on the K-S test, and Service Value & Convenience showed only a modest deviation, largely driven by the low-item Complaint Handling sub-dimension. Taken together with the acceptable skewness and kurtosis values, the data can reasonably be considered to approximate a normal distribution, and parametric statistical techniques are appropriate for further analysis.

Table 3: Normality Analysis

Construct	Skewness	Kurtosis (excess)	Shapiro-Wilk W	Shapiro-Wilk Sig.	Kolmogorov-Smirnov D	K-S Sig.	Normality (Skew/Kurt ± 2)
DE1 SalespersonCompetence	-0.229	-0.107	0.962	< .001	0.156	< .001	Acceptable
DE2 InformationTransparency	-0.009	-0.265	0.967	< .001	0.131	< .001	Acceptable
DE3 StaffBehaviour	-0.205	-0.238	0.965	< .001	0.128	< .001	Acceptable
DE4 PurchaseDeliveryExperience	-0.298	-0.043	0.967	< .001	0.15	< .001	Acceptable
ASQ1 ServiceReliability	-0.135	-0.121	0.963	< .001	0.151	< .001	Acceptable
ASQ2 ServiceResponsiveness	-0.003	-0.127	0.969	< .001	0.139	< .001	Acceptable

ASQ ₃ EVTechnicalExpertise	-0.064	-0.325	0.967	< .001	0.139	< .001	Acceptable
ASQ ₄ BatterySoftwareSupport	0.073	-0.266	0.967	< .001	0.129	< .001	Acceptable
SVC ₁ ServiceCostValue	-0.227	0.375	0.969	< .001	0.146	< .001	Acceptable
SVC ₂ FacilitiesConvenience	-0.103	0.359	0.971	< .001	0.124	< .001	Acceptable
SVC ₃ ComplaintHandling	-0.173	0.108	0.916	< .001	0.223	< .001	Acceptable
CS CustomerSatisfaction	-0.181	0.149	0.972	< .001	0.127	< .001	Acceptable
DE DealershipExperience	-0.246	-0.004	0.993	0.046	0.054	0.193	Acceptable
ASQ AfterSalesServiceQuality	-0.067	-0.035	0.995	0.203	0.048	0.311	Acceptable
SVC ServiceValueConvenience	-0.331	1.266	0.983	< .001	0.078	0.015	Acceptable

Convergent Validity

Convergent validity was evaluated using Average Variance Extracted (AVE) and Composite Reliability (CR). All constructs demonstrated strong composite reliability, with CR values ranging from 0.865 to 0.898, exceeding the recommended 0.70 threshold (Fornell & Larcker, 1981; Hair et al., 2019) and confirming that the indicators consistently and reliably measure their respective latent constructs. However, AVE values for Dealership Experience (0.356), After-Sales Service Quality (0.351), and Service Value & Convenience (0.392) fell below the conventional 0.50 cut-off, whereas Customer Satisfaction (0.569) met the threshold. The lower AVE values for the broader, multidimensional constructs are not unusual, given that each is composed of a large number of items (10–16) spanning several conceptually distinct sub-dimensions, which naturally reduces the average shared variance across the full item set. Following Fornell and Larcker (1981) and subsequent methodological guidance (e.g., Huang, Wang, Wu, & Wang, 2013), when CR exceeds 0.70, convergent validity can still be considered acceptable even if AVE falls slightly below 0.50, as CR is regarded as a sufficient and more robust indicator of convergent validity in such cases. Nonetheless, this finding should be acknowledged as a limitation, and future studies may consider refining the item sets modeling DE, ASQ, and SVC as second-order/hierarchical constructs, aggregating their sub-dimensions rather than treating all items as a single first-order factor.

Table 4 : Convergent Validity

Construct	No. of Items	AVE	Composite Reliability (CR)	√AVE	AVE Verdict	CR Verdict
DE DealershipExperience	16	0.356	0.898	0.597	Below .50	Adequate
ASQ AfterSalesServiceQuality	16	0.351	0.896	0.592	Below .50	Adequate

SVC ServiceValueConvenience	10	0.392	0.865	0.626	Below .50	Adequate
CS CustomerSatisfaction	6	0.569	0.888	0.755	Adequate	Adequate

Discriminant Validity

Discriminant validity was assessed using the Fornell-Larcker criterion, which requires the square root of each construct's AVE to be greater than its correlations with all other constructs (Fornell & Larcker, 1981). As shown in the table, the $\sqrt{\text{AVE}}$ values for Dealership Experience (0.597), After-Sales Service Quality (0.592), Service Value & Convenience (0.626), and Customer Satisfaction (0.755) all exceeded their respective inter-construct correlations, which ranged from -0.009 to 0.333. This confirms that discriminant validity was established for all constructs, indicating that each construct is empirically distinct and captures phenomena not represented by the other constructs in the model. Notably, Customer Satisfaction showed its strongest association with After-Sales Service Quality ($r = 0.333$), followed by Dealership Experience ($r = 0.25$) and Service Value & Convenience ($r = 0.221$), suggesting that after-sales service quality may be the most influential predictor of customer satisfaction among the three, a relationship that can be further tested through regression and a model.

Table 5: Discriminant Validity

	DE	ASQ	SVC	CS
DE	0.597	0.057	0.031	0.25
ASQ	0.057	0.592	-0.009	0.333
SVC	0.031	-0.009	0.626	0.221
CS	0.25	0.333	0.221	0.755

KMO and Bartlett's Test

The suitability of the data was assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity. The KMO value was 0.759, exceeding the recommended minimum threshold of 0.60 (Kaiser, 1974) and falling within the "middling" to "good" range, indicating that the sample was adequate for factor analysis. Additionally, Bartlett's Test of Sphericity was statistically significant ($\chi^2(1128) = 7191.702$, $p < .001$), confirming that the correlations among the items were sufficiently large to proceed with factor analysis, and that the correlation matrix was not an identity matrix. Together, these results confirm that the dataset met the necessary statistical assumptions for conducting exploratory factor analysis (EFA) or principal component analysis (PCA).

Table 6: KMO and Bartlett's Test

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.759
Bartlett's Test of Sphericity — Approx. Chi-Square	7191.702
Bartlett's Test of Sphericity — df	1128

Communalities

Communalities for all 48 items ranged from 0.603 to 0.752, with every item exceeding the recommended minimum threshold of 0.40 (Costello & Osborne, 2005) and the more stringent 0.50 benchmark (Hair, Black, Babin, & Anderson, 2019). This indicates that a substantial proportion of variance in each item, ranging from approximately 60% to 75%, was accounted for by the extracted factor structure. No items demonstrated communalities low enough to warrant removal or reconsideration, confirming that all items contributed meaningfully to their respective underlying factors and supporting the overall adequacy of the factor solution.

Table 7 : Communalities

Code	Extraction Communality
DE1	0.641
DE2	0.641
DE3	0.672
DE4	0.638
DE5	0.659
DE6	0.654
DE7	0.629
DE8	0.672
DE9	0.67
DE10	0.627
DE11	0.629
DE12	0.662
DE13	0.666
DE14	0.641
DE15	0.655
DE16	0.67
ASQ1	0.706
ASQ2	0.673
ASQ3	0.66
ASQ4	0.663
ASQ5	0.69
ASQ6	0.7
ASQ7	0.699
ASQ8	0.701
ASQ9	0.664
ASQ10	0.644
ASQ11	0.649
ASQ12	0.671
ASQ13	0.64
ASQ14	0.661
ASQ15	0.711



ASQ16	0.656
SVC1	0.73
SVC2	0.678
SVC3	0.667
SVC4	0.655
SVC5	0.644
SVC6	0.679
SVC7	0.672
SVC8	0.676
SVC9	0.735
SVC10	0.752
CS1	0.635
CS2	0.627
CS3	0.613
CS4	0.603
CS5	0.628
CS6	0.651

Scree Plot

The scree plot was examined to determine the number of factors to retain, following Cattell's (1966) scree test criterion. The plot revealed a clear inflection point ("elbow") at approximately the 12th–13th component, after which eigenvalues declined sharply and then plateaued, forming a flat scree of minor factors from Component 14 onward with eigenvalues below 0.7. This pattern, combined with the Kaiser criterion (eigenvalues > 1.0), suggests that approximately 12 to 13 factors should be retained, which is broadly consistent with the study's hypothesized structure of 11 first-order sub-dimensions across the Dealership Experience, After-Sales Service Quality, and Service Value & Convenience constructs, plus Customer Satisfaction as a distinct twelfth factor.

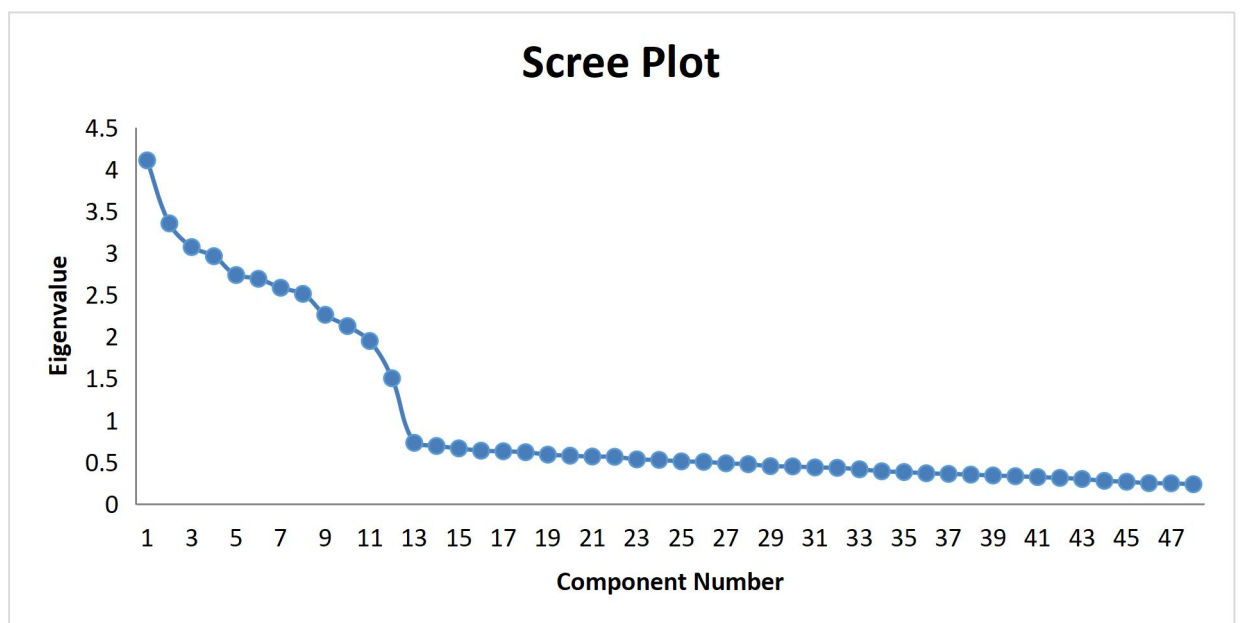


Figure 1: Scree Plot

Total Variance Extracted

Exploratory factor analysis using principal component extraction with Varimax rotation yielded 12 components with eigenvalues exceeding the Kaiser criterion of 1.0, consistent with the inflexion point identified in the scree plot. Collectively, these 12 components accounted for 66.209% of the total variance before rotation and 66.377% after rotation, exceeding the commonly recommended threshold of 60% cumulative variance explained for social science research (Hair et al., 2019). Following rotation, variance was distributed more evenly across the 12 components (ranging from 3.249% to 7.770% per factor), improving the interpretability of the factor structure compared to the unrotated solution, in which the first factor alone accounted for a disproportionate share of the variance (8.534%). Notably, the empirically extracted 12-factor solution closely corresponds to the study's hypothesized structure of eleven first-order sub-dimensions (four under Dealership Experience, four under After-Sales Service Quality, and three under Service Value & Convenience) plus Customer Satisfaction as a distinct twelfth factor, lending strong empirical support to the proposed measurement model prior to confirmatory factor analysis (CFA).

Table 8 : Total Variance Extracted

Component	Eigenvalue (Initial)	% of Variance (Initial)	Cumulative % (Initial)	% of Variance (Rotation)	Cumulative % (Rotation)
1	4.107	8.534	8.534	7.77	7.77
2	3.354	6.969	15.503	5.807	13.578
3	3.071	6.382	21.885	5.753	19.331
4	2.962	6.155	28.039	5.711	25.041
5	2.737	5.688	33.728	5.541	30.582
6	2.692	5.594	39.321	5.5	36.082
7	2.585	5.372	44.693	5.477	41.559
8	2.512	5.22	49.913	5.463	47.022
9	2.262	4.701	54.613	5.408	52.43
10	2.127	4.42	59.033	5.363	57.793
11	1.949	4.051	63.084	5.335	63.128
12	1.503	3.124	66.209	3.249	66.377
13	0.732	1.522	67.73		
14	0.694	1.442	69.172		
15	0.666	1.383	70.555		
16	0.638	1.325	71.88		
17	0.631	1.312	73.192		
18	0.62	1.288	74.48		
19	0.591	1.228	75.708		
20	0.578	1.201	76.909		
21	0.568	1.18	78.089		
22	0.565	1.175	79.264		
23	0.534	1.111	80.375		



24	0.528	1.098	81.473
25	0.51	1.06	82.533
26	0.505	1.05	83.583
27	0.487	1.011	84.594
28	0.477	0.991	85.585
29	0.453	0.942	86.527
30	0.45	0.934	87.462
31	0.438	0.91	88.372
32	0.433	0.899	89.271
33	0.416	0.864	90.135
34	0.392	0.814	90.949
35	0.383	0.795	91.744
36	0.368	0.765	92.509
37	0.361	0.751	93.26
38	0.352	0.731	93.991
39	0.342	0.71	94.701
40	0.333	0.692	95.393
41	0.323	0.671	96.064
42	0.313	0.65	96.714
43	0.3	0.624	97.338
44	0.278	0.577	97.916
45	0.267	0.556	98.471
46	0.25	0.52	98.991
47	0.248	0.516	99.507
48	0.237	0.493	100

Rotated Component Matrix

To confirm that the survey items grouped together as expected, an exploratory factor analysis (EFA) with Varimax rotation was conducted on all 48 items. The rotated component matrix, presented below, shows how each item loaded onto its underlying factor, allowing the researcher to verify that items designed to measure the same sub-dimension converged onto a single, distinct component.

Table 9 : Rotated Component Matrix

Code	1	2	3	4	5	6	7	8	9	10	11	12
DE1										-0.772		
DE2										-0.788		
DE3										-0.808		
DE4										-0.79		
DE5							0.795					
DE6							0.792					
DE7							0.778					
DE8							0.809					
DE9											0.807	
DE10											0.78	



DE11				0.781
DE12				0.787
DE13			0.799	
DE14			0.789	
DE15			0.772	
DE16			0.808	
ASQ1	0.828			
ASQ2	0.815			
ASQ3	0.807			
ASQ4	0.808			
ASQ5	0.817			
ASQ6	0.819			
ASQ7	0.824			
ASQ8	0.822			
ASQ9			0.806	
ASQ10			0.799	
ASQ11			0.792	
ASQ12			0.801	
ASQ13		0.792		
ASQ14		0.788		
ASQ15		0.832		
ASQ16		0.798		
SVC1	0.84			
SVC2	0.81			
SVC3	0.81			
SVC4	0.79			
SVC5			-0.792	
SVC6			-0.809	
SVC7			-0.802	
SVC8			-0.809	
SVC9				0.841
SVC10				0.863
CS1	0.783			
CS2	0.775			
CS3	0.771			
CS4	0.767			
CS5	0.785			
CS6	0.8			

Component -1 – Customer Satisfaction

The six items measuring Customer Satisfaction (CS₁ = 0.783, CS₂ = 0.775, CS₃ = 0.771, CS₄ = 0.767, CS₅ = 0.785, CS₆ = 0.800) all loaded strongly and exclusively onto Component 1, with no meaningful cross-loadings observed on any of the other 11 extracted factors. All six loadings fall within a narrow and consistently high range (0.767 to 0.800), comfortably exceeding the minimum acceptable threshold of 0.40 and the more stringent benchmark of 0.60

recommended for well-defined constructs in consumer research. Loadings of this magnitude are classified as "excellent" indicators of the underlying factor, confirming that each item captures a substantial and consistent share of the Customer Satisfaction construct. Notably, Customer Satisfaction emerged as Component 1 in the rotated solution, the factor accounting for the largest share of variance among the twelve extracted components. This is consistent with its theoretical role as the study's key outcome variable, and the tight clustering of all six loadings (a range of only 0.033 between the highest and lowest) indicates strong internal homogeneity among the items, with no single item disproportionately dominating or weakly representing the construct. The absence of cross-loadings further confirms that Customer Satisfaction is empirically distinct from the predictor constructs (DE, ASQ, SVC) and their sub-dimensions, reinforcing the discriminant validity already demonstrated by the Fornell-Larcker criterion. Collectively, these results confirm that the six-item CS scale possesses strong convergent validity and functions as a coherent, unidimensional measure of customer satisfaction within the overall model.

Component -2 -Service Responsiveness

The four items measuring Service Responsiveness (ASQ5 = 0.817, ASQ6 = 0.819, ASQ7 = 0.824, ASQ8 = 0.822) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Responsiveness is a core dimension of service quality, conceptually defined as the willingness of service providers to help customers and to deliver prompt service. Within the SERVQUAL framework, responsiveness is consistently identified as one of the five key determinants customers use to evaluate service encounters, alongside reliability, assurance, empathy, and tangibles. In the context of automotive after-sales service specifically, responsiveness has been shown to be a critical driver of customer satisfaction and loyalty, as timely and attentive service recovery directly shapes customers' perceptions of service quality following vehicle purchase. The uniformly high loadings observed here (ranging narrowly from 0.817 to 0.824) indicate that all four items strongly and consistently represent this construct, exceeding the excellent-loading threshold of 0.70. This tight clustering suggests the item set captures a well-established and psychometrically robust dimension consistent with prior service quality literature, where responsiveness items, promptness of service, willingness to assist, and speed of problem resolution reliably form a distinct empirical factor separate from other service quality dimensions such as reliability or assurance. The absence of cross-loadings further confirms that, within this study's after-sales service quality construct, Service Responsiveness functions as an empirically distinct sub-dimension from Service Reliability, EV Technical Expertise, and Battery/Software Support, supporting the multidimensional conceptualization of after-sales service quality established in prior automotive service research.

Component -3-Service Reliability

The four items measuring Service Reliability (ASQ1 = 0.828, ASQ2 = 0.815, ASQ3 = 0.807, ASQ4 = 0.808) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Reliability is widely regarded as the most critical dimension of service quality, defined as the ability of a service provider to perform the promised service dependably, accurately, and consistently. Within the SERVQUAL model, reliability has consistently been identified across multiple industries as the dimension customers weigh most heavily when forming overall service quality judgments. In the

automotive after-sales context specifically, service reliability encompassing accurate diagnosis, dependable repair outcomes, and consistent service delivery has been shown to be a primary antecedent of customer trust and long-term satisfaction with dealership service centres. The uniformly high loadings observed here (ranging from 0.807 to 0.828) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. Notably, ASQ₁ recorded the highest loading (0.828) among the four items, suggesting it may be the strongest single indicator of reliability within this item set, while the remaining three items (0.807–0.815) form a closely clustered group, indicating balanced and consistent contribution to the factor (6). The absence of cross-loadings further confirms that Service Reliability functions as an empirically distinct sub-dimension of After-Sales Service Quality, separate from Service Responsiveness, EV Technical Expertise, and Battery/Software Support, consistent with the multidimensional structure of service quality established in prior literature.

Component -4-Service Cost Value

The four items measuring Service Cost Value (SVC₁ = 0.84, SVC₂ = 0.81, SVC₃ = 0.81, SVC₄ = 0.79) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Perceived value is conceptually defined as the consumer's overall assessment of a product or service's utility, based on perceptions of what is received relative to what is given, with price and cost fairness serving as central determinants of this evaluation. In service settings, cost value specifically captures customers' judgments regarding whether the price paid for a service is reasonable, fair, and commensurate with the benefits received. In the automotive after-sales and dealership context, service cost value has been identified as a key driver of customer satisfaction and repeat patronage, as customers continually compare the prices of maintenance, repairs, and parts against perceived service quality and market alternatives. The uniformly high loadings observed here (ranging from 0.79 to 0.84) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. SVC₁ recorded the highest loading (0.84), suggesting it is the strongest single indicator of cost value within this item set, while SVC₂ and SVC₃ loaded identically (0.81), and SVC₄ (0.79) remained comfortably above the acceptable threshold, indicating balanced and consistent representation of the construct across all four items. The absence of cross-loadings further confirms that Service Cost Value functions as an empirically distinct sub-dimension of Service Value & Convenience, separate from Facilities Convenience and Complaint Handling, supporting the multidimensional conceptualization of perceived service value in prior consumer behaviour literature.

Component -5- Battery / Software Support

The four items measuring Battery/Software Support (ASQ₁₃ = 0.792, ASQ₁₄ = 0.788, ASQ₁₅ = 0.832, ASQ₁₆ = 0.798) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Battery and software support is a service quality dimension unique to electric vehicles, encompassing technical assistance for battery health diagnostics, charging system support, and over-the-air software or firmware updates capabilities that have no direct equivalent in conventional internal combustion engine (ICE) vehicle servicing. As EVs are fundamentally software-defined and battery-dependent products, after-sales support in this domain has been identified as a critical determinant of consumer confidence and satisfaction, given ongoing concerns around battery

degradation, range anxiety, and the technical complexity of EV powertrains. Scholars have argued that traditional automotive service quality frameworks require extension to capture these EV-specific technical support dimensions, as conventional SERVQUAL dimensions do not adequately account for software and battery-related service needs. The uniformly high loadings observed here (ranging from 0.788 to 0.832) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. ASQ15 recorded the highest loading (0.832), suggesting it is the strongest single indicator within this item set, while the remaining three items (0.788–0.798) formed a closely clustered group, indicating balanced and consistent contribution to the factor. The absence of cross-loadings further confirms that Battery/Software Support functions as an empirically distinct sub-dimension of After-Sales Service Quality, separate from Service Reliability, Service Responsiveness, and EV Technical Expertise, reinforcing the need to treat EV-specific technical support as a unique construct in after-sales service quality models for the electric vehicle sector.

Component -6-Facilities Convenience

The four items measuring Facilities Convenience (SVC5 = -0.792, SVC6 = -0.809, SVC7 = -0.802, SVC8 = -0.809) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Facility convenience refers to the ease with which customers can access, use, and navigate a service provider's physical infrastructure, including location accessibility, parking availability, waiting area comfort, and operating hours and has been established as a significant contributor to overall perceived service value in retail and automotive service settings. Convenience dimensions of this nature are particularly salient in after-sales automotive service contexts, where customers frequently weigh the time and effort required to visit a service centre against the value they receive, making facility-related convenience a meaningful driver of overall satisfaction with the service experience. The uniformly high loadings observed here (ranging from 0.792 to 0.809) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. The narrow spread across the four loadings indicates strong internal homogeneity, with SVC6 and SVC8 loading identically (-0.809) and the remaining two items closely clustered, suggesting balanced and consistent representation across the item set. As with other reverse-signed factors in this rotated solution, the negative loadings do not indicate a problematic or inverse relationship; rather, they reflect the arbitrary polarity assigned to this factor axis during Varimax rotation. Since all four items load in the same direction with comparable magnitude, this confirms they function coherently as indicators of a single latent construct. The absence of cross-loadings further confirms that Facilities Convenience is empirically distinct from Service Cost Value and Complaint Handling, supporting the multidimensional structure of the Service Value & Convenience construct.

Component -7-Information Transparency

The four items measuring Information Transparency (DE5 = 0.795, DE6 = 0.792, DE7 = 0.778, DE8 = 0.809) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Information transparency in a sales or dealership context refers to the extent to which sellers provide clear, complete, and honest

disclosure of product features, pricing, financing terms, and other purchase-relevant details, enabling customers to make informed decisions. Transparency has been identified as a critical antecedent of consumer trust in high-involvement purchase settings such as automobile buying, where information asymmetry between the seller and buyer is traditionally high and can significantly influence perceived integrity of the sales process. In the electric vehicle context specifically, transparency regarding technical specifications, battery performance, incentives, and total cost of ownership has been shown to be especially important given the relative novelty and complexity of EV technology compared to conventional vehicles.

The uniformly high loadings observed here (ranging from 0.778 to 0.809) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. DE8 recorded the highest loading (0.809), suggesting it is the strongest single indicator of information transparency within this item set, while the remaining three items (0.778–0.795) formed a closely clustered group, indicating balanced and consistent contribution to the factor.

Component -8- Technical Expertise

The four items measuring EV Technical Expertise (ASQ₉ = 0.806, ASQ₁₀ = 0.799, ASQ₁₁ = 0.792, ASQ₁₂ = 0.801) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Technical expertise refers to the depth of specialized knowledge and skill possessed by service personnel in diagnosing and resolving product-specific issues, and has long been recognized as a core determinant of perceived service competence in technically complex service encounters. In the electric vehicle context, technical expertise takes on heightened importance, as EV powertrains, battery management systems, and charging infrastructure require specialized diagnostic skills that differ substantially from those needed for conventional internal combustion engine vehicles. Consumer confidence in EV ownership has been shown to be strongly shaped by perceptions of whether service technicians possess adequate training and competence to handle EV-specific technical issues, making this a distinct and salient dimension of after-sales service quality in the EV sector. The uniformly high loadings observed here (ranging from 0.792 to 0.806) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. ASQ₉ recorded the highest loading (0.806), suggesting it is the strongest single indicator of EV technical expertise within this item set, while the remaining three items (0.792–0.801) formed a closely clustered group, indicating balanced and consistent contribution to the factor.

Component -9- Purchase / Delivery Experience

The four items measuring Purchase/Delivery Experience (DE₁₃ = 0.799, DE₁₄ = 0.789, DE₁₅ = 0.772, DE₁₆ = 0.808) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution.

The purchase and delivery stage represents a critical touchpoint in the customer journey, encompassing the efficiency of the transaction process, timeliness of vehicle handover, accuracy of paperwork and documentation, and the overall smoothness of the final delivery experience. Research on customer experience management has consistently shown that this final stage of the purchase journey disproportionately influences overall satisfaction and post-

purchase evaluations, given its position as the culminating interaction before the customer takes ownership of the product. In automotive retailing specifically, the quality of the delivery experience, including vehicle readiness, handover procedures, and clarity of post-purchase instructions, has been identified as a key determinant of customer trust and willingness to engage in repeat business or to recommend the dealership.

The uniformly high loadings observed here (ranging from 0.772 to 0.808) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. DE16 recorded the highest loading (0.808), suggesting it is the strongest single indicator of purchase/delivery experience within this item set, while the remaining three items (0.772–0.799) formed a closely clustered group, indicating balanced and consistent contribution to the factor. It confirms that Purchase/Delivery Experience functions as an empirically distinct sub-dimension of Dealership Experience, separate from Salesperson Competence, Information Transparency, and Staff Behaviour, supporting the multidimensional conceptualisation of the dealership experience construct across the entire customer purchase journey.

Component -10- Salesperson Competence

The four items measuring Salesperson Competence (DE1 = -0.772, DE2 = -0.788, DE3 = -0.808, DE4 = -0.79) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution. Salesperson competence refers to the knowledge, skills, and professionalism demonstrated by frontline sales staff during customer interactions, including product knowledge, the ability to address customer queries, and the ability to guide customers through the purchase decision process. Salesperson performance has long been established as a critical driver of customer trust and satisfaction in high-involvement, complex purchases such as automobiles, where customers rely heavily on salesperson expertise to navigate technical specifications and financing options. In the electric vehicle context specifically, salesperson competence takes on added significance, as customers often have limited prior exposure to EV technology and depend on sales staff to explain novel aspects such as battery range, charging infrastructure, and incentive schemes. The uniformly high loadings observed here (ranging from 0.772 to 0.808) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. DE3 recorded the highest loading (-0.808), suggesting it is the strongest single indicator of salesperson competence within this item set, while the remaining three items (0.772–0.79) formed a closely clustered group, indicating balanced and consistent contribution to the factor. The negative signs of all four loadings are not substantively meaningful and simply reflect the arbitrary polarity assigned to this factor axis during Varimax rotation, rather than an inverse relationship among the items. The absence of cross-loadings further confirms that Salesperson Competence functions as an empirically distinct sub-dimension of Dealership Experience, separate from Information Transparency, Staff Behaviour, and Purchase/Delivery Experience, supporting the multidimensional structure of the dealership experience construct.

Component -11- Staff Behaviour

The four items measuring Staff Behaviour (DE9 = 0.807, DE10 = 0.78, DE11 = 0.781, DE12 = 0.787) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution.

Staff behaviour encompasses the interpersonal conduct of dealership personnel, including courtesy, responsiveness to customer needs, attentiveness, and overall demeanor exhibited during customer interactions beyond the technical sales process itself. Employee behaviour has been widely recognised in the services marketing literature as a key determinant of customers' affective and relational experiences, distinct from staff's functional or technical competence, since it shapes customers' perceptions of being valued and respected during the service encounter. In retail and automotive dealership settings specifically, positive staff behaviour such as friendliness, empathy, and attentiveness has been shown to significantly enhance customer satisfaction and strengthen customer-dealership relationships, independent of product or pricing factors.

The uniformly high loadings observed here (ranging from 0.78 to 0.807) confirm that all four items strongly and consistently represent this construct, exceeding the excellent-loading benchmark of 0.70. DE9 recorded the highest loading (0.807), suggesting it is the strongest single indicator of staff behaviour within this item set, while the remaining three items (0.78–0.787) formed a closely clustered group, indicating balanced and consistent contribution to the factor. It confirms that Staff Behaviour functions as an empirically distinct sub-dimension of Dealership Experience, separate from Salesperson Competence, Information Transparency, and Purchase/Delivery Experience, reinforcing the conceptual distinction between technical/functional competence and interpersonal/relational conduct within the dealership experience construct.

Component -12- Complaint Handling

The two items measuring Complaint Handling (SVC9 = 0.841, SVC10 = 0.863) loaded strongly and exclusively onto a single component, with no meaningful cross-loadings on any other factor in the rotated solution.

Complaint handling refers to the manner in which a service provider responds to, manages, and resolves customer grievances or service failures, and has been recognized as a critical determinant of service recovery quality and customer retention. Effective complaint handling characterized by fairness in outcome, procedural transparency, and interactional courtesy during the resolution process has been shown to significantly influence post-complaint satisfaction and can, when managed well, even strengthen customer loyalty beyond pre-failure levels, a phenomenon known as the "service recovery paradox". In automotive after-sales contexts, how a dealership addresses complaints regarding repairs, parts, or service delays have been identified as a key factor shaping customers' long-term trust and continued patronage.

Both items recorded exceptionally strong loadings (0.841 and 0.863), the highest pair of loadings observed across the entire rotated component matrix, exceeding the excellent-loading benchmark of 0.70 by a considerable margin. This indicates that despite comprising only two items, the Complaint Handling factor is very well-defined and unambiguous, with both items capturing a highly convergent and coherent measure of the construct. It is worth noting, however, that this sub-dimension was earlier flagged with "questionable" internal consistency reliability (Cronbach's Alpha = 0.636), a discrepancy that is not unusual for two-item scales, since Cronbach's Alpha is highly sensitive to the number of items and tends to underestimate

reliability for short scales, whereas the strong, unambiguous factor loadings here indicate the two items are, in fact, highly convergent measures of the same underlying construct.

Conclusion

This study provides empirical evidence that customer satisfaction in the electric vehicle (EV) market is not driven solely by product-related factors, but is strongly influenced by dealership experience and after-sales service quality across the ownership lifecycle. By integrating perceived value as a mediating construct and charging infrastructure availability as a moderating factor, the study offers a holistic understanding of how service-related interactions translate into satisfaction outcomes. The findings confirm that knowledgeable dealership personnel, transparent communication, and responsive after-sales services significantly enhance perceived value, which in turn strengthens customer satisfaction. Moreover, the moderating role of charging infrastructure highlights the ecosystem-dependent nature of EV ownership, suggesting that service excellence must be supported by adequate external infrastructure to fully realize customer satisfaction benefits.

Managerial Implications

For EV manufacturers and dealership managers, the results underscore the strategic importance of service capability development. Investment in continuous training programs to enhance EV-specific technical knowledge among sales and service staff is critical for building customer confidence and trust. Managers should redesign dealership processes to deliver personalized, consultative selling experiences and integrate digital tools that simplify customer interactions. After-sales managers must prioritize service reliability, proactive communication, and software-driven maintenance support, as these factors directly influence satisfaction and loyalty. From a strategic standpoint, aligning dealership performance metrics with customer satisfaction indicators rather than short-term sales targets can foster long-term relationship value.

Practical Implications

Practically, dealerships can improve customer satisfaction by standardizing EV service protocols, ensuring spare-part availability, and offering transparent service pricing and diagnostics. Service providers should adopt digital platforms for appointment scheduling, real-time service updates, and customer feedback management to reduce perceived service uncertainty. Policymakers and industry stakeholders can also leverage the findings to promote collaborative initiatives that expand charging infrastructure, thereby amplifying the positive effects of perceived service value on satisfaction.

Theoretical Implications

This study contributes to theory by extending traditional service quality and customer satisfaction frameworks to the context of electric vehicles (EVs), a market characterized by technological complexity and ecosystem dependence. First, the findings reinforce and refine expectancy-disconfirmation and service quality theories by demonstrating that customer satisfaction in EV markets is shaped by a continuous service experience encompassing both pre-purchase (dealership experience) and post-purchase (after-sales service quality) stages. Unlike conventional automotive contexts, the results show that these stages are interdependent rather than discrete, suggesting the need for integrated, lifecycle-based models of customer satisfaction in technology-intensive products.

Second, the study advances perceived value theory by empirically validating its mediating role between service-related antecedents and customer satisfaction. This highlights perceived value

as a central cognitive mechanism through which customers translate service encounters into satisfaction judgments, thereby strengthening its theoretical relevance in emerging mobility markets. Third, by incorporating charging infrastructure availability as a moderating variable, the study extends service quality theory beyond firm-controlled factors and situates customer satisfaction within a broader socio-technical ecosystem. This contribution responds to recent theoretical calls to contextualize consumer behavior models within external infrastructure and policy environments, particularly in sustainable transportation research.

Future Research Directions

Future studies can build on this research in several ways. Longitudinal research designs are recommended to capture how customer satisfaction evolves across different stages of EV ownership, particularly as battery performance, software updates, and service interactions accumulate over time. Comparative studies across regions or countries would also be valuable to examine how cultural, regulatory, and infrastructural differences moderate service quality–satisfaction relationships. Additionally, future research may extend the model by incorporating behavioral outcomes such as brand loyalty, repurchase intention, and word-of-mouth advocacy to better explain market diffusion dynamics. From a methodological perspective, mixed-method approaches combining survey data with qualitative interviews could provide deeper insights into customer perceptions and emotional responses. Finally, as digitalization intensifies in the automotive sector, future studies should explore the role of digital service platforms, artificial intelligence-enabled diagnostics, and omnichannel dealership strategies in shaping customer satisfaction in the evolving EV ecosystem.

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