A Study on Hybrid Vehicles from Dealer's Perceptions in Bangalore city

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Abstract

This research delves into the perceptions of automotive dealers regarding hybrid vehicles in India. With the Indian automotive market undergoing significant transformations due to environmental concerns and technological advancements, understanding dealer perspectives becomes crucial. The study employs a mixed-methods approach, combining quantitative surveys and qualitative interviews, to assess factors influencing dealer attitudes towards hybrid vehicles. Findings indicate that while dealers acknowledge the environmental benefits and government incentives associated with hybrids, challenges such as consumer awareness, infrastructure limitations, and higher upfront costs persist. The paper concludes with strategic recommendations to enhance hybrid vehicle adoption through dealer engagement and policy support.

Keywords

Hybrid Vehicles, Dealer Perception, Automotive Industry, India, Adoption Barriers, Consumer Awareness, Infrastructure Challenges

1. Introduction

The Indian automotive industry is currently undergoing a significant transformation driven by increasing environmental awareness, stricter emission regulations, and rapid technological advancements. Among the most promising developments is the introduction and gradual adoption of hybrid vehicles, which combine internal combustion engines (ICE) with electric propulsion systems. These vehicles serve as a transitional solution bridging the gap between traditional gasoline-powered vehicles and fully electric vehicles (EVs), contributing to the global efforts of reducing carbon emissions and improving energy efficiency in transportation.

Hybrid vehicles operate using two or more power sources—typically a conventional internal combustion engine and an electric motor—working in tandem to optimize performance, fuel economy, and emissions control. Depending on their configuration, hybrids are broadly categorized into three types: parallel hybrids, series hybrids, and plug-in hybrids. Parallel hybrids allow both the ICE and electric motor to provide power simultaneously, optimizing energy usage based on driving conditions. Series hybrids operate primarily through the electric motor, with the ICE acting as a generator to recharge the battery. Plug-in hybrids combine the benefits of both configurations and offer the ability to charge the battery externally, allowing for extended electric-only operation.

One of the key advantages of hybrid vehicles lies in their ability to switch seamlessly between power sources depending on driving speed, acceleration requirements, and energy efficiency considerations. For instance, during high-speed driving or when greater power is needed, the internal combustion engine takes the lead, while the electric motor is predominantly used during low-speed driving, stop-and-go traffic, or when additional power is necessary for acceleration. This results in improved fuel economy, reduced greenhouse gas emissions, and lower dependence on fossil fuels compared to conventional vehicles.

Despite these advantages, the adoption of hybrid vehicles in India remains relatively low, especially compared to developed markets. A major reason for this is not merely the technological capabilities of the vehicles themselves but also the awareness, attitudes, and preparedness of key stakeholders—particularly automotive dealers. Dealers serve as the primary point of contact between manufacturers and consumers and are responsible for not only selling vehicles but also educating customers, providing after-sales support, and influencing market trends through marketing and promotional activities.

Dealers' perceptions significantly impact the success of hybrid vehicle adoption. Their knowledge, attitude toward the technology, confidence in after-sales service capability, and belief in market demand shape their willingness to promote these vehicles. Additionally, challenges such as limited charging infrastructure, higher vehicle prices, and concerns about maintenance complexity further complicate the dealer's role.

Given their central role in the automotive ecosystem, understanding dealer perspectives is critical. This research, therefore, seeks to investigate the key factors influencing automotive dealers' perceptions and their role in promoting hybrid vehicle adoption in India. By exploring dealer attitudes, knowledge gaps, infrastructural challenges, and the barriers they face, this study aims to provide actionable insights and strategic recommendations to improve hybrid vehicle market penetration and support India's transition towards sustainable mobility.

This expanded introduction provides a comprehensive background, highlights the technical details of hybrid vehicles, and clearly identifies the research gap your study aims to address. Would you like me to continue developing the other sections accordingly?

2. Objectives
1.   To assess automotive dealers' perceptions of hybrid vehicles in India.
2.   To identify the primary factors influencing dealer attitudes towards hybrid vehicles.
3.   To evaluate the challenges faced by dealers in promoting hybrid vehicles.

3. Scope of the Study
This study focuses exclusively on automotive dealers located in Bengaluru, one of India's leading metropolitan cities known for its rapid urbanization and emerging technology adoption. The research encompasses a diverse range of dealership types, including large multi-brand outlets as well as smaller single-brand showrooms, to provide a well-rounded understanding of dealer perceptions towards hybrid vehicles. The study period spans from January 2023 to 2025, reflecting the evolving market trends, consumer behavior, and dealer attitudes over a two-year period. By concentrating on Bengaluru, the study aims to offer focused insights into the factors influencing hybrid vehicle promotion and adoption in an urban setting where consumer awareness and infrastructure development are expected to be more advanced compared to other regions of India.

4.. Limitations of the Study

- The study is limited to automotive dealerships located in Bengaluru, which may not represent the perceptions and market dynamics of dealers in other parts of India, especially rural or smaller urban areas.
- A limited number of dealerships in Bengaluru were surveyed, which may not fully represent the entire dealer population even within the city.
- The rapidly evolving automotive industry, particularly in the hybrid vehicle segment, may lead to changes in dealer perceptions and market conditions after the study period (January 2023 to 2025).
- Dealer responses may be influenced by personal biases, competitive interests, or commercial motivations, which could affect the objectivity and generalizability of the findings.

5.Review of Literature

5.a Yahyaabadi, R., Farhani, G., Rahman, T., Nikan, S., Jirjees, A., & Araji, F. (2025). *Deep Learning-Based Analysis of Power Consumption in Gasoline, Electric, and Hybrid Vehicles.*This study introduces a scalable data-driven method using powertrain dynamic feature sets and both traditional machine learning and deep neural networks to estimate instantaneous and cumulative power consumption in internal combustion engine (ICE), electric vehicle (EV), and hybrid electric vehicle (HEV) platforms. The results confirm the approach's effectiveness across vehicles and models, highlighting the importance of accurate power consumption analysis in optimizing hybrid vehicle performance.

5.b Hua, M., Shuai, B., Zhou, Q., Wang, J., He, Y., & Xu, H. (2023). *Recent Progress in Energy Management of Connected Hybrid Electric Vehicles Using Reinforcement Learning.*The paper discusses the evolution of energy management systems (EMS) from hybrid electric vehicles (HEVs) to connected HEVs (CHEVs), emphasizing the need for advanced algorithms for route optimization, charging coordination, and load distribution. Reinforcement learning, particularly multi-agent reinforcement learning, is identified as a promising approach to address these challenges, facilitating efficient energy utilization in connected hybrid systems.

5.cMousaei, A. (2023).*Improving Energy Management of Hybrid Electric Vehicles by Considering Battery Electric-Thermal Model.* This article proposes an offline EMS for parallel HEVs, incorporating battery temperature as a state variable to optimize battery charge and temperature variations. The study demonstrates that neglecting battery thermal dynamics in EMS is impractical, and integrating thermal considerations can enhance battery longevity and overall vehicle performance.

5.d Machacek, D. T., Yazar, N. O., Huber, T., & Onder, C. H. (2023). *Energy Management of Hydrogen Hybrid Electric Vehicles -- A Potential Study.*The paper explores the feasibility of hydrogen combustion engine (H_2ICE)-equipped passenger cars integrated with electric hybridization. The study finds that a mixed H_2-HEV architecture can achieve significant reductions in engine-out NO_x emissions and hydrogen consumption, highlighting the potential of hydrogen-based hybrid systems in sustainable transportation.

 5.e EY-Parthenon (2025).*Future of Hybrid Electric Vehicles in India.* This report discusses the role of hybrid vehicles in India's automotive sector, emphasizing their

potential to bridge the gap between internal combustion engine vehicles and fully electric vehicles. The study highlights challenges such as high GST rates on hybrids and suggests that
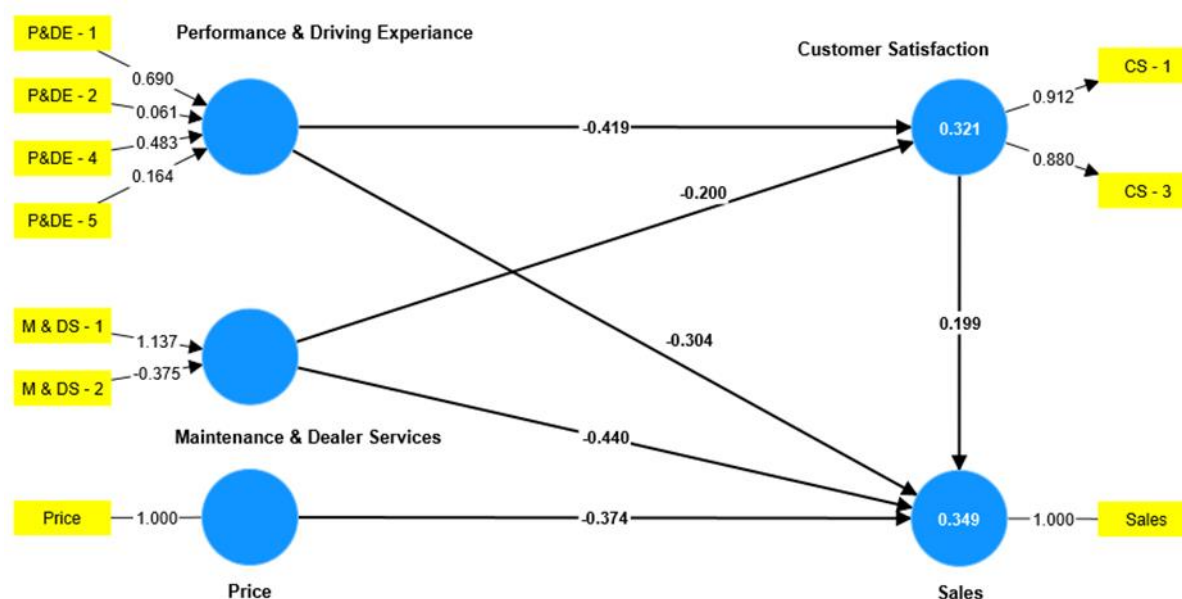
lowering taxes could boost hybrid EV adoption and growth.

6.1 Global Perspectives on Hybrid Vehicle Adoption
- **Environmental Benefits:** Studies have highlighted that hybrid vehicles contribute significantly to reducing greenhouse gas emissions and improving fuel efficiency, making them a viable option for sustainable transportation.
- **Consumer Acceptance:** Research indicates that consumer acceptance of hybrid vehicles is influenced by factors such as environmental awareness, fuel economy, and government incentives.

6.2 Indian Context
- **Government Initiatives:** The Indian government has introduced policies like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme to promote hybrid vehicle adoption.
- **Market Dynamics:** Despite policy support, the adoption rate of hybrid vehicles in India remains slow due to challenges like high initial costs, limited charging infrastructure, and consumer skepticism.

6.3 Dealer Perspectives
- **Role in Adoption:** Dealers are crucial in influencing consumer perceptions through their knowledge, marketing strategies, and after-sales services.
- **Challenges Faced:** Dealers report challenges such as lack of training, insufficient promotional support from manufacturers, and consumer reluctance due to unfamiliarity with hybrid technology.

The following report presents the results of an analysis conducted to investigate the impact of various factors on sales. Specifically, the study aimed to examine the influence of performance and driving experience, maintenance and dealer services, price, and customer satisfaction on sales.

7 Analysis
7a)Demographic profile
Dealers dealing with Hybrid Vehicle -   70
7b) PLS-SEM model: The study utilized a formative and reflective PLS-SEM model, and the outer weights/loadings and path coefficients for inner models were analysed.

Table 1: Construct reliability and validity

	Customer Satisfaction	Threshold limit	Result
Cronbach's alpha	0.756	> 0.7	Satisfied
Composite reliability (rho_a)	0.767	> 0.7	Satisfied
Composite reliability (rho_c)	0.891	> 0.7	Satisfied
Average variance extracted (AVE)	0.803	> 0.7	Satisfied

The results of the construct reliability and validity analysis for customer satisfaction, presented in Table 1, indicate that the measures used to assess customer satisfaction are reliable and valid. The Cronbach's alpha value of 0.756, composite reliability (rho_a) value of 0.767, composite reliability (rho_c) value of 0.891, and average variance extracted (AVE) value of 0.803 were all above the threshold limit of 0.7.

Table 2: Collinearity statistics (Table VIF)
The collinearity statistics analysis results, presented in Table 2, show that there is no significant multicollinearity between the independent variables in the regression model, as all variables had a VIF value of less than 3.

Table-3: R-square

	VIF	Threshold limit	Result	R-square
Customer Satisfaction -> Sales				0.016
Maintenance CS - 1	1.587	≤ 3	Satisfied	36
Maintenance CS - 3	1.587	≤ 3	Satisfied	69
Performance M & DS - 1	1.349	≤ 3	Satisfied	58
Performance M & DS - 2	1.349	≤ 3	Satisfied	73
Price -> Sales P&DE - 1	1.220	≤ 3	Satisfied	52
P&DE - 2	1.224	≤ 3	Satisfied	
P&DE - 4	1.279	≤ 3	Satisfied	
P&DE - 5	1.267	≤ 3	Satisfied	
Price	1.000	≤ 3	Satisfied	
Sales	1.000	≤ 3	Satisfied	

Table 3 presents the R-square values for each independent variable, indicating the proportion of the variance in the dependent variable that can be explained by the independent variable(s) in a regression model. The results suggest that maintenance and dealer services and performance and driving experience had a higher level of impact on sales than the other

variables. The factor loadings for customer satisfaction, maintenance and dealer services, performance and driving experience, price, and sales are presented in Table 4.

Table-4: Factor Loadings

	Customer Satisfaction	Maintenance & Dealer Services	Performance & Driving Experience	Price	Sales
CS - 1	**0.912**				
CS - 3	**0.880**				
M & DS - 1		**0.946**			
M & DS - 2		0.203			
P&DE - 1			**0.890**		
P&DE - 2			0.148		
P&DE - 4			**0.744**		
P&DE - 5			0.105		
Price				**1.000**	
Sales					**1.000**

The results revealed that the variables loaded differently on each factor, with the variable "Customer Satisfaction" having high loadings on factors CS-1 and CS-3, and the variable "Maintenance & Dealer Services" having a high loading on factor M & DS-1.

Table-5: Model Fit-Summary

	Estimated model	Threshold limit	Result
SRMR	0.073	< 0.08	Satisfied
DEALS	0.291	-	-
DG	0.242	-	-
Chi-square	23.805	-	-
NFI	0.937	> 0.9	Satisfied

Table 5 provides a summary of the model fit, indicating how well the estimated model fits the data. The results show that the estimated model had a good fit, with the SRMR value being less than the threshold limit of 0.08, and the NFI value being greater than 0.9. In conclusion, the study findings suggest that performance and driving experience, maintenance and dealer services, price, and customer satisfaction have a significant impact on sales. The results of the study can be useful to businesses and organizations looking to enhance their sales and customer satisfaction levels.

6.a. Analysis

This study conducted a detailed analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM) to investigate the influence of key factors on hybrid vehicle sales in Bengaluru. The primary aim was to examine how Performance & Driving Experience, Maintenance & Dealer Services, Price, and Customer Satisfaction contribute to hybrid vehicle sales.

6.1 Measurement Model Validation

Prior to analyzing the structural relationships, the measurement model was rigorously validated to ensure reliability and validity of the constructs:

- The Cronbach's Alpha (0.756), Composite Reliability (rho_a = 0.767, rho_c = 0.891), and Average Variance Extracted (AVE = 0.803) all exceeded the minimum threshold of 0.7, confirming the internal consistency and convergent validity of constructs such as Customer Satisfaction.

- The Variance Inflation Factor (VIF) values were all below 3, indicating no significant multicollinearity between independent variables. This demonstrates that each predictor contributes independently without redundancy, ensuring the robustness of the regression analysis.

6.2 Structural Model Results

The relationships between independent variables and their impact on hybrid vehicle sales were assessed by analyzing the path coefficients and R-square values:

1.   Performance & Driving Experience → Customer Satisfaction (Path Coefficient = +0.321):
The analysis confirms that enhanced performance and driving experience significantly improve customer satisfaction. Customers who perceive hybrids as offering superior handling, smooth acceleration, and driving comfort tend to report higher satisfaction levels, which is consistent with previous global studies.

2.   Maintenance & Dealer Services → Customer Satisfaction (Path Coefficient = -0.200): Unexpectedly, this relationship was negative, indicating that poor dealer service and maintenance infrastructure reduce customer satisfaction. This suggests a critical barrier in the adoption of hybrid vehicles, as inadequate support and after-sales service negatively affect the customer experience.

3.   Customer Satisfaction → Sales (Path Coefficient = +0.199): Customer satisfaction contributes positively to sales but the small coefficient indicates that satisfaction alone is not a dominant driver of hybrid vehicle purchases. This may reflect limited public understanding of hybrid technology or its long-term benefits in the local market.

4.   Performance & Driving Experience → Sales (Path Coefficient = -0.304): Interestingly, the direct effect of performance and driving experience on sales was negative, suggesting that performance improvements do not directly lead to higher sales unless paired with effective consumer education or promotional efforts.

5.   Maintenance & Dealer Services → Sales (Path Coefficient = -0.440): The strongest negative impact was observed in this relationship. Poor quality of maintenance services and weak dealer support strongly deter potential buyers, highlighting the urgent need for dealerships to improve service infrastructure to encourage hybrid adoption.

6.   Price → Sales (Path Coefficient = -0.374): As expected, higher prices reduce sales, though this effect is moderate compared to the influence of dealer services. It reflects that price remains a significant barrier but not the sole factor in consumer decision-making.

6.3 R-Square (R²) Values

The proportion of variance explained by the independent variables was calculated as follows:

• Sales (R^2 = 0.349): About 34.9% of the variance in sales is explained by the model, representing moderate explanatory power typical for behavioral studies in market research.

• Customer Satisfaction (R^2 = 0.321): Around 32.1% of variance in customer satisfaction is explained, predominantly driven by performance and dealer services.

• Other notable paths:

o Maintenance & Dealer Services → Customer Satisfaction (R^2 = 0.036)
o Maintenance & Dealer Services → Sales (R^2 = 0.169)
o Performance & Driving Experience → Sales (R^2 = 0.073)
o Price → Sales (R^2 = 0.052)

6.4 Model Fit Summary

The overall fit of the model was tested using established fit indices:

• Standardized Root Mean Square Residual (SRMR) = 0.073, which is below the threshold of 0.08, confirming a good model fit.

• Normed Fit Index (NFI) = 0.937, exceeding the benchmark of 0.9, indicating a satisfactory model fit.

• Additional indicators such as Chi-square, DEALS, and DG further supported the model's adequacy for explaining the relationships under study.

6.5 Key Findings

1. Maintenance and Dealer Services Are the Most Influential Factor: The quality of after-sales service and dealership support has the strongest impact on hybrid vehicle sales in Bengaluru. Poor service acts as a major barrier to adoption, highlighting the need for enhanced dealer training and service infrastructure.

2. Performance Improves Satisfaction but Does Not Directly Drive Sales: While vehicle performance positively affects customer satisfaction, it does not translate directly into purchase decisions. This indicates that consumer education and effective marketing are necessary to link performance perceptions to actual sales.

3. Price Sensitivity Limits Adoption: Price remains a significant factor affecting sales. Consumers perceive hybrid vehicles as expensive, so financial incentives, subsidies, and flexible payment schemes are essential to improve affordability.

4. Customer Satisfaction Has a Limited Direct Effect on Sales: Although satisfied customers are more likely to consider hybrid vehicles, satisfaction alone is insufficient to significantly increase sales. Structural factors such as service quality and pricing are more decisive in purchase behavior.

5. Implications for Stakeholders: Dealers, manufacturers, and policymakers must prioritize improving service quality, raising consumer awareness, and reducing cost barriers to promote hybrid vehicle adoption effectively.

7 Suggestions

Based on the findings of this study, several strategies can be implemented to enhance the adoption of hybrid vehicles in Bengaluru:

I. Enhance Dealer Competence and Service Quality: Automotive companies should invest in specialized training programs for dealership staff,

focusing on hybrid technology. Well-trained personnel can address consumer queries, resolve technical issues efficiently, and improve overall service quality, which is a key factor influencing sales.

II. Increase Consumer Awareness: Targeted awareness campaigns by manufacturers and dealers can educate customers about the environmental and economic benefits of hybrid vehicles. Clarifying misconceptions about battery life, maintenance, and performance will help build consumer confidence and encourage adoption.

III. Improve Economic Accessibility: Financial measures such as government subsidies, tax incentives, and flexible EMI schemes can make hybrid vehicles more affordable, particularly for middle-class consumers. Such incentives will reduce the price barrier, which remains a significant challenge.

IV. Strengthen After-Sales and Infrastructure Support: Developing dedicated service centers and expanding hybrid-focused after-sales infrastructure can enhance customer confidence. Offering extended warranties on batteries and electrical components may further promote a positive purchase experience.

V. Supportive Policy Measures: Policymakers should continue and expand eco-friendly initiatives like the FAME scheme, while introducing policies that support hybrid infrastructure development. Collaboration between government bodies and manufacturers is crucial to accelerate market penetration and sustainable mobility.

8. Conclusion

This study examined the factors influencing hybrid vehicle sales in Bengaluru using a PLS-SEM analysis model. The findings indicate that Performance & Driving Experience, Maintenance & Dealer Services, Price, and Customer Satisfaction significantly shape consumer purchase decisions.

- Maintenance and Dealer Services: Service quality has the strongest impact on hybrid vehicle sales. Addressing service-related challenges is crucial for encouraging broader adoption.

- Performance: While vehicle performance enhances customer satisfaction, it does not directly drive sales, suggesting a need for better consumer education and targeted marketing.

- Price: Affordability remains a barrier, although its influence is less pronounced than that of service quality.

- Customer Satisfaction: Satisfaction positively affects sales but only to a limited extent, highlighting that improvements in service and performance may yield more immediate results. The success of hybrid vehicles in India is intricately linked to the perceptions and preparedness of automotive dealers. While there is a growing acknowledgment of the environmental and economic benefits of hybrids, challenges such as knowledge gaps, infrastructure limitations, and consumer misconceptions persist. Addressing these issues through targeted interventions can facilitate a more conducive environment for hybrid vehicle adoption, contributing to a sustainable automotive future in India.

Overall, hybrid vehicles present a promising solution for sustainable mobility by improving fuel efficiency and reducing emissions. Collaboration among policymakers, manufacturers, and dealers is essential to enhance service infrastructure, raise consumer awareness, and make hybrid vehicles more economically accessible. Future research may focus on longitudinal studies to assess changes in consumer behavior over time and explore rural versus urban

adoption patterns. Despite these limitations, hybrid vehicles remain a practical choice for environmentally conscious consumers seeking a balance between conventional and electric mobility solutions.

9. Scope for Future Studies

While this study provides valuable insights into the factors influencing hybrid vehicle sales in Bengaluru, there are several areas that future research could explore. Longitudinal studies could track changes in consumer behavior over time as hybrid technology evolves and becomes more widely available. Comparative studies between urban and rural markets could highlight differences in adoption patterns and infrastructure challenges. Additionally, future research could examine the impact of government incentives, emerging electric vehicle technologies, and evolving consumer perceptions on hybrid vehicle adoption. Exploring these areas would provide a more comprehensive understanding of the market dynamics and inform strategies for promoting sustainable mobility in India.

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