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Consumer Perceptions and Behaviour in the Transition from Internal Combustion Engine Vehicles to Battery Electric Vehicles

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Abstract. In recent years, the world has been accelerating the development of electric vehicles, but the response of consumers is not consistent. This study focuses on how economic cognition, safety beliefs and technical knowledge affect consumers' willingness to shift from fuel vehicles to pure electric vehicles, and examines how these effects differ across income levels and household car scenarios. The study surveyed 296 car owners. The results showed that cost savings and driving experience were the main driving factors, while battery decay and endurance anxiety were the main obstacles. Regression analysis found that electric vehicle knowledge is the strongest predictor of purchase intention, economic factors and safety factors also have a significant positive effect. Different consumer groups have different preferences: people with higher incomes pay more attention to technology and performance, while buyers with limited budgets pay more attention to total cost of ownership. In addition, pure electric vehicles as a second commuter car are more acceptable than as the main household car. These results suggest that in order to accelerate the popularity of electric vehicles, not only price incentives, but also targeted consumer education and marketing for different usage scenarios are needed.

Keywords: Electric Vehicles (EVs), Consumer Behaviour, EV Adoption, Purchase Intention, ICE-to-EV Transition

1. Introduction

In recent years, the global transition from internal combustion engine (ICE) vehicles to battery electric vehicles (BEV) has been greatly accelerated. The International Energy Agency reports that global electric vehicle sales will exceed 20 million by 2025, accounting for about a quarter of global new vehicle sales [1]. However, the rise in sales figures does not necessarily mean that consumers are also willing to adopt BEVs. Consumer acceptance remains an important part of the transformation, as the adoption of electric vehicles depends heavily on consumers' perceptions of technology [2].

Previous studies have identified a number of factors that affect consumers' adoption of electric vehicles. Rezvani et al. combed the driving factors and barriers to the adoption of electric vehicles in existing research, and found that purchase costs can become barriers, while lower use costs can

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encourage adoption [2]. These economic considerations are particularly relevant as consumers may assess whether the potential savings from the use of electric vehicles can compensate for their higher initial cost. At the same time, cruising range is another important issue. Endurance anxiety has been identified as a prominent problem related to the use of battery electric vehicles. Personal characteristics, attitudes, experience and technical characteristics all affect the occurrence of endurance anxiety [3].

Consumer knowledge provides another perspective for the adoption of electric vehicles. Jaiswal et al. investigated the role of electric vehicle knowledge in predicting consumers' adoption intention, and also studied how knowledge affects consumers' decision to adopt electric vehicles. Their findings support the importance of consumer knowledge in the adoption process [4]. This shows that if consumers know more about electric vehicle technology, it may affect how they evaluate the potential benefits and limitations of switching from traditional vehicles. Importantly, consumers' reactions to BEVs are not always the same. There are differences in personal opinions, financial status and actual vehicle requirements, which may lead to different adoption decisions. Therefore, existing research emphasizes the importance of examining consumer adoption behavior, rather than viewing the electric vehicle market as a homogeneous group [2]. However, people pay less attention to the combination of economic perception, perceived risk and electric vehicle knowledge, and consider the differences in household vehicle usage scenarios. This study used survey data from 296 car owners to fill in this area. It focuses on three research questions: how multidimensional perception affects BEV-switching intention, how consumers choose between directly adopting BEVs and other alternative pathways, and how these choices vary according to demographics and household-vehicle-use contexts.

2. Literature review

2.1. Economic perceptions and perceived benefits

The purchase cost of electric vehicles is relatively high, which may prevent consumers from adopting them, while lower use costs may make them more attractive. Rezvani et al. identified the cost of purchase as an obstacle to the adoption of electric vehicles, while reducing the cost of use as a driver [2]. Their review also considers upfront costs and usage costs compared to traditional ICE vehicles, including charging and maintenance. Therefore, the economic advantages of electric vehicles are not necessarily determined only by the purchase price. Consumers will also consider the costs incurred during the use of the vehicle. Sovacool and Hirsh illustrate this point when discussing plug-in hybrid vehicles [5]. They studied the economic benefits of replacing gasoline with electricity, also discussed the potential to reduce fuel expenditure, and also recognized the economic uncertainty surrounding this technology.

These findings provide a basis for studying how consumers evaluate the financial advantages and disadvantages of shifting from ICE vehicles to BEVs. In this study, economic perception refers to the consumer's perception of the costs and potential savings associated with the possession and use of BEV, which is examined as a factor associated with BEV purchase intention.

2.2. Perceived risks and EV knowledge

Endurance anxiety is still a major psychological disorder in accepting BEVs [6]. It refers to the fear of running out of power before reaching the charging station, which is shaped by vehicle characteristics, personal psychological assessment, charging infrastructure, and in-vehicle

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information design [6]. The higher the level of anxiety, the lower the perceived ease of use and driving pleasure, and the greater the resistance to the BEV purchase price [6]. Prolonged charging time also brings practical limitations, because drivers must plan their trips around charging opportunities [6].

However, Ueda and Ota found that the timing of endurance anxiety is more driven by personal charging habits than by driving experience or charger density [7]. In a survey of Japanese users switching from ICE vehicles to BEVs, the average charging state at which users began to feel anxious was 34.5%. This threshold is related to the time that individuals typically charge BEVs and mobile phones, but not to monthly mileage, battery capacity, or charger availability [7]. Therefore, endurance anxiety reflects individual behavioral tendencies, not just external conditions.

Gupta et al. further demonstrated that knowledge plays a mediating role between perceived barriers, environmental consequences, policy interventions, and the intention to use electric vehicles [8]. In their structural equation model, knowledge significantly increased the intention to use EV and reduced the negative effects of perceived barriers [8]. This is consistent with the evidence that system-related knowledge can be used as a response resource [6].

2.3. Consumer heterogeneity and vehicle-use context

2.3.1. Consumer segment shaped by household vehicle compositon

Iogansen et al. emphasized that BEV adopters are far from uniform, which indicates that there are meaningful differences between BEV users]. Based on survey data from 1443 U.S. residents, they distinguished between households with battery-only electric vehicles (BEV users only) and those with BEVs in combination with other fuel-based vehicles (BEV blended fuel users). The authors found that the two groups differed in socio-demographic characteristics, motivations, and vehicle use patterns. In particular, only BEV users are more closely related to economic considerations, while blended fuel users value the symbolic appeal of BEVs more. The study also shows that families that retain conventional vehicles can use them for long-distance travel, which provides an alternative when the limitations of BEV endurance become relevant. In general, the fuel composition of household vehicles provides an important dimension for segmenting BEV consumers and understanding the different backgrounds in which they use and adopt BEVs [9].

2.3.2. Multi-car households and BEV as second vehicle

Jakobsson et al. used driving data from Sweden and Germany to investigate whether multi-car families are more suitable for BEV adoption than single-car families. This study distinguishes the first car with higher mileage and the second car with lower mileage in multi-car families. The authors found that the second car had more regular driving patterns and fewer long-distance days, which made them technically more suitable for replacing BEVs. Specifically, the proportion of second cars that can meet all daily driving without adaptation is 20 percentage points higher than that of the first car or a single-car family. The range, which covers 70% of driving demand, is only 220 km for the second car and 390 km for the average car. Economically, the second car also achieves higher market viability based on the total cost of ownership. These findings suggest that multi-car homes represent a key early market segment and that BEVs can be used as complementary vehicles for everyday travel, which reinforces the importance of the home vehicle environment in understanding BEV adoption [10].

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2.4. Research gap

The studies reviewed above explain the different parts used by BEVs, but they do not link these parts. Rezvani et al. and Sovacool and Hirsh show that cost shapes adoption. Rainieri et al. and Ueda and Ota show that endurance anxiety and personal charging behavior are important. Jaiswal et al. and Gupta et al. show that knowledge affects intention. It is still unclear how these factors are interrelated and which factor has greater weight when consumers decide whether to switch.

The second gap is how to measure the adoption rate. Many existing studies regard the adoption of BEVs as a binary result, but the conversion from ICE vehicles is not a single decision. Consumers can choose a BEV directly, a PHEV or EREV, or continue to use ICE vehicles. These paths may reflect different priorities and limitations, but they are rarely compared in the same study.

The family environment has further increased the gap. Iogansen et al. showed that BEV users will vary due to household fuel composition, and Jakobsson et al. showed that the second car may be more suitable for replacing a BEV. However, these two studies did not link the background of household vehicles with consumers' own views and knowledge. This study used survey data from 296 car owners to address these gaps, integrating economic perception, safety perception, electric vehicle knowledge, and family environment into a single analysis.

3. Case analysis

3.1. Sample profile and data source

From July to August 2026, the study distributed a structured online questionnaire through WeChat and online groups. The study obtained a total of 296 valid responses from adult car owners. The number of female respondents was slightly higher than that of male respondents (58.1% vs.40.5%), and 1.4% chose non-binary or preferred not to say options. The majority of respondents were 18-34 years old (81.0%), of which 50.3% were 26-34 years old. The majority of respondents had a bachelor's degree or higher (79.0%). In terms of annual household income, 26.4% reported an income of $60,000 or more, 44.6% were in the middle-income class of $25,000 to $60,000, and 25.3% reported an income of less than $25,000. Regarding vehicle ownership, 57.8% of people drive standard commuter cars and 19.9% have high-performance sports cars. For daily use of the main powertrain, 35.5% of the respondents drive a pure BEV. The sample covers current BEV users and non-BEV adopters, allowing subgroup comparisons across consumer data.

3.2. Descriptive statistics and correlations

Table 1 reports the means and standard deviations. EV purchase intention had a mean of 4.243 (SD = 1.142), indicating a generally high level of purchase intention. EV knowledge had the lowest mean (M = 3.108, SD = 0.996), followed by safety cognition (M = 3.507, SD = 0.971) and economic sustainability identity (M = 3.926, SD = 0.704).

Table 1. Descriptive statistics (N = 296)

Variables	Mean (M)	Std. Deviation (SD)
EV purchase intention	4.243	1.142
EV Knowledge level	3.108	0.996
Safety cognition	3.507	0.971

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Table 1. (continued)

Economic sustainabililty identity	3.926	0.704

Table 2 presents the Pearson correlations. All three predictors were positively correlated with purchase intention. EV knowledge showed the strongest correlation ($r = 0.534$, $p < 0.001$), followed by safety cognition ($r = 0.356$, $p < 0.001$) and economic sustainability identity ($r = 0.326$, $p < 0.001$).

Table 2. Correlations (N =296)

Variables	1	2	3	4
EV purchase intention	1.000			
EV knowledge level	0.534**	1.000		
Safety cognition	0.356**	0.420**	1.000	
Economic sustainability identity	0.326**	0.326**	0.333**	1.000

3.3. Regression analysis

A multiple regression analysis was conducted. The model is significant ($F = 46.623$, $p < 0.001$) and explains 32.4% of the variance in purchase intention ($R^2 = 0.324$). As shown in Table 3, EV knowledge was the strongest driver ($\beta = 0.435$, $p < 0.001$), followed by economic identity ($\beta = 0.142$, $p = 0.007$) and safety cognition ($\beta = 0.126$, $p = 0.021$). The equation is:

$$Purchase\ Intention = 1.267 + 0.499(Knowledge) \quad (1)$$

$$+0.231(Economic) + 0.149(Safety)$$

Table 3. Regression results (dependent variables: EV purchase intention)

Variables	B	Std. Error	Beta (β)	t	Sig.
(constant)	1.267	0.330	-	3.835	<0.001
EV knowledge level	0.499	0.062	0.435	8.007	<0.001
Economic identity	0.231	0.085	0.142	2.724	0.007
Safety cognition	0.149	0.064	0.126	2.319	0.021

Note: $R^2 = 0.324$, Adjusted $R^2 = 0.317$, $F = 46.623$, $p < 0.001$.

3.4. Consumer differences and switching choices

Table 4 shows the transition pathways. The most common choice was ICE → BEV (34.46%), followed by ICE → PHEV/EREV (31.08%) and NEV → NEV (16.22%). Interestingly, while 12.50% of respondents chose to stay with ICE vehicles, only a small proportion switched from electric back to fuel (PHEV/EREV → ICE: 3.38%; BEV → ICE: 2.36%). This confirms that once consumers enter the electrified ecosystem, they rarely revert to pure fuel vehicles.

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Table 4. Powertrain transition paths (N = 296)

Transition Path	N	Percentage (%)
ICE → ICE	37	12.5%
ICE → PHEV/EREV	92	31.08%
ICE → BEV	102	34.46%
PHEV/EREV → ICE	10	3.38%
BEV → ICE	7	2.36%
NEV → NEV	48	16.22%
Total	296	100%

3.5. Results

This study has three main findings. First, EV knowledge is the strongest predictor of purchase intention ($\beta = 0.435$, $p < 0.001$). This supports Jaiswal et al. and Gupta et al., who found that consumer knowledge plays a key role in EV adoption. Second, economic factors are significant but weaker than knowledge ($\beta = 0.142$, $p = 0.007$), even though 62.16% of respondents said lower operating costs encourage them to choose EVs. This gap suggests that what people say is important may not be what actually drives their decision. Third, Table 4 shows that 34.46% of consumers chose a direct ICE → BEV transition while 31.08% preferred PHEV/EREV, supporting the view that consumer needs are not the same. Very few consumers switched back to pure fuel vehicles, which suggests that electrification is largely a one-way transition.

Overall, the results show that increasing BEV adoption requires two things: helping consumers understand the technology, and offering different marketing strategies for different consumer groups.

4. Conclusion

This study used survey data from 296 car owners to examine how consumers' perceptions, electric vehicle knowledge, and home vehicle background shape the transition from ICE vehicles. The regression results showed that EV knowledge was the strongest predictor of purchase intention ($\beta = 0.435$, $p < 0.001$), followed by economic identity ($\beta = 0.142$, $p = 0.007$) and safety cognition ($\beta = 0.126$, $p = 0.021$). An important finding is the gap between self-reported confidence and objective knowledge. Many respondents thought they knew electric cars well, but failed to answer basic technical questions correctly. This shows that consumer education is more important than just providing economic incentives.

The results also show that the role of household vehicles is important. Consumers are more open to BEVs as a second-class home car, while owners of single-master cars prefer PHEV/EREV or keep their ICE vehicles. This helps to explain why the transition is not a simple 'switch,' but a phased process.

This study has two major limitations. First, cross-sectional surveys cannot prove causality. Second, the data relies on self-reports rather than actual driving records. Future research can use long-term follow-up surveys and GPS driving data to test these findings and require participants to rank household vehicles by frequency of use.

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