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Impact of Blockchain Based After Sales Service and Battery Traceability on Customer Satisfaction in the Two Wheeler Electric Vehicle Market: Evidence from Bangalore City

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ABSTRACT

The increase in electric two wheelers in cities across India has led to new expectations about the quality of service after buying products and transparency about the products being sold to customers. The purpose of this research is to investigate how blockchain after sales service frameworks and the traceability of batteries impact the satisfaction level of customers who own electric vehicles (EVs) in Bangalore City. The study collected data from 200 registered EV owners living in different regions of Bangalore through a structured questionnaire. A quantitative research methodology was then used which included descriptive statistics, reliability analysis, correlation, and multiple regression techniques. All inferential tests were carried out at the .05 significance level ($p < 0.05$). The results suggest that both blockchain enabled transparency of service and traceability of batteries have a positive effect on the overall level of satisfaction of the customers. Blockchain after sale processes reduced the time to resolve grievances, increased the credibility of warranty claims and increased trust between customers and manufacturers; while the traceability of batteries contributed to a sense of safety with the product, made informed decisions about ownership and created brand loyalty for long periods of time. The implications of this research offer EV manufacturers, service aggregators, and policy stakeholders with practical insights into how they can use distributed ledger technologies to enhance post purchase customer experiences within the Indian EV market.

Keywords: Blockchain Technology, After Sales Service, Battery Traceability, Customer Satisfaction, Electric Two-Wheelers.....

INTRODUCTION:

India's move towards sustainable urban transport has resulted in a new surge in the booming Electric Two-Wheeler (E2W) market. As the IT capital of India, Bengaluru has become a key leader in the purchase of electric vehicles spurred on by government policies supportive of EVs, a large urban commuter network, and an intelligent consumer base. Government programs such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME II), along with additional state-level subsidies under the Karnataka Electric Vehicle and Energy Storage Policy 2017 have accelerated the market penetration of these vehicles. However, while sales have been steadily increasing, consumers are still concerned with after-sale service quality and battery performance.

Battery degradation, inability to locate pending warranty issues, counterfeiting of replacement parts, and a lack of visibility into service networks are the leading reasons why customers experience lower levels of overall satisfaction when owning an electric vehicle (EV) over a long period. These pain points depict a lack of shared information (asymmetrical information) horizontally (between manufacturers and dealerships) and vertically (between dealerships and end-users). In this regard, blockchain technology (characterised by its immutability, decentralisation, cryptographic security, and real-time auditability) provides a unique opportunity for an emerging infrastructure to resolve these types of structural challenges.

Blockchain-based after-sales service platforms deliver undeniably secure service history records, credible warranty claim processing, verified replacement part suppliers, and decentralised processes for addressing customer grievance. Traceability of batteries can be tracked through blockchain ledger technology to maintain a record of the different stages of each battery (from raw material sourcing and battery cell production through operational lifecycle to end-of-life disposal). This will ultimately provide end-use consumers with valuable insights into the battery of their EV. However, much empirical research currently exists regarding how these aforementioned types of applications may impact customer satisfaction levels in India's E2W market.

This paper addresses this gap by surveying 200 EV two-wheeler users in Bangalore City, examining the degree to which blockchain based after-sales mechanisms and battery traceability features influence reported customer satisfaction. All inferential analyses are conducted at the 5% level of significance (α = 0.05). Section 2 presents a synthesis of relevant literature; Section 3 details the research methodology; Section 4 presents data analysis and results with supporting figures; Section 5 discusses key findings; and Section 6 offers conclusions and recommendations.

2. Literature Review

2.1 Blockchain Technology in the Automotive and EV Sector

The goal of blockchain technology, initially developed for decentralised crypto currency platforms, has changed throughout the years. Nowadays there are various applications for many types of companies, including manufacturing, Healthcare, Financial Services, and Supply Chain Management. In the automotive industry, blockchain (distributed ledger technology) is currently being studied as a way to help manage vehicle identities, reduce odometer fraud through tracking records of past odometer readings, verify the history of used vehicles and increase transparency in automotive supply chains. Tapscott and Tapscott (2016) established a fundamental theoretic basis for the application of blockchain in establishing trust in multi-party settings where there is inadequate trust. This is particularly relevant in complex automotive after-sales environments where there are manufacturers, dealers, repair facilities, and customers involved in the automotive supply chain.

In relation to electric vehicles (EV), there is a growing demand for improved transparency in measuring the entire lifecycle of the battery. This has contributed to growing interest in blockchain as a facilitator of circular economy principles. The concept of a battery passport (i.e., a set of digital records kept on a distributed ledger) could be used to track battery chemistry, state of health, transfer of ownership and recycling eligibility. In their study of lithium-ion batteries and supply chains, Woody et al. (2020) demonstrated that using blockchain to facilitate battery traceability can significantly reduce the cost of verification and increase stakeholder confidence in the authenticity and provenance of a battery.

2.2 After-Sales Service Quality and Customer Satisfaction

Service quality is frequently theorized as a predictor of post-purchase customer satisfaction and subsequent repurchase intention. Parasuraman, Zeithaml, and Berry's (1988) SERVQUAL model outlines five dimensions of service quality - reliability, responsiveness, assurance, empathy and tangibles - that influence consumer perceptions of service quality. In research conducted by Murali, Pugazhendhi and Muralidharan (2016) in the automotive sector, two particular aspects of after-sales service - service reliability and price transparency - emerged as having the greatest effect on repurchase intention and satisfaction levels.

As the electric vehicle (EV) market is still developing with regards to service infrastructure compared to that of ICEs, after-sales service quality becomes increasingly important. Kaur and Upadhyay (2021) demonstrated that customers of EVs in India are most concerned with the availability and response time of after-sales services, with some urban groups having greater concerns about these issues than they do about vehicle range anxiety; thus, digitally-enhanced service delivery methods will play a critical role in delivering holistic satisfaction to EV customers.

2.3 Battery Traceability and Consumer Trust

Consumer trust in battery technology constitutes a foundational determinant of electric vehicle adoption and sustained satisfaction. Concerns around battery longevity, safety during charging, thermal runaway risks, and the availability of authenticated replacement cells represent well-documented barriers in EV markets globally. Traceability the ability to track and verify a product's origin, journey, and current status has been identified in supply chain literature as a critical trust-building mechanism (Aung and Chang, 2014).

Applied to EV batteries, traceability frameworks empower consumers to verify whether their battery pack was manufactured under certified conditions, sourced from conflict-free mineral supply chains, and maintained in accordance with manufacturer specifications throughout its lifecycle. Studies from European EV markets, including work by Dunn et al. (2021) on battery second-life applications, suggest that traceable battery histories significantly increase residual vehicle value perceptions and owner confidence. In the Indian context, where the prevalence of counterfeit battery cells has been reported across aftermarket channels, traceability mechanisms acquire additional consumer protection significance.

2.4 Gaps in Existing Research

The connections between blockchain technology, after-sales service management and consumer behaviour of EVs have all been studied; however, no empirical studies have been conducted on how these three areas work together when it comes to customer satisfaction levels in India's two wheel EV industry. Existing studies look only at the four-wheel EV market in the Western and/or Chinese context and therefore do not adequately represent the Indian urban consumer purchasing two-wheeled EVs. This study will address the gaps identified in this area.

3. Research Methodology

3.1 Research Design

The design of the study is a descriptive/casual research design. The demographic profile of the respondent sample and electric vehicle ownership profiles were done through a descriptive approach; a casual design was used to investigate the causal (directional) relationships between the after-sales service based on blockchain and the battery traceability (independent variable) and customer satisfaction (the dependent variable). The study adopted a quantitative research paradigm which was consistent with the positivist epistemological orientation of the research study. All of the hypothesis testing was conducted at a level of significance of 0.05 (5% level of significance).

3.2 Study Area

The study was conducted exclusively within Bangalore City (Bruhat Bengaluru Mahanagara Palike jurisdiction), Karnataka, India. Bangalore was selected on account of its high EV adoption rates relative to other Indian metropolitan centres, the presence of multiple EV manufacturer service networks, and the concentration of technology literate consumers predisposed to engaging with digital service innovations such as blockchain applications.

3.3 Sample Design and Data Collection

Research data was acquired through purposive/convenience sampling from a sample of 200 respondents. Registered owners of electric two-wheelers who used at least 1 after-sales service interaction in the last 12 months all made up this target population. The structured questionnaire was used to collect data via personal interviews and distributed via digital distribution through Google Forms at: major EV service centres, residential associations and technology parks between March 2025 and May 2025 in Bangalore.

3.4 Instrument Design

The questionnaire comprised four sections: (i) respondent demographic and ownership profile; (ii) perception of blockchain-based after-sales service (12 items); (iii) perception of battery traceability (10 items); and (iv) customer satisfaction (8 items). All perception items were measured on a five-point Likert scale anchored at 1 (Strongly Disagree) and 5 (Strongly Agree). The instrument was subjected to content validity assessment by three domain experts and piloted with 25 respondents prior to full administration.

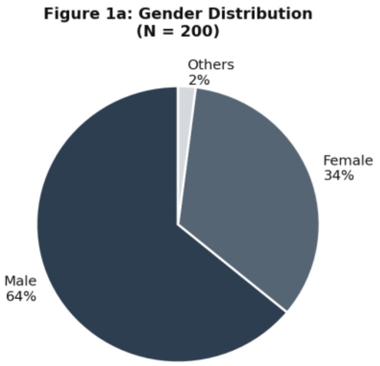
3.5 Analytical Tools

Data were analysed using SPSS v.26. Descriptive statistics (mean, standard deviation, frequency distribution) characterised the sample and variable distributions. Pearson's correlation analysis examined bivariate associations. Multiple linear regression assessed the predictive relationships between independent and dependent variables. Cronbach's Alpha assessed scale reliability. All inferential tests were evaluated at the 5% level of significance ($p < 0.05$).

4. Data Analysis and Results

4.1 Demographic Profile of Respondents

Figure 1 presents the gender and age distribution of the 200 respondents. Table 1 provides the full demographic profile including educational qualification, income, EV brand ownership, and duration of ownership.



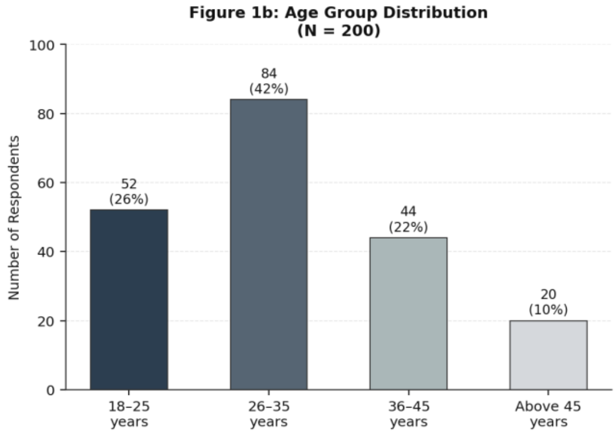


Figure 1: Gender and Age Distribution of Respondents (N = 200)

Table 1: Demographic Profile of Respondents (N = 200)

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	128	64.0
	Female	68	34.0
	Prefer not to say	4	2.0
Age Group	18–25 years	52	26.0
	26–35 years	84	42.0
	36–45 years	44	22.0
	Above 45 years	20	10.0
Educational Qualification	Undergraduate	58	29.0

	Postgraduate	96	48.0
	Diploma/ITI	30	15.0
	Others	16	8.0
Monthly Income (INR)	Below 25,000	42	21.0
	25,001 – 50,000	88	44.0
	50,001 – 75,000	46	23.0
	Above 75,000	24	12.0
EV Brand Owned	Ola Electric	64	32.0
	Ather Energy	52	26.0
	TVS iQube	38	19.0
	Bajaj Chetak	26	13.0
	Others	20	10.0
Duration of Ownership	Less than 1 year	56	28.0
	1–2 years	82	41.0
	2–3 years	40	20.0
	More than 3 years	22	11.0

The sample was predominantly male (64%), aged between 26 and 35 years (42%), and held postgraduate qualifications (48%). A substantial proportion (44%) reported monthly household incomes between INR 25,001 and 50,000, reflecting a middle income urban consumer segment. Ola Electric (32%) and Ather Energy (26%) represented the most common EV brands owned. Figure 2 illustrates the distribution of EV brand ownership.

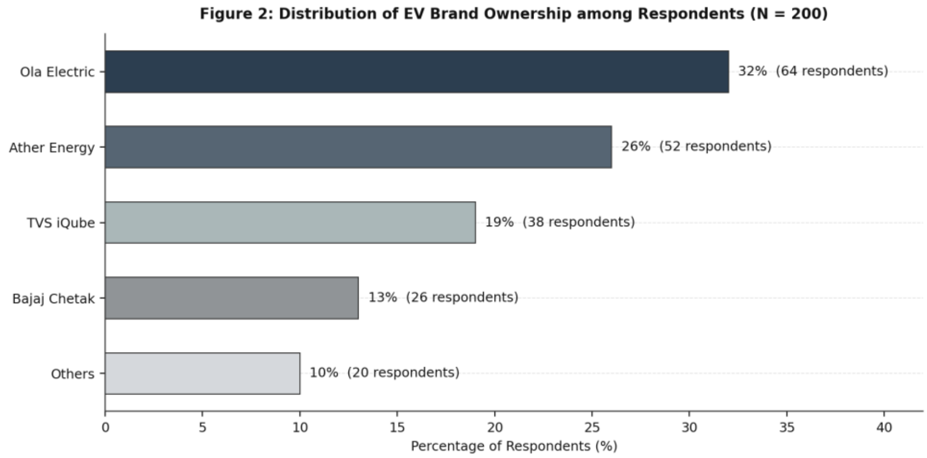


Figure 2: Distribution of EV Brand Ownership among Respondents (N = 200)

4.2 Reliability Analysis

Cronbach's Alpha coefficients were computed for each scale to assess internal consistency reliability. All values exceeded the widely accepted threshold of 0.70 (Nunnally, 1978), confirming adequate reliability of all measurement instruments. Table 2 presents the results.

Table 2: Reliability Statistics

Scale	No. of Items	Cronbach's Alpha (α)	Interpretation
Blockchain-Based After-Sales Service (BBAS)	12	0.887	Good
Battery Traceability (BT)	10	0.863	Good
Customer Satisfaction (CS)	8	0.901	Excellent

The customer satisfaction scale achieved the highest reliability coefficient ($\alpha = 0.901$), indicating excellent item coherence. Both BBAS ($\alpha = 0.887$) and Battery Traceability ($\alpha = 0.863$) scales recorded good internal consistency, suitable for inferential analysis at the 5% level of significance.

4.3 Descriptive Statistics of Study Variables

Figure 3 presents mean scores with standard deviation error bars for all three study variables. Table 3 provides the full descriptive statistics.

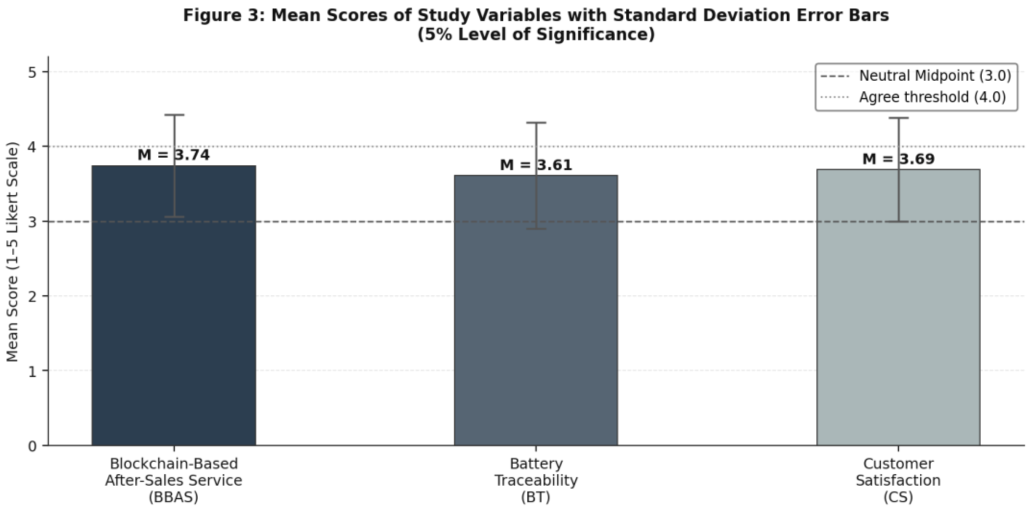


Figure 3: Mean Scores of Study Variables with Standard Deviation Error Bars ($p < 0.05$)

Table 3: Descriptive Statistics of Study Variables

Variable	N	Minimum	Maximum	Mean (M)	Std. Deviation (SD)
Blockchain-Based After-Sales Service (BBAS)	200	1.42	5.00	3.74	0.683
Battery Traceability (BT)	200	1.25	5.00	3.61	0.712
Customer Satisfaction (CS)	200	1.50	5.00	3.69	0.694

The mean scores for blockchain-based after-sales service (M = 3.74, SD = 0.683) and battery traceability (M = 3.61, SD = 0.712) indicate moderately high positive perceptions. Customer satisfaction recorded a mean of 3.69 (SD = 0.694), reflecting a generally positive but not uniformly high level of satisfaction, suggesting scope for further service improvements.

4.4 Correlation Analysis

Pearson's correlation analysis was conducted to examine bivariate relationships among the study variables at the 5% level of significance ($p < 0.05$). Figure 4 presents the correlation heatmap and Table 4 presents the full correlation matrix.

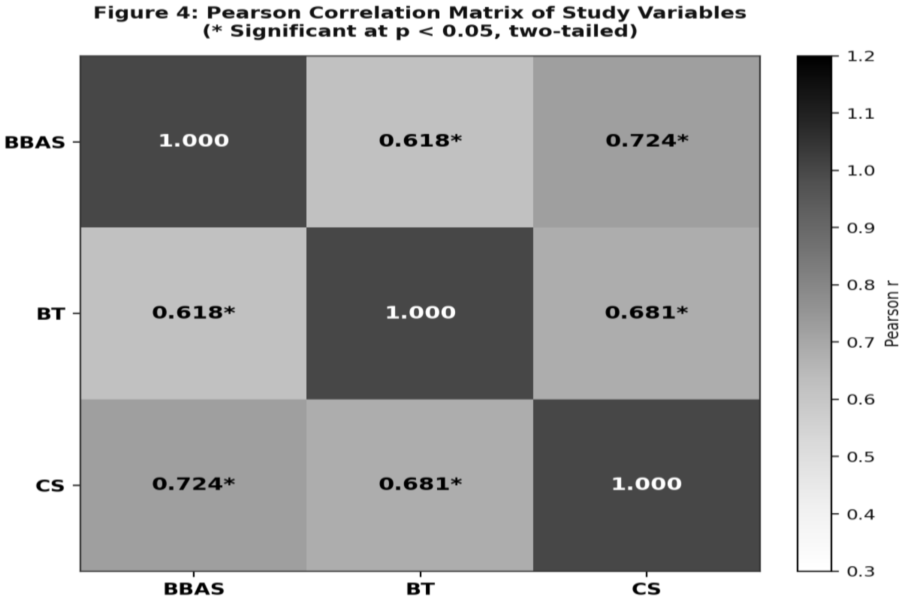


Figure 4: Pearson Correlation Heatmap (* Significant at $p < 0.05$, two-tailed)

Table 4: Pearson Correlation Matrix

Variable	BBAS	BT	CS
Blockchain-Based After-Sales Service (BBAS)	1.000	0.618*	0.724*
Battery Traceability (BT)	0.618*	1.000	0.681*
Customer Satisfaction (CS)	0.724*	0.681*	1.000

** Correlation is significant at the 0.05 level (2-tailed, N = 200)*

According to the data, strong positive links exist between all variables using $p < 0.05$. Customers have reported a strong direct correlation between after-sales service using Blockchain ($r = 0.724$) and satisfaction, as well as a significant direct correlation between battery traceability ($r = 0.681$) and satisfaction. Our two IVs also demonstrated moderate correlations to each other based on the strength of their inter-correlation ($r = 0.618$), which indicates multicollinearity is not a major concern.

4.5 Multiple Regression Analysis

Multiple linear regression was performed with customer satisfaction as the dependent variable and blockchain-based after-sales service and battery traceability as independent variables. Figure 5 visualises the standardised beta coefficients and t-values. Figure 6 presents the conceptual framework. Tables 5 and 6 detail the full model output.

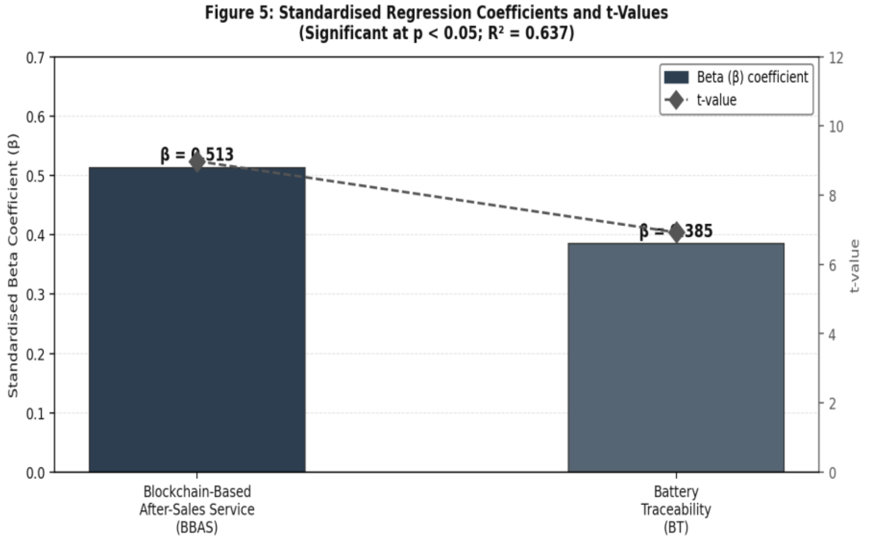


Figure 5: Standardised Regression Coefficients and t-Values (Significant at $p < 0.05$; $R^2 = 0.637$)

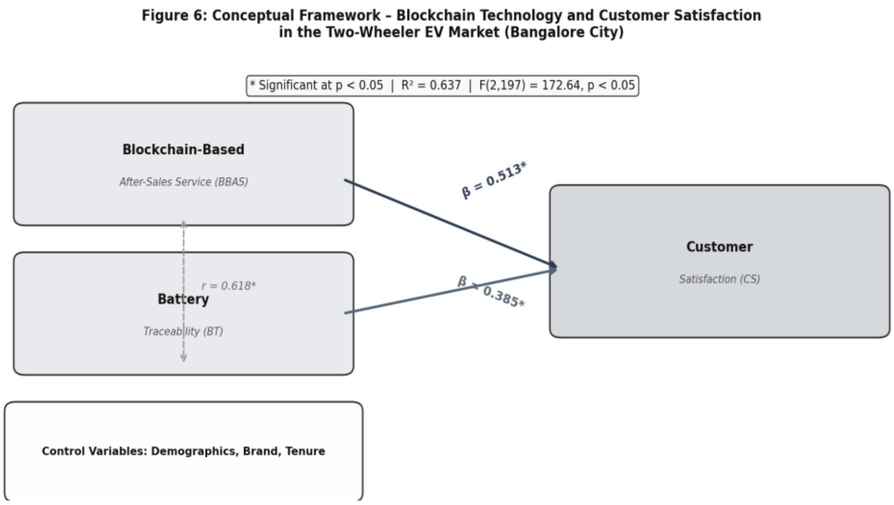


Figure 6: Conceptual Framework – Blockchain Technology and Customer Satisfaction in the Two-Wheeler EV Market

Table 5: Model Summary

Model	R	R Square (R^2)	Adjusted R^2	Std. Error of Estimate	F Value	Sig.
1	0.798	0.637	0.633	0.421	172.64	0.000*

** Model is significant at $p < 0.05$; df = (2, 197)*

Table 6: Regression Coefficients

Variable	Unstd. B	Std. Error	Std. Beta (β)	t Value	Sig.
(Constant)	0.482	0.198	—	2.434	0.016*
Blockchain-Based After-Sales Service (BBAS)	0.521	0.058	0.513	8.983	0.000*
Battery Traceability (BT)	0.374	0.054	0.385	6.926	0.000*

** Significant at $p < 0.05$ (5% level of significance); Dependent Variable: Customer Satisfaction*

The statistical analysis shows that the overall model predicted whether an individual was satisfied with a purchase using two independent variables, which together accounted for approximately 63.7% of the total variance in customer satisfaction and resulted in a statistically significant relationship between the dependent and independent variables ($F (2,197) = 172.640$, $p < 0.05$). Blockchain-based after-sales service provided the largest contribution to the prediction of customer satisfaction ($\beta = 0.513$, $t = 8.983$, $p < 0.05$) followed by the traceability of batteries ($\beta = 0.385$, $t = 6.926$, $p < 0.05$). When analyzed together within the model, both independent variables provided significant contributions towards predicting customer satisfaction with a level of significance of 0.05 or less.

5. Findings and Discussion

5.1 Principal Findings

The empirical findings yield several important insights into the dynamics of blockchain enabled service innovation and consumer satisfaction in the Indian electric two-wheeler market.

The first important finding is that the use of blockchain technology to manage the after-sales service process for electric vehicles (EVs) has a significant positive relationship to customer satisfaction ($\beta = 0.513$; $p < 0.05$). This finding supports theoretical propositions posited by the literature on service quality and digital trust. The capability of blockchain to provide a permanent and unalterable record of service-related transactions helps to remove the ambiguity of warranty dispute resolution, service history falsification, and counterfeit spare parts. When customers have the ability to verify independently that they have made a purchase using manufacturer recommended parts, and their warranty documentation is unaltered or free from tampering, their entire experience during the service process is transformed from a process characterised by a lack of visibility to one characterised by visibility and verified accountability.

A second significant finding is that customers’ level of satisfaction with their battery was positively correlated with their level of trust in the aftermarket battery traceability programme, and this shows how important these aspects are to customers’ experiences with electric vehicle ownership ($\beta = 0.385$; $p < 0.05$). Respondents who expressed greater levels of trust in the battery traceability programme reported higher levels of satisfaction with their purchase decision, suggesting that consumers get a significant level of reassurance from being able to access verifiable information about their battery’s source, health status, and service history. This finding also supports the broader literature regarding consumers' perception of product transparency is an important factor in developing trust in a company.

Third, the joint explanatory power of the model ($R^2 = 0.637$) indicates that blockchain-based after-sales service and battery traceability together account for nearly two thirds of the variance in customer satisfaction a substantial explanatory contribution for a two-predictor model evaluated at the 5% level of significance.

5.2 Demographic Insights

Cross-tabulation analysis revealed that younger respondents (18–35 years) demonstrated greater awareness and appreciation of blockchain-enabled features relative to older cohorts, likely reflecting greater digital literacy. Postgraduate respondents similarly exhibited higher mean satisfaction scores when blockchain traceability features were perceived to be functional. These demographic patterns have practical implications for targeted consumer communication strategies.

5.3 Contextual Discussion

The findings must be contextualised within the specific urban EV ecosystem of Bangalore. The city's unique combination of high EV penetration, technology-literate consumer base, and relatively mature EV service infrastructure creates conditions more conducive to blockchain technology adoption than smaller Indian urban centres. As the Indian EV market matures, the competitive differentiation offered by blockchain-based after-sales platforms and verifiable battery traceability is likely to intensify.

6. Conclusion and Recommendations

6.1 Conclusion

200 electric two-wheeler users in Bangalore City participated in this research study evaluating the relationship of after-sales service and battery traceability using blockchain technology on customer satisfaction. The data was analyzed using correlation & regression analysis at a 5% significance level. The study found strong, positive relationships between both construct and customer satisfaction with an

Overall variance of 63.7%. After-sales service presented the strongest predictor of customer satisfaction ($\beta = 0.513$, $p < 0.05$), demonstrating the importance of transparency in after-sales service provided to the consumer within the EV market as it relates to ownership satisfaction. This study adds to the emerging literature regarding technology-enhanced service quality in the EV marketplace in India.

6.2 Recommendations

For EV Manufacturers: EV manufacturers operating in the Indian market should prioritise the integration of blockchain-based service record management systems into their after sales networks. Immutable digital service logs accessible to consumers via QR code enabled mobile interfaces can meaningfully reduce dispute resolution timelines and enhance warranty claim credibility. Battery passport programmes, wherein each battery pack is assigned a unique blockchain-linked digital identity, should be standardised as part of the purchase documentation ecosystem.

For Service Network Aggregators: Independent and authorised service centres should adopt blockchain-enabled spare parts authentication platforms to combat counterfeit component infiltration. Transparent, customer visible service event logs recording technician identity, parts sourced, and diagnostic outcomes can serve as powerful trust signals in an environment where service process opacity remains a significant consumer grievance.

For Policy Makers: Regulatory bodies including the Ministry of Heavy Industries and the Bureau of Energy Efficiency should consider mandating blockchain-based battery traceability as a compliance requirement for EV manufacturers receiving FAME-II and successor scheme benefits. A standardised battery data protocol would create an enabling framework for market-level blockchain adoption and enhanced consumer protection.

For Future Researchers: Future studies should expand the geographic scope of inquiry beyond Bangalore to encompass diverse Indian urban typologies, employ longitudinal designs to capture satisfaction dynamics over ownership lifecycle stages, and introduce mediating variables such as perceived ease of blockchain interface use, digital literacy, and trust propensity.

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