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Economic Value, Battery Reliability and Post-Purchase Satisfaction of Electric Vehicle Users: Evidence from Haryana

Author name: Jitender
Research Scholar
Mdu Rohtak.
Guide name : Dr.Jai Pal Sharma
Principal Gaur Brahman degree College Rohtak

Abstract-This research examines the influence of economic value and battery reliability on post-purchase satisfaction among electric vehicle users in Haryana. The study is based on primary survey responses collected from 480 electric vehicle owners/primary users across six administrative divisions of Haryana. The analysis focuses on two validated product-quality dimensions: Battery Efficiency and Operating Reliability and Economy and Value Assessment. The results show that Economy and Value Assessment is the strongest product-quality dimension, with a mean score of 3.94 and the highest standardized regression coefficient $\beta = 0.301$, $p < 0.001$. Battery Efficiency and Operating Reliability is the second strongest dimension, with a mean score of 3.89 and standardized regression coefficient $\beta = 0.247$, $p < 0.001$. The findings prove that EV users in Haryana are most satisfied when electric vehicles provide clear running-cost savings, good value for money, dependable battery performance, adequate driving range and reliable daily-use performance.

Keywords: Electric vehicles, economic value, battery reliability, post-purchase satisfaction, running cost, Haryana.

I. INTRODUCTION

Electric vehicles are not evaluated only at the time of purchase. Their real value is judged after regular use, when consumers compare purchase cost, running cost, battery performance, range adequacy and daily travel reliability. For this reason, post-purchase satisfaction becomes an important measure of EV success. A consumer may accept an EV because it appears modern or environmentally useful but satisfaction is created only when the vehicle gives dependable performance and visible economic benefit in daily life. Economic value is especially important in EV ownership because many consumers face a higher purchase price at the beginning but expect savings later through lower fuel cost and lower routine maintenance. Hidrue et al. found that consumers consider driving range, charging time, fuel-cost saving, pollution reduction and performance while valuing electric vehicles, and they also connect fuel savings with purchase value (Hidrue et al., 2011). Dumortier et al. further explained that total cost of ownership information affects consumer preference because EV value is better understood when purchase cost and operating cost are considered together (Dumortier et al., 2015). Battery reliability is the second major pillar of EV satisfaction. The battery determines range, daily usability, replacement anxiety and confidence during travel. Degirmenci and Breitner treated price value and range confidence as important EV evaluation factors, while Skippon and Garwood found that consumers connect EV suitability with practical range expectations after direct experience (Degirmenci & Breitner, 2017; Skippon & Garwood, 2011).

II. REVIEW OF LITERATURE

2.1 Economic Value, Perceived Value and Satisfaction

Consumer satisfaction is formed when actual ownership experience confirms the expectations held before purchase. Oliver explained satisfaction through expectation and disconfirmation, which means that consumers become satisfied when product performance meets or exceeds expected value after use (Oliver, 1980). In the EV context, this theory is important because the consumer does not judge only the vehicle's appearance or technology; the user compares expected savings, reliability and convenience with the actual ownership experience. Perceived value connects price, quality and benefit. Zeithaml defined value as a consumer's overall assessment of what is received compared with what is given, and

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Woodruff treated customer value as a central source of competitive advantage (Zeithaml, 1988; Woodruff, 1997). For EV users, this means that satisfaction depends on whether the vehicle justifies its cost through lower running expenses, dependable performance and long-term usefulness. Fornell et al. also linked perceived quality and perceived value with satisfaction in the American Customer Satisfaction Index model, supporting the argument that EV satisfaction should be measured through quality and value together (Fornell et al., 1996).

Research on EV valuation gives direct support to the role of economy. Hidrue et al. found that fuel-cost savings and driving range are major EV attributes, while Tanaka et al. found that consumers are sensitive to fuel-cost reduction and alternative fuel-station availability in alternative-fuel vehicle choice (Hidrue et al., 2011; Tanaka et al., 2014). Dumortier et al. added that consumers may underestimate EV benefits when they look only at purchase price; total ownership cost information helps consumers evaluate long-term economic value more correctly (Dumortier et al., 2015).

2.2 Battery Reliability, Range Confidence and Daily-Use Performance

Battery reliability is central to EV satisfaction because it affects range adequacy, travel planning, confidence and replacement-cost concern. Graham-Rowe et al. analysed mainstream drivers after direct plug-in vehicle use and reported that consumers evaluate EVs through practical experience, including usage fit and limitations (Graham-Rowe et al., 2012). Bühler et al. found that real-life EV experience can change perceptions of EV advantages and barriers, especially when users judge whether the vehicle is suitable for daily life (Bühler et al., 2014). Range confidence also shapes satisfaction. Plötz et al. connected EV suitability with user profile and travel requirements, while She et al. identified uncertainty about BEV performance and high battery cost as barriers to wider acceptance (Plötz et al., 2014; She et al., 2017). Degirmenci and Breitner treated range confidence and price value as important factors in EV purchase intention, which supports the present paper's combined focus on battery dependability and economic value (Degirmenci & Breitner, 2017).

2.3 Indian EV Consumer Context

Indian EV consumer research shows that adoption and satisfaction are influenced by a combination of cost, technology confidence, perceived usefulness, environmental concern and practical ownership conditions. Khurana, Kumar and Sidhpuria examined EV adoption in India through the mediating role of attitude and placed consumer attitude at the centre of adoption behaviour (Khurana et al., 2020). Kumar and Alok reviewed EV adoption literature and organised EV adoption factors into economic, environmental, technological and social dimensions, which supports the view that Indian EV satisfaction cannot be understood through a single factor (Kumar & Alok, 2020). Jaiswal et al. empirically tested Indian EV adoption intention and found that attitude, perceived usefulness, perceived ease of use, perceived risk and financial incentives influence adoption intention (Jaiswal et al., 2021). Dutta and Hwang used a modified theory of planned behaviour framework and found that technological and environmental considerations influence green EV purchase intention, which indicates that Indian consumers evaluate both functional reliability and sustainable value (Dutta & Hwang, 2021). Jain and Singh further confirmed the importance of attitude, green nudges and perceived behavioural control in Indian EV adoption, while Parmar and Machhar identified maintenance, reliability, EV features, environment and cost-benefit as factors affecting EV buying behaviour (Jain & Singh, 2024; Parmar & Machhar, 2024). Post-purchase EV satisfaction literature also supports the present focus. Cruz-Jesus et al. connected EV satisfaction and continuance intention with ownership conditions, while Liang et al. examined consumer satisfaction with EVs using objective product attributes and consumer reviews, identifying range and performance-related attributes as important satisfaction drivers (Cruz-Jesus et al., 2023; Liang et al., 2024). Samarasinghe et al. and Zhao et al. show that developing-market EV intention and perceived green value remain connected with practical and economic evaluation, not only environmental awareness (Samarasinghe et al., 2024; Zhao et al., 2024).

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III. OBJECTIVES

1. To examine EV users' perception of economic value and battery reliability in Haryana.
2. To analyse the effect of Economy and Value Assessment on overall consumer satisfaction.
3. To analyse the effect of Battery Efficiency and Operating Reliability on overall consumer satisfaction.
4. To identify the relative contribution of product-quality dimensions to satisfaction.

IV. HYPOTHESES

1. **$H_0$1:** Economy and Value Assessment has no significant effect on overall EV consumer satisfaction.
   $H_1$1: Economy and Value Assessment has a significant effect on overall EV consumer satisfaction.
2. **$H_0$2:** Battery Efficiency and Operating Reliability has no significant effect on overall EV consumer satisfaction.
   $H_1$2: Battery Efficiency and Operating Reliability has a significant effect on overall EV consumer satisfaction.
3. **$H_0$3:** Economy and battery reliability are not the strongest satisfaction predictors.
   $H_1$3: Economy and battery reliability are the strongest satisfaction predictors.

V. RESEARCH METHODOLOGY

The present paper is empirical, quantitative and cross-sectional. The population consists of electric vehicle owners or primary users in Haryana. The sample includes 480 respondents, with equal representation of 80 respondents each from Ambala, Rohtak, Gurugram, Hisar, Karnal and Faridabad divisions. Purposive non-probability sampling was used because the research required respondents with actual EV usage experience. The questionnaire measured perceived product quality, consumer satisfaction and satisfaction-influencing factors through five-point scales.

The sample size was checked through the formula:

$$n = \frac{Z^2 pq}{e^2}$$

$$n = \frac{(1.96)^2(0.50)(0.50)}{(0.05)^2} = 384.16$$

The final sample of 480 exceeds the minimum required sample of approximately 384.

The main regression equation used for interpretation is:

$$OCS = 0.982 + 0.132F1 + 0.187F2 + 0.082F3 + 0.109F4 + 0.221F5$$

Where:

1. **OCS** = Overall Consumer Satisfaction
2. **F2** = Battery Efficiency and Operating Reliability
3. **F5** = Economy and Value Assessment

VI. ANALYSIS AND INTERPRETATION

Table 1 : Response Pattern of Perceived Product Quality - Battery and Economy Items

Code	Statement	Agreement %	Neutral %	Disagreement %	Mean	S.D.
PQ3	Battery performance is reliable	65.21	21.04	13.75	3.95	0.86
PQ4	Battery backup is consistent	59.58	24.17	16.25	3.79	0.91
PQ5	Driving range per charge is adequate	57.92	24.38	17.70	3.76	0.94
PQ11	EV is reliable for daily use	69.38	19.79	10.83	4.05	0.81
PQ16	Running cost is	72.08	18.13	9.79	4.12	0.79

International Journal for Novel Research in Economics , Finance and Management
www.ijnrefm.com
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ISSN: 3048-7722

	economical					
PQ19	EV provides good value for money	66.04	21.88	12.08	3.98	0.82
PQ20	Overall product quality of EV is high	55.83	25.42	18.75	3.71	0.89

Source: Primary survey data.

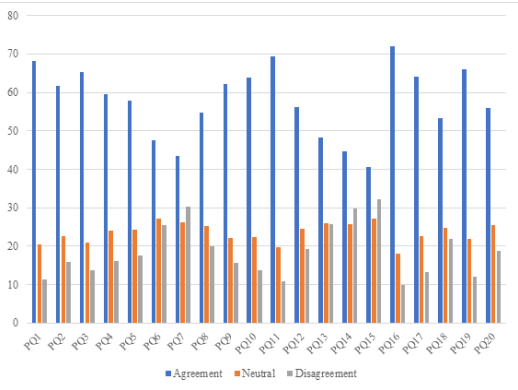

Figure 1 : Response Pattern of Perceived Product Quality

The highest agreement is found for running cost is economical at 72.08%, followed by EV is reliable for daily use at 69.38%. This proves that the strongest quality perception is linked with economic saving and daily reliability.

Table 2 : Rank Order of Perceived Product Quality Statements - Relevant Items

Rank	Code	Statement	Mean Score
1	PQ16	Running cost is economical	4.12
2	PQ11	EV is reliable for daily use	4.05
4	PQ19	EV provides good value for money	3.98
5	PQ3	Battery performance is reliable	3.95
10	PQ4	Battery backup is consistent	3.79
11	PQ5	Driving range per charge is adequate	3.76

Source: Primary survey data.

The first rank belongs to running-cost economy, and the second rank belongs to daily-use reliability. Battery performance also appears among the top five. This confirms that EV users judge quality mainly through savings, reliability and battery dependability.

Table 3 : Rotated Component Matrix - Battery and Economy Dimensions

Dimension	Code	Statement	Factor Loading
Battery Efficiency and Operating Reliability	PQ3	Battery performance is reliable	0.812
Battery Efficiency and Operating Reliability	PQ4	Battery backup is consistent	0.788
Battery Efficiency and Operating Reliability	PQ5	Driving range per charge is adequate	0.754
Battery Efficiency and Operating Reliability	PQ11	EV is reliable for daily use	0.768
Economy and Value Assessment	PQ16	Running cost is economical	0.781
Economy and Value Assessment	PQ19	EV provides good value for money	0.818
Economy and Value Assessment	PQ20	Overall product quality of EV is high	0.836

Source: Primary survey data.

International Journal for Novel Research in Economics , Finance and Management
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ISSN: 3048-7722

The factor loadings are strong. Battery items load between 0.754 and 0.812, while economy-value items load between 0.781 and 0.836. Therefore, both dimensions are statistically suitable for satisfaction analysis.

Table 4 : Reliability Statistics of Relevant Product Quality Dimensions

Product Quality Dimension	Number of Statements	Cronbach's Alpha	Reliability Status
Battery Efficiency and Operating Reliability	4	0.853	High
Economy and Value Assessment	3	0.861	High
Overall Product Quality Scale	20	0.936	Excellent

Source: Primary survey data.

Both focused dimensions have Cronbach's alpha values above 0.85, which confirms internal consistency.

Table 5 : Mean Score and Rank of Extracted Product Quality Factors

Factor	Product Quality Dimension	Mean Score	S.D.	Rank
Factor 5	Economy and Value Assessment	3.94	0.66	1
Factor 2	Battery Efficiency and Operating Reliability	3.89	0.71	2
Factor 4	Safety, Durability and Maintenance	3.82	0.69	3
Factor 1	Driving Performance and Ride Comfort	3.81	0.68	4
Factor 3	Charging and Service Support	3.42	0.78	5

Source: Primary survey data.

Economy and Value Assessment is ranked first, and Battery Efficiency and Operating Reliability is ranked second. This supports the central argument of the paper.

Table 6 : Rank Order of Consumer Satisfaction Statements - Relevant Items

Rank	Code	Statement	Mean Score
1	CS9	Satisfaction with running cost savings compared to conventional vehicles	4.11
2	CS15	Ownership experience with the EV is satisfactory	4.02
3	CS12	Satisfaction with reliability of the EV for daily travel	3.96
4	CS1	Experience of using the EV is satisfactory	3.94
9	CS6	Satisfaction with battery performance of the EV	3.82

Source: Primary survey data.

The highest satisfaction score is for running-cost savings. Daily-travel reliability and ownership experience are also among the top three. This proves that post-purchase satisfaction is strongest where EVs provide economic benefit and reliable daily use.

Table 7 : Correlation between Overall Product Quality and Relevant Satisfaction Items

Code	Consumer Satisfaction Statement	Pearson's r	p-value
CS6	Satisfaction with battery performance	0.694	<0.001
CS9	Satisfaction with running cost savings	0.629	<0.001

International Journal for Novel Research in Economics , Finance and Management
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CS12	Satisfaction with reliability for daily travel	0.701	<0.001
CS15	Ownership experience is satisfactory	0.718	<0.001

Source: Primary survey data.

All correlations are positive and significant. The strongest correlation among the relevant items is ownership experience r = 0.718, followed by daily-travel reliability r = 0.701 and battery performance satisfaction r = 0.694.

Table 8 : Model Summary of Multiple Regression

Model	R	R Square	Adjusted R Square	Std. Error	Durbin-Watson
Product Quality Dimensions → Consumer Satisfaction	0.803	0.645	0.641	0.365	1.98

Source: Primary survey data.

The five product-quality dimensions explain 64.50% of the variation in overall consumer satisfaction.

Table 9 : Regression Coefficients

Predictor	B	Standardized Beta	t-value	p-value	VIF
Battery Efficiency and Operating Reliability	0.187	0.247	7.54	<0.001	1.83
Economy and Value Assessment	0.221	0.301	9.21	<0.001	1.87

Source: Primary survey data.

Both predictors are positive and significant. Therefore, $H_0 1$ and $H_0 2$ are rejected. Economy and Value Assessment has the strongest impact, while Battery Efficiency and Operating Reliability has the second strongest impact.

Table 10 : Relative Contribution of Product Quality Dimensions

Rank	Product Quality Dimension	Standardized Beta	p-value	Relative Influence
1	Economy and Value Assessment	0.301	<0.001	Strongest
2	Battery Efficiency and Operating Reliability	0.247	<0.001	Very strong
3	Driving Performance and Ride Comfort	0.166	<0.001	Strong
4	Safety, Durability and Maintenance	0.137	<0.001	Moderate
5	Charging and Service Support	0.119	<0.001	Moderate

Source: Primary survey data.

The table proves $H_0 3$ is rejected. Economy and battery reliability are the two strongest satisfaction predictors.

Table 11 : Rank Order of Factors Influencing Consumer Satisfaction - Relevant Items

Rank	Code	Factor	Mean Score
2	SF2	Battery replacement cost	4.21
4	SF5	Running cost savings	4.11
5	SF8	Ease of daily usage	4.09
8	SF6	Reliability for long trips	4.03

Source: Primary survey data.

Battery replacement cost is ranked second, and running-cost savings is ranked fourth. This

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Volume 4, Issue 2, Mar-Apr-2026, PP: 1-8

shows that consumers think about both present savings and future battery-related cost.

VII. DISCUSSION

The findings prove that post-purchase EV satisfaction in Haryana is mainly supported by two practical ownership outcomes: economic value and battery reliability. Running-cost economy records the highest product-quality mean score, and satisfaction with running-cost savings records the highest consumer satisfaction mean score. This means that consumers are most satisfied when EV ownership gives visible savings compared with conventional vehicles. Battery reliability is also central. Battery performance, battery backup, driving range and daily-use reliability form one statistically reliable dimension. This dimension has high internal consistency and a significant regression effect on satisfaction. Consumers therefore evaluate battery quality not only as a technical feature but as a daily-use requirement. The regression results give the strongest proof. Economy and Value Assessment has the highest standardized beta coefficient, followed by Battery Efficiency and Operating Reliability. These two dimensions have stronger effects than all other product-quality dimensions. Therefore, satisfaction is not based only on the modern image of EVs; it is based on whether the vehicle saves money and performs dependably after purchase.

VIII. RECOMMENDATIONS

1. EV manufacturers should communicate running-cost savings clearly through simple cost-comparison information at the time of sale.
2. Battery warranty, battery-health reporting and replacement-cost transparency should be improved because battery replacement cost is one of the strongest satisfaction-influencing factors.
3. Dealers should explain real driving range, battery backup, charging behaviour and range variation under different usage conditions before delivery.
4. Manufacturers should improve range consistency and battery durability because battery reliability directly affects daily-use confidence.
5. EV promotion in Haryana should focus on two strong satisfaction messages: economical ownership and dependable battery performance.

IX. CONCLUSION

This research concludes that economic value and battery reliability are the strongest determinants of post-purchase satisfaction among EV users in Haryana. Economy and Value Assessment records the highest product-quality mean score of 3.94 and the strongest standardized regression coefficient $\beta = 0.301$, $p < 0.001$. Battery Efficiency and Operating Reliability records a high mean score of 3.89 and the second strongest regression coefficient $\beta = 0.247$, $p < 0.001$.
The satisfaction ranking supports the same conclusion. Running-cost savings is ranked first among satisfaction statements with a mean score of 4.11, while daily-travel reliability and ownership experience are also among the highest-ranked satisfaction indicators. Battery replacement cost and running-cost savings are also among the most influential satisfaction factors. Therefore, EV satisfaction in Haryana is strengthened when consumers experience lower running cost, better value for money, reliable battery performance, adequate range and dependable daily travel. Long-term EV acceptance will depend on improving battery confidence and strengthening the economic value of EV ownership.

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