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Research Article

Marketing and Consumer Dynamics Based Analsis of Key Determinants for Electric and Hybrid Vehicle Adoption

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ABSTRACT

In the recent years, the adoptability of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) is highly increased among the customers. However, there are various factors which influenced their perception. Keeping these facts in mind, present research article, examines the key influencing aspects for the adoption of EVs and HEVs, especially marketing strategies, customer satisfaction, loyalty, and adoption factors. For this purpose, data was collected from 324 manufacturers, with 163 responses kept after the cleaning of data. Reliability analysis indicated higher value of Cronbach's Alpha scores for all constructs as 0.846 for marketing strategies, 0.834 for customer satisfaction, 0.844 for customer loyalty, and 0.837 for adoption factors. Thereafter, Principal Component Analysis (PCA) is used, which revealed significant variance explained by the first component for each construct. Moreover, ANOVA results also emphasized significant statistical group differences, with F-values varies from 13.113 to 39.726 across metrics. In conclusion, well-targeted marketing strategies, robust satisfaction drivers, and loyalty-building efforts have been observed to be important in driving adoption.

Keywords: Electric Vehicles, Hybrid Electric Vehicles, Marketing Strategies, Customer Satisfaction, Customer Loyalty, Adoption Factors.

INTRODUCTION

The increasing urgency to mitigate environmental degradation and achieve energy sustainability has positioned EVs and HEVs as critical components of contemporary transportation systems [1-3]. These technologies, driven by advancements in battery efficiency, energy management systems, and renewable energy integration, are poised to reduce greenhouse gas emissions and dependence on fossil fuels significantly [4-6]. However, the widespread adoption of EVs and HEVs is impeded by multifaceted challenges, including infrastructural deficits, high capital costs, and varying consumer perceptions [7-10].

Benzidia et al. [11] discussed various buyer's perspective during purchasing the electric and hybrid vehicles. Kumar et al. [12] pointed towards the potential challenges during this adoption in Indian perspective. Utami et al. [13] developed successfully an intention model for adoption of electric vehicles in Indonesia. Das & Bhat [14] advocated towards a robust poly implementation for global adoption of electric vehicles in their study. Palit et al. [15] successfully performed a hybrid PCA and Interpretive Structural Equation Modeling (SEM) approach for decision making in electric vehicle adoption process.

KV et al. [16] also identified various influencing factors which affects the adoption of electric vehicles in Indian scenario. Patyal et al. [17] successfully performed the modeling of various potential barriers during the adoption of electric vehicles in India. Brückmann et al. [18] discussed in detail about the adoption of battery Electric Vehicles without strong policies. Tarei et al. [19] also pointed towards various barriers for this adoption purpose in India. Huang et al. [20] successfully performed agent-based modelling for chianese market acceptance of electric vehicles. Hamzah & Tanwir [21] identified various pro-environmental concerns which lead to increase the purchase intention of hybrid vehicles among customers.

This study adopts a rigorous analytical approach to investigate the interdependencies among marketing strategies, customer satisfaction, loyalty, and adoption factors, which collectively shape the diffusion of EVs and HEVs. A dual-

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perspective methodology, incorporating insights from manufacturers and end-users, facilitates the derivation of statistically robust conclusions through reliability assessments, principal component analyses, and ANOVA tests.

METHODOLOGY

This study employs a structured analytical framework to evaluate marketing strategies, customer satisfaction, loyalty, and adoption factors for Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs). Data collection was conducted in Delhi NCR area using a questionnaire tailored for manufacturers, encompassing Likert scale (1-7) and open-ended questions. The sample included 324 manufacturers, with 163 responses retained for analysis after screening for missing data.

The analysis measured reliability using Cronbach's Alpha, achieving high consistency across metrics, as shown in Table 1. Marketing strategies had a Cronbach's Alpha of 0.846, customer satisfaction scored 0.834, customer loyalty reached 0.844, and adoption factors achieved 0.837, confirming the reliability of the measures. Validity was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The KMO values for all factors exceeded 0.78, with Bartlett's tests yielding significant p-values (0.000), as detailed in Table 2. These results confirm the adequacy of the data for factor analysis and the validity of the constructs.

Table 1: Reliability Statistics for all factors

Factors	Cronbach's Alpha	No. of Items
Marketing strategies	0.846	4
Customer satisfaction	0.834	4
Customer Loyalty	0.844	4
Adoption Factors	0.837	4

Table 2: KMO and Bartlett's Test results for all factors

Factors	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
		Approx. Chi-Square	df	Sig.
Marketing strategies	0.821	255.995	6	0.000
Customer satisfaction	0.782	244.622	6	0.000
Customer Loyalty	0.817	255.127	6	0.000
Adoption Factors	0.790	251.103	6	0.000

RESULTS & DISCUSSION

Marketing strategies

The analysis of marketing strategies for Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) reveals significant insights, as summarized in Table 3, Table 4, and Table 5. The descriptive statistics (Table 3) show that the mean scores for the four metrics (MS1 to MS4) are consistently above 5.4, with minimal standard deviations (ranging from 0.884 to 0.952). This indicates a positive and consistent evaluation of marketing strategies among respondents. The skewness values are close to zero, suggesting a near-symmetrical distribution of responses, while the kurtosis values are slightly negative, indicating flatter distributions. The variance explained by the first component in the principal component analysis (Table 4) is 68.4%, as shown in Figure 2, signifying that a single underlying factor explains most of the variance in the responses. This highlights the unified perception of marketing strategies' effectiveness.

Table 3: Descriptive Statistics for Marketing Strategies

	N	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
MS1	163	3	7	5.52	0.884	-0.039	-0.446
MS2	163	3	7	5.50	0.912	-0.083	-0.563

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MS3	163	3	7	5.52	0.952	-0.215	-0.514
MS4	163	3	7	5.43	0.916	-0.130	-0.422
Valid N (listwise)	163						

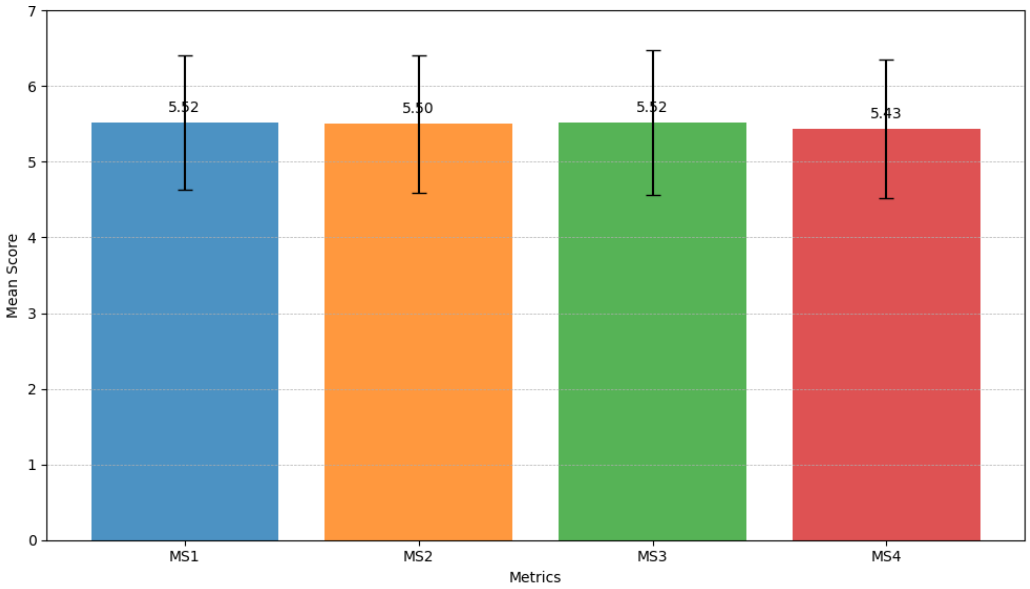

Figure 1: Enhanced mean and standard deviation for marketing strategies

Table 4: Total Variance Explained table for Marketing Strategies

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.737	68.415	68.415	2.737	68.415	68.415
2	0.476	11.897	80.313			
3	0.410	10.249	90.561			
4	0.378	9.439	100.000			
Extraction Method: Principal Component Analysis.						

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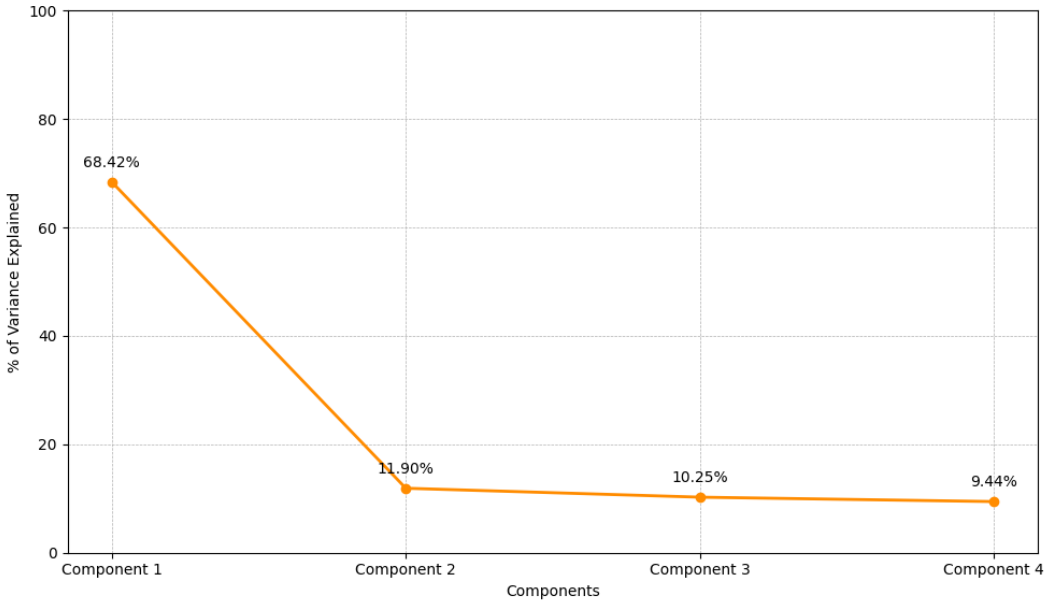

Figure 2: Enhanced total variance explained for marketing strategies

The ANOVA results (Table 5) reveal statistically significant group differences for all metrics (p-value = 0.000), with F-values ranging from 20.578 (MS1) to 39.726 (MS3), indicating that the variance between groups is substantially greater than the variance within groups. Figure 1 further illustrates the mean scores and standard deviations for the four metrics, emphasizing the relatively high and consistent responses. These findings suggest that targeted marketing strategies, particularly those represented by MS3, play a pivotal role in shaping consumer perceptions and driving adoption. The dominant role of the first component indicates that comprehensive, well-integrated campaigns are likely the most effective in influencing consumer behavior.

Table 5: AOVA table for Marketing Strategies

		SS	df	MS	F	Sig.
MS1	**Between Groups**	35.428	3	11.809	20.578	0.000
	Within Groups	91.247	159	0.574		
	Total	126.675	162			
MS2	**Between Groups**	51.825	3	17.275	33.124	0.000
	Within Groups	82.923	159	0.522		
	Total	134.748	162			
MS3	**Between Groups**	62.839	3	20.946	39.726	0.000
	Within Groups	83.836	159	0.527		
	Total	146.675	162			
MS4	**Between Groups**	39.943	3	13.314	22.053	0.000
	Within Groups	95.996	159	0.604		
	Total	135.939	162			

Customer Satisfaction

The analysis of customer satisfaction metrics (CS1 to CS4) reveals key insights into consumer perceptions of Electric and Hybrid Vehicles, as presented in Table 6 and Figure 3. The mean scores for all metrics range from 5.37 (CS3) to 5.52 (CS2), with minimal standard deviations (below 1), indicating consistent positive responses across the dataset. Skewness values near zero and kurtosis values within acceptable limits highlight a balanced and symmetrical distribution of responses. The total variance explained through principal component analysis (Table 7 and Figure 4) shows that the first component accounts for 66.87% of the variance, emphasizing the dominance of a single underlying factor in shaping overall satisfaction. The cumulative variance explained by the first two components reaches 80.50%, underscoring the robustness of the satisfaction construct. ANOVA results (Table 8) demonstrate

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significant group differences for all metrics (p-value = 0.000), with F-values ranging from 18.764 (CS1) to 21.260 (CS4). These findings indicate strong differentiation in satisfaction levels across groups, with CS4 showing the highest variability. Collectively, these results suggest that addressing key satisfaction drivers such as product performance and service quality can enhance consumer experience, fostering loyalty and adoption. The visualizations in Figures 3 and 4 complement this analysis by providing a detailed overview of the statistical trends.

Table 6: Descriptive Statistics for Customer Satisfaction

	N	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
CS1	163	4	7	5.40	0.879	0.046	-0.697
CS2	163	3	7	5.52	0.932	-0.295	-0.006
CS3	163	3	7	5.37	0.889	-0.101	-0.100
CS4	163	3	7	5.47	0.870	-0.152	-0.144
Valid N (listwise)	163						

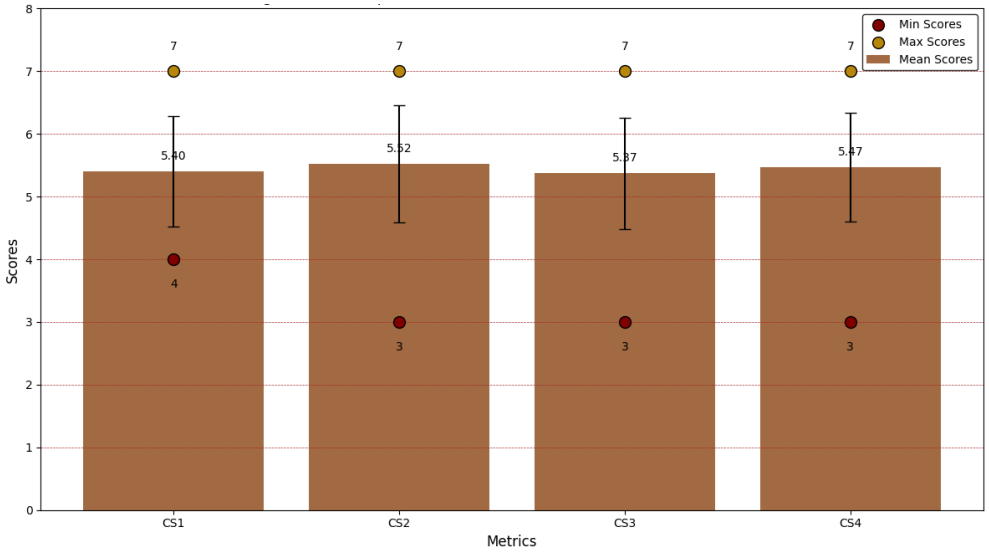

Figure 3: Descriptive statistics for customer satisfaction metrics

Table 7: Total Variance Explained table for Customer Satisfaction

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.675	66.872	66.872	2.675	66.872	66.872
2	0.545	13.626	80.498			
3	0.451	11.266	91.765			
4	0.329	8.235	100.000			
Extraction Method: Principal Component Analysis.						

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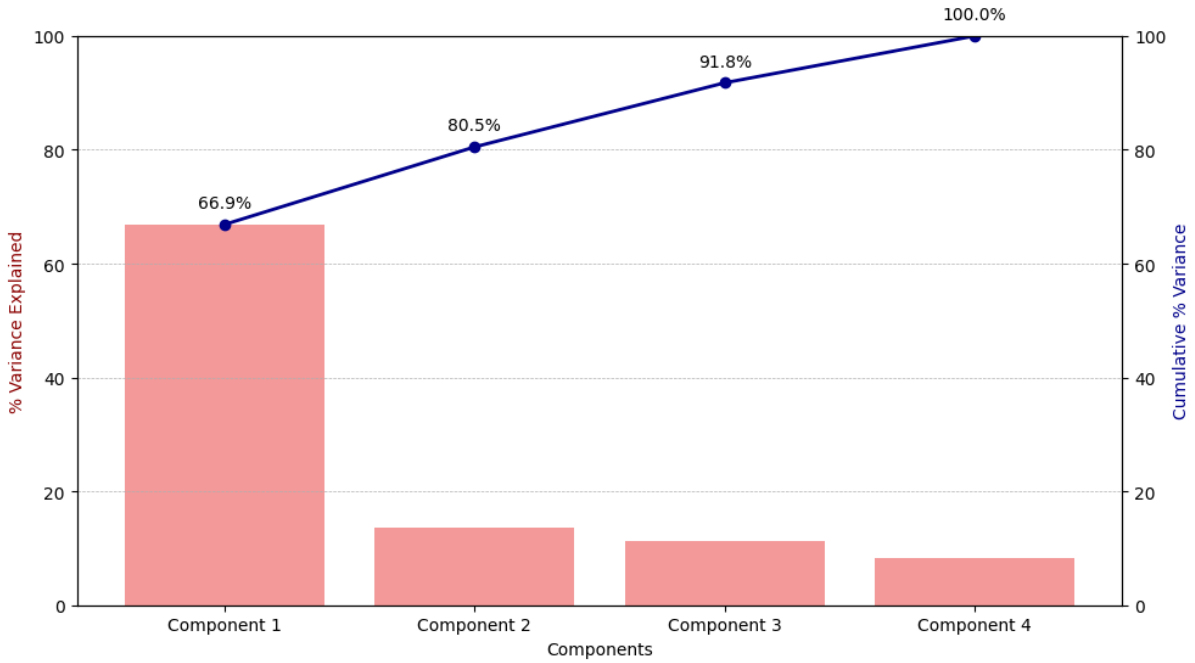

Figure 4: Total and cumulative variance explained for customer satisfaction

Table 8: AOVA table for Customer Satisfaction

		SS	df	MS	F	Sig.
CS1	**Between Groups**	40.345	4	10.086	18.764	0.000
	Within Groups	84.931	158	0.538		
	Total	125.276	162			
CS2	**Between Groups**	46.801	4	11.700	19.693	0.000
	Within Groups	93.874	158	0.594		
	Total	140.675	162			
CS3	**Between Groups**	41.648	4	10.412	19.070	0.000
	Within Groups	86.266	158	0.546		
	Total	127.914	162			
CS4	**Between Groups**	42.885	4	10.721	21.260	0.000
	Within Groups	79.679	158	0.504		
	Total	122.564	162			

Customer Loyalty

The analysis of customer loyalty metrics (CL1 to CL4) provides an in-depth understanding of the factors influencing repeat purchase behavior and brand attachment among consumers. As shown in Table 9 and Figure 5, mean scores are consistently high, ranging from 5.38 (CL2) to 5.43 (CL1 and CL3), reflecting overall positive sentiments. Standard deviations remain below 1, indicating low variability in responses. Skewness and kurtosis values are within acceptable ranges, suggesting well-distributed responses with minimal outliers. The principal component analysis (Table 10 and Figure 6) reveals that the first component explains 68.36% of the variance, highlighting a strong unidimensional construct underlying customer loyalty. The cumulative variance explained by the first two components reaches 80.26%, further validating the robustness of the loyalty framework. ANOVA results (Table 11) underscore statistically significant group differences for all metrics (p-value = 0.000), with F-values ranging from 13.113 (CL3) to 25.973 (CL4). CL4, associated with deeper emotional and social loyalty factors, exhibited the highest F-value, emphasizing

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its critical role in differentiating loyalty levels across groups. These insights demonstrate the importance of fostering customer trust and engagement to enhance loyalty. The detailed visualizations in Figures 5 and 6 support this analysis, providing a clear and actionable view of the statistical findings.

Table 9: Descriptive Statistics for Customer Loyalty

	N	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
CL1	163	3	7	5.43	0.968	-0.046	-0.640
CL2	163	3	7	5.38	0.890	-0.084	-0.329
CL3	163	3	7	5.43	0.868	-0.268	0.331
CL4	163	3	7	5.42	0.838	-0.105	-0.302
Valid N (listwise)	163						

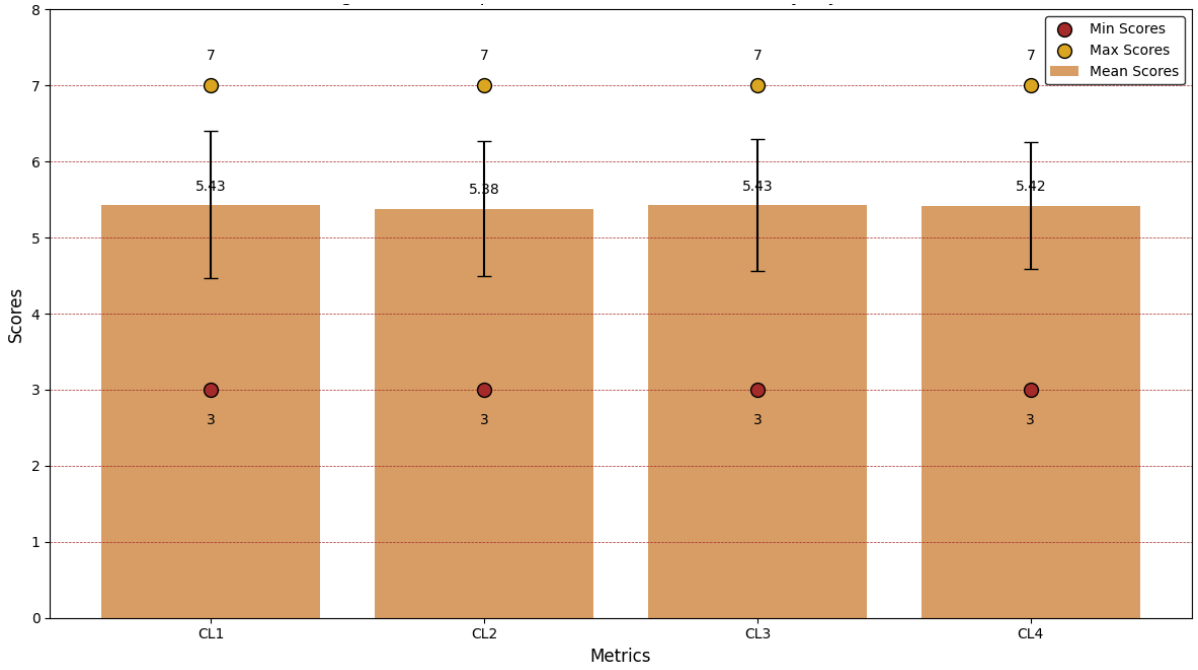

Figure 5: Descriptive statistics for customer loyalty metrics

Table 10: Total Variance Explained table for Customer Loyalty

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.734	68.359	68.359	2.734	68.359	68.359
2	0.476	11.899	80.257			
3	0.408	10.207	90.464			
4	0.381	9.536	100.000			
Extraction Method: Principal Component Analysis.						

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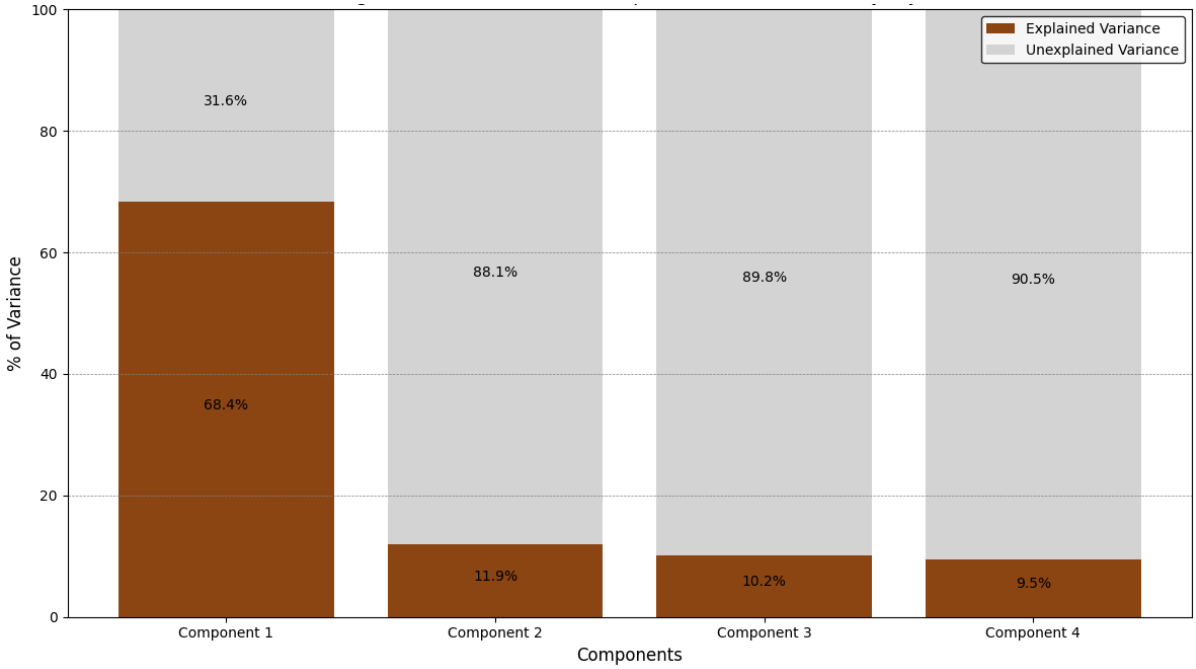

Figure 6: Stacked variance explained for customer loyalty

Table 11: AOVA table for Customer Loyalty

		SS	df	MS	F	Sig.
CL1	**Between Groups**	43.557	4	10.889	15.874	0.000
	Within Groups	108.382	158	0.686		
	Total	151.939	162			
CL2	**Between Groups**	36.263	4	9.066	15.543	0.000
	Within Groups	92.154	158	0.583		
	Total	128.417	162			
CL3	**Between Groups**	30.391	4	7.598	13.113	0.000
	Within Groups	91.548	158	0.579		
	Total	121.939	162			
CL4	**Between Groups**	45.141	4	11.285	25.973	0.000
	Within Groups	68.650	158	0.434		
	Total	113.791	162			

Adoption Factor

The analysis of adoption factor metrics (AF1 to AF4) offers a comprehensive view of the elements driving consumer acceptance of new technologies, as illustrated in Table 12 and Figure 7. The mean scores, ranging from 5.45 (AF3, AF4) to 5.51 (AF2), demonstrate a generally favorable attitude toward adoption factors, supported by minimal standard deviations, indicating consistency among responses. Skewness and kurtosis values suggest balanced distributions with no significant outliers. Principal component analysis results (Table 13 and Figure 8) highlight that the first component explains 67.31% of the variance, underscoring a strong unidimensional structure influencing adoption. The cumulative variance of 79.98% across two components validates the robustness of these factors. ANOVA findings (Table 14 and Figure 9) reveal significant group differences across metrics (p-value = 0.000), with F-values ranging from 16.285 (AF2) to 26.625 (AF1). The highest F-value for AF1 indicates that it plays the most prominent role in explaining group variations, possibly linked to perceived ease of use and usefulness. These insights emphasize the critical importance of enhancing the features most strongly associated with consumer preferences. Together, the statistical summaries and visualizations provide a detailed understanding of the dynamics influencing adoption, paving the way for targeted interventions to improve consumer uptake.

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Table 12: Descriptive Statistics for Adoption Factor

	N	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
AF1	163	3	7	5.47	0.884	-0.322	0.264
AF2	163	3	7	5.51	0.891	-0.240	0.018
AF3	163	3	7	5.45	0.924	-0.059	-0.425
AF4	163	3	7	5.45	0.938	-0.297	-0.137
Valid N (listwise)	163						

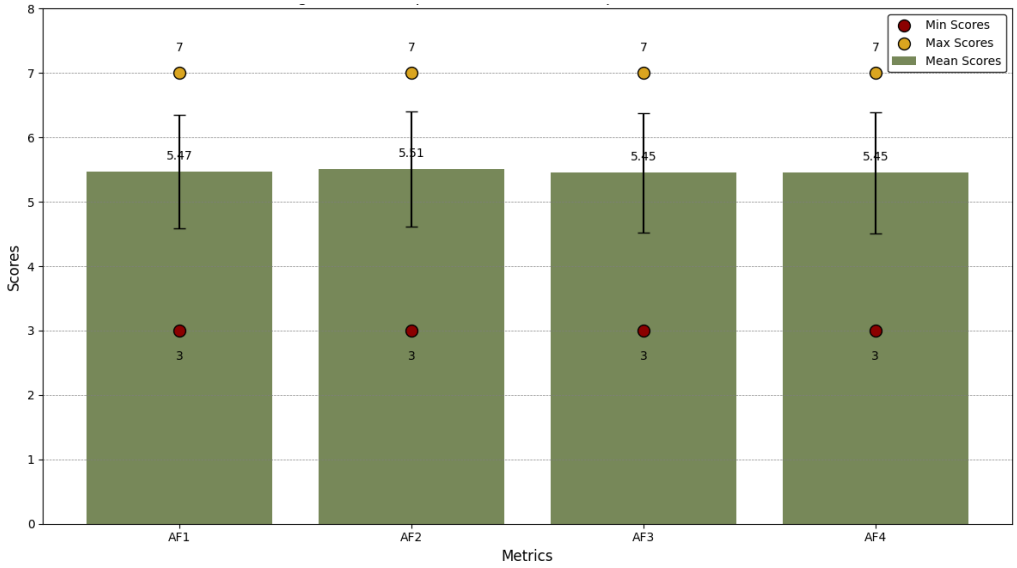

Figure 7: Descriptive statistics for adoption factor metrics

Table 13: Total Variance Explained table for Adoption Factor

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.692	67.308	67.308	2.692	67.308	67.308
2	0.507	12.669	79.977			
3	0.490	12.253	92.230			
4	0.311	7.770	100.000			
Extraction Method: Principal Component Analysis.						

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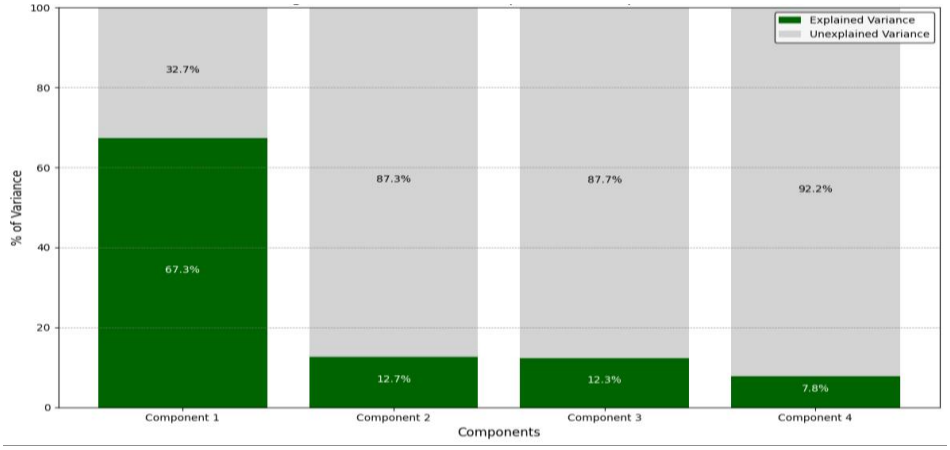

Figure 8: Stacked variance explained for adoption factor

Table 14: AOVA table for Adoption Factor

		SS	df	MS	F	Sig.
AF1	**Between Groups**	50.985	4	12.746	26.625	0.000
	Within Groups	75.641	158	0.479		
	Total	126.626	162			
AF2	**Between Groups**	37.582	4	9.395	16.285	0.000
	Within Groups	91.154	158	0.577		
	Total	128.736	162			
AF3	**Between Groups**	53.149	4	13.287	24.653	0.000
	Within Groups	85.158	158	0.539		
	Total	138.307	162			
AF4	**Between Groups**	46.379	4	11.595	19.078	0.000
	Within Groups	96.026	158	0.608		
	Total	142.405	162			

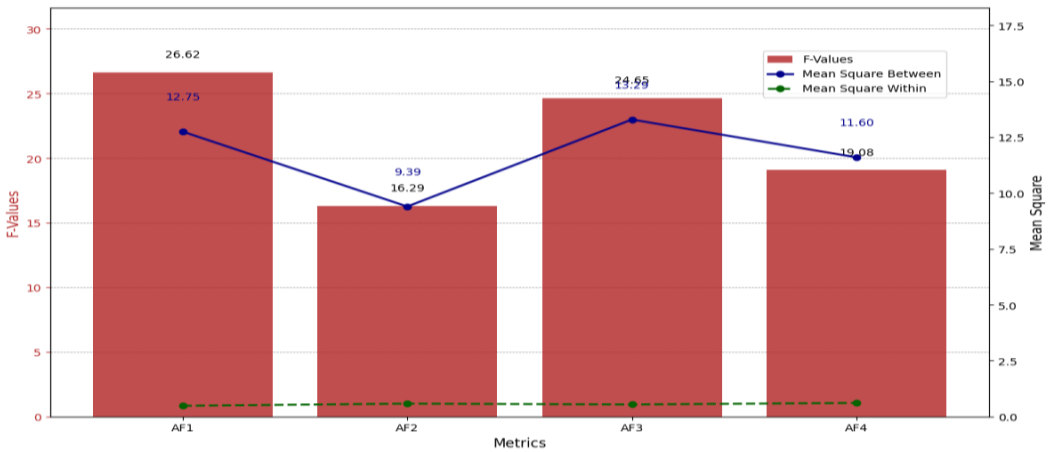

Figure 9: Interaction plot of ANOVA for adoption factor

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CONCLUSION

This study provides comprehensive insights into the determinants of Electric and Hybrid Electric Vehicle adoption. Marketing strategies were consistently evaluated as effective, with MS3 exhibiting the highest influence (mean = 5.52, F = 39.726). Customer satisfaction metrics revealed a balanced and positive distribution, with CS2 achieving the highest mean (5.52). PCA results confirmed the dominance of single underlying components, explaining significant variance—67.31% for adoption factors and 68.36% for customer loyalty. ANOVA results underscored substantial group differences across metrics, with the highest F-values recorded for CL4 (25.973) and AF1 (26.625). These findings highlight the critical role of personalized marketing campaigns, enhanced product satisfaction, and loyalty-driven incentives in fostering EV and HEV adoption. The alignment of consumer and manufacturer perspectives ensures strategic interventions can address key barriers and leverage facilitators effectively. By optimizing marketing strategies and addressing satisfaction and loyalty drivers, stakeholders can accelerate sustainable adoption of EVs and HEVs. This research provides a robust analytical framework for future studies, offering actionable insights to policymakers and industry leaders.

REFERENCES

[1] Isik, M., Dodder, R., & Kaplan, P. O. (2021). Transportation emissions scenarios for New York City under different carbon intensities of electricity and electric vehicle adoption rates. *Nature energy*, *6*(1), 92-104.
[2] Kumar, R. R., & Alok, K. (2020). Adoption of electric vehicle: A literature review and prospects for sustainability. *Journal of Cleaner Production*, *253*, 119911.
[3] Selvakumar, S. G. (2021, December). Electric and hybrid vehicles–a comprehensive overview. In *2021 IEEE 2nd International Conference On Electrical Power and Energy Systems (ICEPES)* (pp. 1-6). IEEE.
[4] Ling, Z., Cherry, C. R., & Wen, Y. (2021). Determining the factors that influence electric vehicle adoption: A stated preference survey study in Beijing, China. *Sustainability*, *13*(21), 11719.
[5] Liu, X., Sun, X., Zheng, H., & Huang, D. (2021). Do policy incentives drive electric vehicle adoption? Evidence from China. *Transportation Research Part A: Policy and Practice*, *150*, 49-62.
[6] Higueras-Castillo, E., Kalinic, Z., Marinkovic, V., & Liébana-Cabanillas, F. J. (2020). A mixed analysis of perceptions of electric and hybrid vehicles. *Energy Policy*, *136*, 111076.
[7] Maybury, L., Corcoran, P., & Cipcigan, L. (2022). Mathematical modelling of electric vehicle adoption: A systematic literature review. *Transportation Research Part D: Transport and Environment*, *107*, 103278.
[8] Tanwir, N. S., & Hamzah, M. I. (2020). Predicting purchase intention of hybrid electric vehicles: Evidence from an emerging economy. *World Electric Vehicle Journal*, *11*(2), 35.
[9] Chen, C. F., de Rubens, G. Z., Noel, L., Kester, J., & Sovacool, B. K. (2020). Assessing the socio-demographic, technical, economic and behavioral factors of Nordic electric vehicle adoption and the influence of vehicle-to-grid preferences. *Renewable and Sustainable Energy Reviews*, *121*, 109692.
[10] Kumar, R., Jha, A., Damodaran, A., Bangwal, D., & Dwivedi, A. (2020). Addressing the challenges to electric vehicle adoption via sharing economy: An Indian perspective. *Management of Environmental Quality: An International Journal*, *32*(1), 82-99.
[11] Benzidia, S., Luca, R. M., & Boiko, S. (2021). Disruptive innovation, business models, and encroachment strategies: Buyer's perspective on electric and hybrid vehicle technology. *Technological Forecasting and Social Change*, *165*, 120520.
[12] Kumar, R., Jha, A., Damodaran, A., Bangwal, D., & Dwivedi, A. (2020). Addressing the challenges to electric vehicle adoption via sharing economy: An Indian perspective. *Management of Environmental Quality: An International Journal*, *32*(1), 82-99.
[13] Utami, M. W. D., Yuniaristanto, Y., & Sutopo, W. (2020). Adoption intention model of electric vehicle in Indonesia. *Jurnal Optimasi Sistem Industri*, *19*(1), 70-81.
[14] Das, P. K., & Bhat, M. Y. (2022). Global electric vehicle adoption: implementation and policy implications for India. *Environmental Science and Pollution Research*, *29*(27), 40612-40622.
[15] Palit, T., Bari, A. M., & Karmaker, C. L. (2022). An integrated Principal Component Analysis and Interpretive Structural Modeling approach for electric vehicle adoption decisions in sustainable transportation systems. *Decision Analytics Journal*, *4*, 100119.
[16] KV, S., Michael, L. K., Hungund, S. S., & Fernandes, M. (2022). Factors influencing adoption of electric vehicles–A case in India. *Cogent Engineering*, *9*(1), 2085375.

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[17] Patyal, V. S., Kumar, R., & Kushwah, S. (2021). Modeling barriers to the adoption of electric vehicles: An Indian perspective. *Energy*, *237*, 121554.
[18] Brückmann, G., Willibald, F., & Blanco, V. (2021). Battery Electric Vehicle adoption in regions without strong policies. *Transportation Research Part D: Transport and Environment*, *90*, 102615.
[19] Tarei, P. K., Chand, P., & Gupta, H. (2021). Barriers to the adoption of electric vehicles: Evidence from India. *Journal of Cleaner Production*, *291*, 125847.
[20] Huang, X., Lin, Y., Zhou, F., Lim, M. K., & Chen, S. (2021). Agent-based modelling for market acceptance of electric vehicles: evidence from China. *Sustainable Production and Consumption*, *28*, 206-217.
[21] Hamzah, M. I., & Tanwir, N. S. (2021). Do pro-environmental factors lead to purchase intention of hybrid vehicles? The moderating effects of environmental knowledge. *Journal of Cleaner Production*, *279*, 123643.