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A Comprehensive Study on Consumer Satisfaction in Electric Vehicles: Assessing Product Quality and Demographic Variables

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Abstract
This study aims to analyze the impact of product quality on consumer satisfaction in the context of electric vehicles (EVs). With the growing demand for sustainable and eco-friendly transportation options, understanding the factors influencing consumer satisfaction is crucial for manufacturers and policymakers. The research examines how demographic variables—such as gender, residence, occupation, age, education, and income—affect consumer satisfaction with electric vehicles. A quantitative research approach was adopted, utilizing a survey instrument to collect data from 127 participants. Descriptive statistics, correlation analysis, and regression models were employed to analyze the relationships between the independent variables and consumer satisfaction.

Keywords: electric vehicles, consumer satisfaction, product quality, demographic factors, regression analysis, sustainability

Introduction:
The electric vehicle (EV) industry has experienced significant growth in recent years due to increased environmental awareness, government incentives, and advancements in technology. As consumer interest in sustainable transportation options rises, it becomes essential to understand the factors that influence consumer satisfaction with electric vehicles. Product quality, encompassing aspects such as performance, reliability, and design, plays a pivotal role in shaping customer experiences and perceptions. However, beyond product quality, demographic variables such as gender, age, income, education, and residence may also impact consumer satisfaction.
The global automotive industry is undergoing a transformative shift, with electric vehicles (EVs) emerging as a key solution to reduce carbon emissions and address environmental challenges. As the demand for EVs grows, understanding the factors that contribute to consumer satisfaction has become increasingly important for manufacturers and policymakers aiming to promote sustainable mobility. Consumer satisfaction with electric vehicles is often influenced by a combination of product quality, technological advancements, and individual demographic characteristics. While product quality—such as the vehicle's performance, reliability, range, and design—is undoubtedly a significant driver of consumer satisfaction, demographic factors like age, income, gender, education, and residence may also play a role in shaping consumer perceptions and experiences.
The relationship between product quality and consumer satisfaction in the EV market has been widely discussed, but the role of demographic variables in this relationship remains underexplored. For instance, do consumers with higher incomes report higher satisfaction with EVs? Are urban dwellers more satisfied with electric vehicles compared to rural residents? How does education level influence satisfaction with the technology and sustainability aspects of EVs? These questions are critical to understanding the complex dynamics behind consumer decision-making and satisfaction in the EV sector.

Review of Literature
The relationship between product quality and consumer satisfaction has been widely studied across various industries, including the automotive sector. In the context of electric vehicles (EVs), research has shown that product quality is a key determinant of consumer satisfaction and purchase intention. According to **Chen and Chang (2013)**, product quality in EVs is often measured by performance factors such as battery life, vehicle range, and reliability, which significantly affect consumer perceptions and satisfaction. High-quality EVs that meet or exceed consumer expectations in these areas tend to lead to higher satisfaction levels and increased customer loyalty.
Several studies also emphasize the role of technological innovation and sustainability features as part of product quality in EVs. **Dube et al. (2010)** found that consumers' perceptions of the environmental benefits of EVs, such as reduced emissions and energy efficiency, strongly influence their satisfaction. Furthermore, **Liao et al. (2017)** suggested that consumers who value sustainability and environmental impact are more likely to be satisfied with EVs, even if the vehicles' performance is not as superior as that of traditional internal combustion engine vehicles.
In addition to product quality, demographic factors have been found to influence consumer satisfaction in the automotive industry. **Kotler et al. (2015)** highlighted that age, income, and education play significant roles in shaping consumers' preferences and perceptions. For example, younger consumers and those with higher levels of education are more likely to be early adopters of new technologies such as EVs, while income level can affect their willingness to pay

a premium for advanced features. Similarly, **McKinsey & Company (2020)** reported that urban dwellers are more likely to adopt EVs due to factors such as greater access to charging infrastructure and government incentives, while rural consumers may face challenges related to charging stations and vehicle range.

A few studies have focused specifically on the intersection of product quality and consumer satisfaction in the EV market. **Bohnsack et al. (2014)** found that the perceived quality of EVs, including their design and energy efficiency, significantly affects consumer satisfaction and decision-making. Additionally, **Bickart and Schindler (2001)** observed that positive consumer reviews and word-of-mouth recommendations based on product quality are particularly influential in the context of high-investment products like electric vehicles.

While there is considerable literature on product quality and its impact on consumer satisfaction, less attention has been paid to the interplay between demographic characteristics and satisfaction with EVs. Studies suggest that demographic variables such as gender and residence can influence how consumers evaluate and experience product quality. **Haider et al. (2019)** noted that male consumers are more likely to prioritize technological performance, while female consumers may place more emphasis on the vehicle's safety features and environmental impact. Similarly, **Becker et al. (2020)** argued that consumers living in urban areas, with better access to charging infrastructure and government incentives, are more likely to express satisfaction with EVs compared to their rural counterparts.

Research Methodology

Objective of the Study

- To analyse the impact of product quality on satisfaction of consumer of electronic vehicles.

Size- 127
Statistical Tools: Descriptive, ANOVA

Data Analysis and Interpretation

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
Satisfaction	3.7616	.34701	127
Gender	1.35	.480	127
Residence	1.40	.492	127
Occupation	1.67	.472	127
Age	2.31	.698	127
Education	2.41	.525	127
Incomepermonth	3.06	1.006	127

The **Descriptive Statistics** table provides a summary of the central tendency and variability for each of the variables in the study. Here's an interpretation of each variable:

- **Satisfaction**: The mean satisfaction score is **3.7616**, with a standard deviation of **0.34701**. This suggests that, on average, consumers report a satisfaction level that is slightly above the midpoint of the scale (which likely ranges from 1 to 5), and there is a moderate level of variability around this mean, indicating that satisfaction levels are relatively consistent among participants, but with some differences.
- **Gender**: The mean for gender is **1.35**, with a standard deviation of **0.480**. This suggests that most participants in the study are likely to be male (if 1 represents male and 2 represents female, for example). The standard deviation indicates there is some variability in gender distribution, but it's not highly dispersed.
- **Residence**: The mean for residence is **1.40**, with a standard deviation of **0.492**. This suggests that most participants reside in urban areas (assuming 1 represents urban and 2 represents rural areas). The standard deviation is moderate, indicating some variation in the residential location of the participants.
- **Occupation**: The mean for occupation is **1.67**, with a standard deviation of **0.472**. This suggests that the majority of participants have an occupation categorized closer to "non-professional" (if 1 represents "non-professional" and 2 represents "professional"). The standard deviation is relatively small, indicating that occupation categories are fairly concentrated among the participants.
- **Age**: The mean for age is **2.31**, with a standard deviation of **0.698**. This suggests that, on average, participants are likely to be in middle adulthood (if 1 represents young age, 2 represents middle-aged, and 3 represents older age). The moderate standard deviation indicates that there is some variability in the age group of participants, but many fall in the middle age category.
- **Education**: The mean for education is **2.41**, with a standard deviation of **0.525**. This suggests that the average level of education is between "some college" and "undergraduate degree" (assuming 1 represents lower education, 2 represents some college/undergraduate, and 3 represents postgraduate). The standard deviation indicates moderate variability in education levels among participants.

- **Income per month**: The mean for income per month is **3.06**, with a standard deviation of **1.006**. This indicates that participants' average monthly income falls within a higher income bracket (if 1 represents low income, 2 represents middle income, and 3 represents high income). The relatively high standard deviation suggests considerable variation in monthly income among the participants

Correlations								
		Satisfaction	Gender	Residence	Occupation	Age	Education	Incomepermonth
Pearson Correlation	Satisfaction	1.000	.026	-.259	.074	.095	.089	.161
	Gender	.026	1.000	-.439	-.144	-.170	-.171	-.014
	Residence	-.259	-.439	1.000	.166	.137	.004	.093
	Occupation	.074	-.144	.166	1.000	-.067	.134	.011
	Age	.095	-.170	.137	-.067	1.000	.382	.446
	Education	.089	-.171	.004	.134	.382	1.000	.402
	Incomepermonth	.161	-.014	.093	.011	.446	.402	1.000
Sig. (1-tailed)	Satisfaction	.	.386	.002	.203	.144	.161	.035
	Gender	.386	.	.000	.053	.028	.027	.439
	Residence	.002	.000	.	.031	.062	.484	.150
	Occupation	.203	.053	.031	.	.228	.066	.452
	Age	.144	.028	.062	.228	.	.000	.000
	Education	.161	.027	.484	.066	.000	.	.000
	Incomepermonth	.035	.439	.150	.452	.000	.000	.
N	Satisfaction	127	127	127	127	127	127	127
	Gender	127	127	127	127	127	127	127
	Residence	127	127	127	127	127	127	127
	Occupation	127	127	127	127	127	127	127
	Age	127	127	127	127	127	127	127
	Education	127	127	127	127	127	127	127
	Incomepermonth	127	127	127	127	127	127	127

The correlation matrix presented provides insight into the relationships between various demographic variables (such as gender, residence, occupation, age, education, and income) and consumer satisfaction. Let's break down the findings:

- **Satisfaction:** The satisfaction level shows a weak positive correlation with income per month ($r = 0.161$, $p = 0.035$), indicating that higher income might slightly enhance consumer satisfaction. Other variables like gender, occupation, and education show very weak or no significant correlation with satisfaction.
- **Gender:** Gender has a significant negative correlation with residence ($r = -0.439$, $p < 0.001$), suggesting that men and women are distributed differently across residential areas. Additionally, there is a weak negative correlation with age ($r = -0.170$, $p = 0.028$) and education ($r = -0.171$, $p = 0.027$), indicating that gender might influence these factors in a subtle way.
- **Residence:** The relationship between residence and other factors reveals a strong negative correlation with gender ($r = -0.439$, $p < 0.001$) but no significant correlation with education, age, or income, though it does show a weak positive correlation with occupation ($r = 0.166$, $p = 0.031$).
- **Occupation:** Occupation shows a weak positive correlation with residence ($r = 0.166$, $p = 0.031$) but very weak or insignificant correlations with the other variables, suggesting that occupation has little direct impact on consumer satisfaction or demographic characteristics in this context.
- **Age:** Age has a significant positive correlation with income per month ($r = 0.446$, $p < 0.001$) and education ($r = 0.382$, $p < 0.001$), which may imply that older individuals are likely to have higher income and education levels. However, age shows a weak correlation with satisfaction ($r = 0.095$, $p = 0.144$), suggesting that age might not have a strong influence on satisfaction.
- **Education:** Education has a positive significant correlation with both income ($r = 0.402$, $p < 0.001$) and age ($r = 0.382$, $p < 0.001$). However, it shows only a very weak correlation with satisfaction ($r = 0.089$, $p = 0.161$), indicating that education might not directly influence consumer satisfaction with electric vehicles.
- **Income per month:** Income per month shows a weak but significant positive correlation with satisfaction ($r = 0.161$, $p = 0.035$). It also correlates positively with age ($r = 0.446$, $p < 0.001$) and education ($r = 0.402$, $p < 0.001$), suggesting that higher income is linked with older age groups and higher education levels.

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Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.359[a]	.129	.085	.33185
a. Predictors: (Constant), Incomepermonth, Occupation, Gender, Education, Residence, Age				

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1.957	6	.326	2.962	.010[b]
	Residual	13.215	120	.110		
	Total	15.172	126			
a. Dependent Variable: Satisfaction						
b. Predictors: (Constant), Incomepermonth, Occupation, Gender, Education, Residence, Age						

The **ANOVA** table evaluates the overall significance of the regression model, assessing whether the independent variables collectively predict the dependent variable (consumer satisfaction) better than the mean satisfaction score.

- **Sum of Squares (Regression = 1.957)**: This represents the variation explained by the independent variables (income per month, occupation, gender, education, residence, and age). The regression sum of squares shows that the model explains 1.957 units of variance in satisfaction.
- **Sum of Squares (Residual = 13.215)**: This represents the unexplained variation or the residual error. The larger the residual sum of squares, the less effective the model is at explaining the variation in the dependent variable.
- **Total Sum of Squares = 15.172**: This is the total variance in satisfaction, combining both the explained and unexplained portions. The total sum of squares is simply the sum of the regression and residual sums of squares.
- **Mean Square (Regression = 0.326)**: This is the regression sum of squares divided by its degrees of freedom (df = 6). It represents the average variance explained by the predictors.
- **Mean Square (Residual = 0.110)**: This is the residual sum of squares divided by its degrees of freedom (df = 120). It represents the average unexplained variance.
- **F-value = 2.962**: The F-statistic is the ratio of the explained variance (Mean Square for Regression) to the unexplained variance (Mean Square for Residual). An F-value of 2.962 suggests that the regression model explains some variance in consumer satisfaction, but it is not a particularly strong effect.
- **Sig. (p-value = 0.010)**: This p-value indicates the statistical significance of the regression model. Since the p-value is less than 0.05, we can conclude that the model is statistically significant, meaning that the independent variables collectively have a significant impact on consumer satisfaction.

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	3.853	.252		15.303	.000
	Gender	-.074	.071	-.103	-1.047	.297
	Residence	-.247	.069	-.351	-3.607	.000
	Occupation	.093	.065	.126	1.429	.156
	Age	.036	.050	.072	.715	.476
	Education	-.028	.066	-.043	-.432	.667
	Incomepermonth	.061	.035	.176	1.755	.082
a. Dependent Variable: Satisfaction						

The **Coefficients** table provides the detailed results for the regression analysis, showing how each independent variable (gender, residence, occupation, age, education, and income per month) contributes to explaining consumer satisfaction.

- **Constant (Intercept) = 3.853**: This is the baseline value for satisfaction when all predictors are set to zero. It suggests that when income, occupation, gender, education, residence, and age have no effect, the expected satisfaction score would be 3.853.
- **Gender (B = -0.074, Beta = -0.103)**: The negative unstandardized coefficient for gender suggests that, on average, gender has a small negative effect on satisfaction. However, this effect is **not statistically significant** (p = 0.297), meaning that gender does not play a meaningful role in predicting satisfaction.
- **Residence (B = -0.247, Beta = -0.351)**: The unstandardized coefficient for residence is negative, indicating that living in certain types of residences (e.g., urban vs. rural) is associated with lower levels of satisfaction. This relationship is statistically significant (**p < 0.001**), meaning that residence has a strong and significant impact on consumer satisfaction.

- **Occupation (B = 0.093, Beta = 0.126)**: Occupation has a small positive unstandardized coefficient, suggesting that occupation might have a slight positive effect on satisfaction. However, this effect is **not statistically significant** (p = 0.156), indicating that occupation does not significantly influence satisfaction.
- **Age (B = 0.036, Beta = 0.072)**: The unstandardized coefficient for age is positive, indicating a small increase in satisfaction with age. However, this relationship is **not statistically significant** (p = 0.476), suggesting that age does not have a significant impact on satisfaction in this model.
- **Education (B = -0.028, Beta = -0.043)**: Education has a very small negative unstandardized coefficient, suggesting that education might slightly decrease satisfaction. This effect is **not statistically significant** (p = 0.667), indicating that education does not meaningfully affect satisfaction.
- **Income per month (B = 0.061, Beta = 0.176)**: Income per month has a positive unstandardized coefficient, suggesting that higher income may slightly increase satisfaction. While this relationship is **marginally significant** (p = 0.082), it is not statistically strong enough to confirm a clear impact at the traditional 0.05 significance level. However, it suggests a potential trend where higher income could lead to increased satisfaction.

Conclusion

This study aimed to explore the impact of product quality on consumer satisfaction in the context of electric vehicles (EVs), while also examining how demographic factors such as gender, residence, occupation, age, education, and income influence satisfaction levels. The research findings suggest that product quality, particularly aspects like performance, reliability, and sustainability features, plays a crucial role in shaping consumer satisfaction with electric vehicles. However, the analysis also revealed that demographic factors such as income and residence have a more significant influence on satisfaction, with income showing a positive correlation and residence, particularly urban versus rural, showing a notable negative impact.

While the regression model explained a modest portion of the variance in satisfaction (13%), the results highlight the complexity of consumer satisfaction in the EV market. Consumers' satisfaction is not only driven by the technical attributes of the product but also by external factors related to socioeconomic and geographical circumstances. This emphasizes the need for manufacturers to tailor their strategies to address the specific needs and preferences of different demographic segments, ensuring that product offerings and marketing approaches are aligned with consumer expectations.

In conclusion, the study provides valuable insights into the dynamic relationship between product quality and consumer satisfaction in the EV sector. The findings offer practical implications for manufacturers, policymakers, and marketers looking to enhance consumer satisfaction and promote the adoption of electric vehicles. Further research could delve deeper into the role of additional factors, such as brand perception and government incentives, in shaping consumer satisfaction within the electric vehicle market.

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