

Article

Understanding the Barriers to Consumer Purchasing of Electric Vehicles: The Innovation Resistance Theory

Yixi Xue ¹, Xiaoyan Zhang ¹, Yi Zhang ^{1,2} and Exiang Luo ^{2,*}

¹ School of Management, Shanghai University, Shanghai 200444, China; nkxueyixi@sina.com (Y.X.); zxyxxzshu@shu.edu.cn (X.Z.); yizhang0612@aliyun.com (Y.Z.)

² School of Management, University of Shanghai for Science and Technology, Shanghai 200093, China

* Correspondence: luoxiang_usst@163.com

Abstract: In the context of sustainable transition, the factors that impact the decision to purchase electric vehicles (EVs) have garnered significant interest. However, existing research predominantly concentrates on the promotional factors while disregarding an examination of the resistance effects. Drawing on the innovation resistance theory (IRT), this study aims to investigate the influence of three functional barriers (usage, value, and risk) and two psychological barriers (tradition and image) on consumers' intention to purchase EVs. Additionally, we also analyze the moderating effect of environmental concern and incentive policy. Based on a survey of 297 respondents in China, we used SPSS 26.0 and AMOS 24.0 to verify our hypothesis. Our findings indicate that usage, value, risk, and tradition barriers negatively affect EV purchase intentions. Moreover, the negative relationship between functional barriers and EV purchase intentions is weaker for a strong incentive policy. Furthermore, we found that Gen Y and households with private car consumers are more willing to purchase EVs. These findings contribute to extending the applicability of IRT to the sustainable transportation field. They also offer practical guidance for EV enterprises with regard to marketing strategies that effectively mitigate the functional and psychological barriers to enhance profits, and for policymakers to better stimulate the development of the EV market.

Keywords: electric vehicles; innovation resistance theory; purchase intention; usage barrier; risk barrier; tradition barrier; image barrier; environmental concern; incentive policy



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1. Introduction

Electric vehicles (EVs) represent a crucial avenue for fostering an environmentally conscious evolution and low-carbon metamorphosis within the global automotive industry [1]. The latest report from the International Energy Agency (IEA) reveals that global EV sales surpassed the 10 million mark in 2022, with projections anticipating a further 35% surge to 14 million units by 2023. Notably, China currently leads the world in EV sales, trailed by Europe and the United States, but mass acceptance of EVs among consumers remains relatively low [2]. According to the Ministry of Industry and Information Technology of China, as of the end of 2022, the total number of EVs in China reached 13.1 million, accounting for only 4.10% of the total vehicle count, underscoring the comparatively modest adoption rate, which highlights the need to investigate the influencing factors behind the consumer rejection of EVs.

Given that the widespread adoption of EVs is ultimately contingent on consumer acceptance, various studies have endeavored to discern factors linked to consumer purchase intentions [3–6]. Following a thorough examination of existing research, three primary categories influencing consumers' intention to purchase EVs have been identified: (1) instrumental attributes of EVs encompassing economic factors and technical characteristics; (2) consumers' psychological or personality factors, including demographic characteristics, subjective norms, environmental values, and considerations of risk and

benefit; and (3) external stimuli such as incentive policies, infrastructural factors, and fluctuations in gas prices. While numerous studies have explored the adoption and acceptance of EVs, many have exhibited a pro-change bias by assuming that users inherently desire the latest services and by concentrating on the favorable outcomes of the adoption process (i.e., innovation acceptance) [7,8]. In contrast, a critical knowledge gap exists concerning the reasons behind consumer resistance to EV purchases, warranting further exploration. Understanding resistance to innovation is crucial, as many businesses encounter a high failure rate in production stemming from consumer resistance [9]. Therefore, firms must comprehend various drivers of consumer resistance to mitigate product failure [10] and devise strategies to enhance adoption rates [8]. Consequently, grounded in innovation resistance theory (IRT), this study elucidates the fundamental reasons for consumer resistance to EVs, emphasizing both functional and psychological barriers.

The concern and attitude toward the environment have garnered significant attention in the existing literature, capturing the interest of researchers. Some scholars posit that consumers' environmental concern can influence their attitudes toward EVs and consequently bolster their purchase intentions [11,12]. However, certain consumers express concerns that the manufacturing and disposal processes of power batteries could result in more pronounced environmental pollution, potentially outweighing the environmental benefits accrued throughout the life cycle of these vehicles [13,14]. This divergence in perspectives may stem from prior studies treating consumers' environmental concerns solely as an antecedent variable to EV purchase intention, overlooking its role as a contingent factor amid various resistance barriers and purchase intentions [15]. Moreover, external stimuli such as policy incentives can play a pivotal role in altering consumers' psychological perspectives [16]. For instance, policy incentives may contribute to shaping consumers' identity and status, thereby stimulating their purchase intentions [17]. Consequently, this study adopts a comprehensive approach, integrating both consumers' internal perspectives and external environmental stimuli. It considers consumers' environmental concerns and government policy incentives as moderating variables, seeking to explore the boundary conditions of various obstacles to purchase intentions. This approach enables a more nuanced understanding of the interplay between internal beliefs, external stimuli, and consumers' intention to purchase EVs.

Therefore, this study utilizes the IRT by Ram and Sheth (1989) [9] and adapts it to the context of consumer resistance to EV purchase intentions in China. Specifically, the study addresses two research questions:

RQ 1. What are the primary barriers affecting EV purchase intentions and the gap between purchase intention and actual purchase behavior?

RQ 2. Do environmental concern and incentive policy have a significant moderating influence on the relationship between barriers and purchase intention?

The contribution of this article is not limited to answering the two key questions mentioned above, but more importantly, it extends the effectiveness of IRT to the field of sustainable transportation and sheds new light on what inhibits consumers' EV purchase intention in a brand new way. At the same time, considering the moderating roles of consumers' environmental concerns and policy incentives in the specific context of China, this study further expands IRT by utilizing both internal and external perspectives of consumers. This expansion aims to facilitate enhanced synergies among research endeavors in interconnected domains and to provide managers and policymakers with valuable guidance on promoting consumer acceptance of EVs in the sustainable transportation landscape.

The remainder of this paper is organized as follows. Section 2 reviews the existing literature on IRT and develops our hypotheses, and Section 3 presents the research method. Section 4 introduces the empirical results. We also discuss the main findings in Section 5, the theoretical and practical implications in Section 6, and the limitations and future research in Section 7.

2. Literature Review and Hypothesis Development

2.1. Innovation Resistance Theory

According to Ram [10], the IRT is suggested as a reliable framework for examining consumer resistance or barriers. Previous research has indicated that when individuals adopt and utilize innovations that differ from their existing state and beliefs, resistance can emerge [9]. Customer resistance plays a significant role in determining the success or failure of novel technological innovations [18]. The IRT provides an explanation for consumer resistance toward innovative products, services, and technology. Barriers emerge when consumers intentionally refrain from adopting new technologies or products in order to preserve their current state.

IRT has previously undergone extensive testing regarding purchase intentions, with research mainly focused on two aspects. Firstly, there have been studies examining the impact of various innovation resistance barriers on purchase intention, mainly focusing on the fields of mobile payments [19] and environmentally friendly products [18]. Secondly, there have been investigations into the relationship between resistance barriers and purchase behavior. For example, Ju and Lee (2020) [20] conducted a study utilizing grounded theory and IRT to examine the impact of perceived utility and perceived risk on the resistance of Korean consumers toward smart wearable devices.

According to IRT, barriers to innovation can be classified into two main categories: functional barriers and psychological barriers. Functional barriers emerge when conflicts arise from behavioral contradictions related to the use, value, and risk of innovation, impeding its adoption and utilization. These conflicts typically arise when the key features of an innovation fail to meet users' expectations or are evaluated negatively [21]. On the other hand, psychological barriers, such as concerns related to image and tradition, stem from the immediate rejection and evaluation resistance toward an innovation [22]. Individuals may resist evaluating an innovation to maintain their current state and achieve satisfaction [23].

Through a comprehensive literature review, it becomes evident that the IRT has been extensively applied in the examination of purchase intention. However, in the present context of green transformation and low-carbon transition, a connection between IRT and EVs has not yet been established.

2.2. EV Purchase Intentions Based on IRT

It is crucial to examine the influence of consumer acceptance on purchase intention. However, there is often a tendency to overlook the exploration of the impact of barriers to consumer adoption of innovation on purchase intention from the standpoint of consumer resistance. The IRT offers an alternative perspective for studying the obstacles to consumer adoption of innovation and their willingness to purchase EVs. Based on the IRT, this article incorporates functional and psychological barriers into the factors that hinder EV purchase intention [9].

2.2.1. Functional Barriers and EV Purchase Intentions

When there are changes in consumer product usage habits, innovative product value, and the level of risk associated with using the product, functional barriers can emerge [10,24]. Usage barriers typically arise when innovative products are not compatible with consumers' existing practices or habits. Previous research has shown that in the context of organic food [25], mobile payment [19], and environmentally friendly cosmetics [26], usage barriers can lead to a decrease in purchase intention. In the case of EVs, during the process of consumer usage, they might not perceive EVs as user-friendly, or encounter design flaws that hinder convenience [25]. This includes significant changes in usage compared to traditional fuel-driven vehicles (TFVs), leading to the emergence of usage barriers. The adoption of EVs poses a challenge for consumers, as even though they may grasp the concept of innovation, their consumption habits need to adapt [26]. Previous studies on EVs have emphasized significant technological advancements in comparison to TFVs [27].

However, technological innovation that is difficult for consumers to comprehend does not effectively improve consumer convenience. Hence, we propose the following hypothesis:

Hypothesis 1a. *Usage barriers have a negative relationship with EV purchase intentions.*

Price is a crucial determinant that influences purchasing decisions [28]. Unless innovative products possess strong technological characteristics and substitutability that alter consumer perception, high prices often act as a key deterrent to purchases. Value barriers pertain to innovative products that lack cost-effectiveness for consumers [10], as well as the perceived value of new products in comparison to their substitutes [29]. This barrier is associated with the product's performance and its monetary value relative to substitutes [10,29]. Existing research has identified value barriers as the most significant resistance factor in internet banking when compared to intentions to use mobile banking [30]. Talwar et al. (2020) [31] discovered that the inclination to utilize online tourism platforms is predominantly influenced by functional barriers, and value barriers are the most critical factor affecting consumer adoption of online tourism platforms, significantly impairing their willingness to use them. In the context of EVs, as an innovative product, EVs are priced higher relative to TFVs due to R&D as well as manufacturing cost pressures [32]. Coupled with the drawbacks of slow charging and limited driving range, value barriers substantially undermine EV purchase intentions. Hence, we propose the following hypothesis:

Hypothesis 1b. *Value barriers have a negative relationship with EV purchase intentions.*

Risk barriers refer to the perceived risks that consumers face when considering innovative products compared to their alternatives [29]. When it comes to innovations, consumers often encounter uncertainties and unknown impacts, which can lead to hesitation or even the complete rejection of adopting such products [10,33]. A considerable amount of research has focused on exploring the EV purchase intentions of consumers from the perspective of perceived risk. These studies consistently indicate that perceived risk has a significant negative impact on the intention to purchase EVs [34,35]. Specifically, consumers may have concerns regarding the safety, limited driving range, and potential resale value of EVs. Even though these risks may be mitigated to a certain extent, they still exist and can diminish consumers' confidence in EVs, leading to weakened purchase intentions. For instance, consumers may worry about the safety of EV batteries and the possibility of accidents or fire hazards. They may also be concerned about the limited driving range of EVs, which could restrict their mobility and cause anxiety about running out of power during longer journeys. Based on the above analysis, we propose the following hypothesis:

Hypothesis 1c. *Risk barriers have a negative relationship with EV purchase intentions.*

2.2.2. Psychological Barriers and EV Purchase Intentions

Psychological barriers often arise when innovative products challenge consumers' existing cultural concepts or when negative impressions are formed [10]. Traditional barriers, in this context, pertain to consumers' beliefs that adopting an innovative product will disrupt their habits and lifestyle, thereby making them more inclined to stick with existing alternative products [29]. Cultural conflicts often contribute to the failure of innovative products, and the negative experiences reported by close social circles, such as family and friends, act as significant deterrents to consumer adoption [36]. Given that EVs are still in the early stages of development [37], many consumers face limited knowledge and encounter difficulties in accessing reliable information on the subject [34]. It has been demonstrated that a lack of understanding of EVs can substantially contribute to traditional barriers and hinder consumers' intention to purchase [38]. Based on these observations, we propose the following hypothesis:

Hypothesis 2a. *Tradition barriers have a negative relationship with EV purchase intentions.*

Image barriers refer to the negative impression that users have about the country of origin, brand, industry, or other aspects of innovative products [35]. The image barrier is a perceptual problem originating from stereotyped thinking, making innovative products difficult to move forward. Previous studies have proved that image barriers have a significant negative impact on purchase intention [30,36]. For example, when people question the authenticity of the quality of a green product and its environmental friendliness [39], then an image barrier may affect the intention to purchase an innovative product [38,40]. In addition, product image barriers may also occur in areas such as excellent product quality [41,42], or environmentally friendly packaging [43,44]. For EVs, consumers have a clear understanding of the influence and status of the EV brand, and poor brand image and user impressions can weaken their purchasing intentions. In other words, consumers who do not purchase environmentally friendly products have trust issues [45], which can be explained as consumers reasonably suspecting the EVs, leading to the negative image associated with the product. Therefore, we propose the following hypothesis:

Hypothesis 2b. *Image barriers have a negative relationship with EV purchase intentions.*

2.3. The Moderating Role of Environmental Concern

In recent years, there has been a strong focus in China on promoting the concept of low-carbon living and setting goals such as achieving “carbon neutrality”. This has led to a significant increase in consumer awareness of the environment. As EVs are considered a form of green consumption, it is important to consider consumer environmental concerns when studying their purchase intentions. Previous research has shown that environmental concern plays a positive moderating role in the relationship between value barriers, image barriers, and purchase intentions for environmentally friendly cosmetics [36]. Similarly, studies have emphasized the impact of consumer environmental concerns on their preferences and attitudes toward EVs [46]. Consumers with a heightened environmental concern are more likely to perceive EVs as greener, low-carbon, and environmentally friendly in comparison to TFVs. This perception weakens the negative influence of functional and psychological barriers on their purchase intentions. On the contrary, consumers with low environmental concern are more susceptible to the negative impact of functional and psychological barriers, further inhibiting their purchase intention for EVs. Thus, we propose the following hypotheses:

Hypothesis 3a. *The relationship between functional barriers and EV purchase intentions will be moderated by environmental concern.*

Hypothesis 3b. *The relationship between psychological barriers and EV purchase intentions will be moderated by environmental concern.*

2.4. The Moderating Role of Incentive Policy

In general, incentives can be defined as tools that influence people’s intentions and behaviors [47]. Incentive policies aimed at promoting the adoption of EVs have received significant attention due to their potential effectiveness. During the early stages of introducing innovative products, external factors such as incentive policies play a crucial role. In the Chinese auto industry, the lack of interest and demand among consumers is a major obstacle to the adoption of EVs, which directly influences the prosperity of the prefabrication market [48]. Prior research has identified three types of policies used to promote the consumption of EVs, namely financial incentive policies, information provision policies, and convenience policies [49]. Financial incentive policies seek to reduce the purchase and usage costs of EVs by offering tax incentives, rebates, and other financial benefits.

Information provision policies focus on conveying EV-related information to consumers, such as the environmental benefits associated with EVs and their low energy consumption. Convenience policies aim to provide consumers with the necessary infrastructure and services needed to facilitate the use of EVs [50,51]. This includes guiding the construction of new energy vehicle infrastructure and offering preferential policies for EV owners [52,53]. However, the high cost of EVs has been identified as a significant barrier to consumer acceptance of the technology [54]. Government-sponsored financial incentives can help mitigate this barrier and encourage consumers to embrace green consumption behaviors such as the adoption of EVs [52,55]. Similarly, if the government formulates policy documents outlining the environmental benefits of EVs, it can strengthen consumer familiarity with the technology and promote purchase intentions [53]. Additionally, convenience policies such as preferential parking and other privileges have been shown to increase consumer convenience when using EVs, especially in first-tier cities [56]. Based on these points, we propose that higher levels of incentive policies can weaken the negative relationship between functional and psychological barriers and purchase intentions. Therefore, we propose the following hypotheses:

Hypothesis 4a. *The relationship between functional barriers and EV purchase intentions will be moderated by incentive policy.*

Hypothesis 4b. *The relationship between psychological barriers and EV purchase intentions will be moderated by incentive policy.*

2.5. Demographic Characteristics and EV Purchase Intentions

In the realm of consumer behavior research, the investigation of individual differences holds significant relevance in understanding purchase intentions. Lissitsa and Kol (2021) [57] categorize individuals into four distinct groups and explore the association between various personality traits and hedonic shopping behavior. Talwar et al. (2020) [31] suggest that future studies on IRT could benefit from examining demographic variables. For the purpose of this article, the demographic variables considered include gender, age, level of education, household disposable income, and ownership of EVs. Specifically, individuals between the ages of 18 and 25 are classified as Generation Z, those aged 26 to 35 as Generation Y, and individuals aged 36 and above as Generation X. Education level is categorized into three tiers: high school or below, bachelor's degree, and master's degree. Furthermore, based on Shanghai's per capita disposable income of RMB 89,477/year in 2023, calculated by 2 people/household, households with disposable income below RMB 200,000 are classified as middle-income families, while those with disposable income exceeding RMB 200,000 are classified as high-income families [58]. Accordingly, we present the following hypothesis:

Hypothesis 5. *There are significant differences in EV purchase intentions among consumers with different demographic characteristics.*

In summary, the theoretical model of the relationship between functional barriers, psychological barriers, environmental concern, incentive policy, demographic characteristics, and EV purchase intentions is shown in Figure 1.

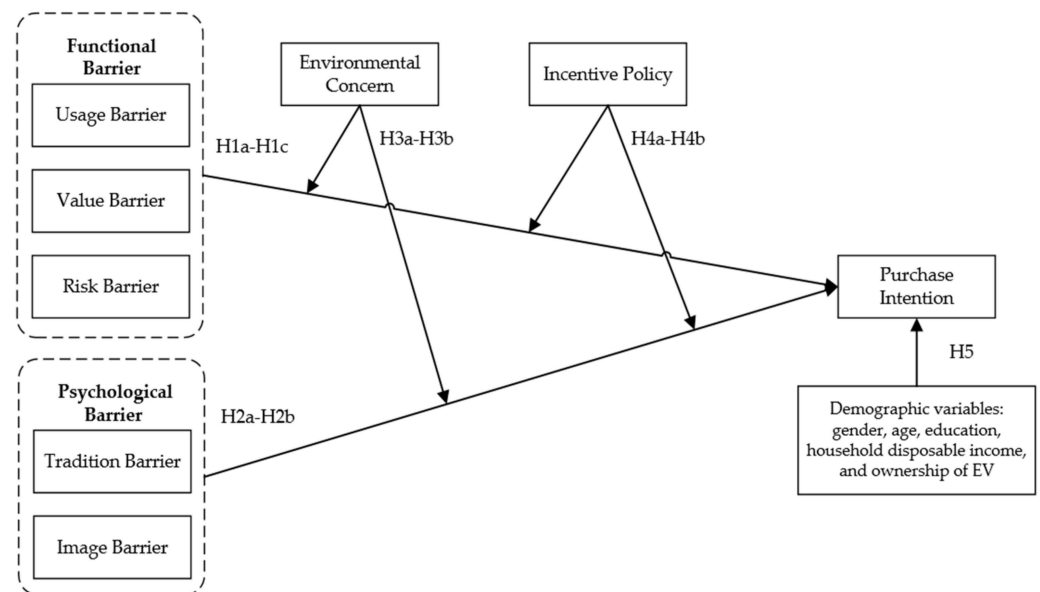


Figure 1. Theoretical model.

3. Methodology

3.1. Data Collection and Samples

To examine the research hypotheses, a comprehensive survey using both online and offline questionnaires was conducted in China. The online data were collected via Wenjuanxing.com, the country's most widely used and reputable online questionnaire survey platform [50]. For offline data collection, visits were made to Auto 4S stores, car washes, and beauty shops, where consumers were invited to complete paper questionnaires. To avoid redundancy in responses across online and offline surveys, three robust strategies have been implemented: (1) a comprehensive online questionnaire collection was carried out, with response limitations based on unique IP addresses; (2) subsequent offline surveys employed distinct screening questions in the paper questionnaire (e.g., "Have you recently conducted a survey related to EV purchase intention online?"); (3) to mitigate any confusion among offline participants, a QR code linking to the online questionnaire was appended to the paper survey for verification of respondents' unique response status. The questionnaire items were carefully designed based on existing research to ensure their validity. In total, 332 questionnaires were collected, and after data cleaning, 297 valid responses were obtained, resulting in a valid response rate of 89.46%. The basic situation of the sample is shown in Table 1.

3.2. Variable Measurements

In this study, a total of eight constructs were utilized, and the measures for these constructs were adapted from previously validated and tested sources. The variables were assessed using a 5-level Likert scale, with responses ranging from "strongly disagree" (1) to "strongly agree" (5). The constructs, indicators, and sources of these constructs are presented in Table 2.

UB was measured with three items adapted from [30]. The sample item read as follows: "I think driving EVs is convenient". The reliability coefficient of UB was 0.820.

VB was measured with three items adapted from [7,59]. The sample item read as follows: "In my opinion, EVs are more environmentally friendly than TFVs". The Cronbach's alpha reliability coefficient of VB was 0.875.

RB was measured with four items adapted from [7,30]. The sample item read as follows: "I am concerned that the lifespan of EVs is too short". The Cronbach's alpha reliability coefficient of RB was 0.867.

Table 1. Sample statistics.

Sample Classification		Have EV		Have No EV		Overall	
		Quantity	Percentage	Quantity	Percentage	Quantity	Percentage
Number of people		55	19%	242	81%	297	100%
Gender	Male	25	18%	112	82%	137	46%
	Female	30	19%	130	81%	160	54%
Age	Gen Z 18–25	9	14%	56	86%	65	22%
	Gen Y 26–35	10	13%	67	87%	77	26%
	Gen X > 36	36	23%	119	77%	155	52%
Highest education level	High school or below	11	16%	59	84%	70	24%
	Bachelor’s degree	41	20%	162	80%	203	68%
	Master’s degree	3	13%	21	88%	24	8%
Families with disposable income	Middle-income families (below RMB 200,000)	34	19%	146	81%	180	61%
	High-income families (over RMB 200,000)	21	18%	96	82%	117	39%
Ownership of private car	Yes	55	25%	162	75%	217	73%
	No	0	/	80	/	80	27%

Table 2. Confirmatory factor analysis.

Variable and Sources	Number	Measurement Question Items	Factor Loading	α	AVE	CR
Usage Barrier [30] (UB)	UB1	I think driving EVs is convenient (-)	0.765	0.820	0.611	0.825
	UB2	I think the operation of the vehicle interface for EVs is convenient (-)	0.813			
	UB3	I think it is very fast to shift from the usage habits of TFFVs to the usage habits of EVs	0.767			
Value Barrier [7,59] (VB)	VB1	In my opinion, EVs are more environmentally friendly than TFFVs (-)	0.866	0.875	0.704	0.877
	VB2	In my opinion, EVs can make energy utilization more efficient (-)	0.857			
	VB3	In my view, EVs can reduce air pollution (-)	0.793			
Risk Barrier [7,30] (RB)	RB1	I am concerned that the lifespan of EVs is too short	0.697	0.867	0.625	0.868
	RB2	I am concerned about the safety of driving EVs	0.764			
	RB3	I am concerned that the maintenance frequency of EVs is too high	0.899			
	RB4	I am concerned about the inconvenience caused by the limited availability of repair points by EV manufacturers	0.789			
Tradition Barrier [31] (TB)	TB1	I think TFFVs are already sufficient for me to use	0.690	0.813	0.735	0.843
	TB2	Compared to EVs, I still prefer TFFVs	0.997			
Image Barrier [7] (IB)	IB1	In my opinion, the new product is often too complicated to be useful	0.927	0.856	0.758	0.862
	IB2	I have such an image that EVs are difficult to use	0.810			
Environmental Concern [60,61] (ENV)	ENV1	The use of alternative energy sources can mitigate the intensity of the greenhouse effect	0.564	0.888	0.596	0.889
	ENV2	Human must maintain the balance with nature in order to survive	0.847			
	ENV3	Individual use of green energy still makes a certain contribution to the Earth	0.867			

Table 2. Cont.

Variable and Sources	Number	Measurement Question Items	Factor Loading	α	AVE	CR
Incentive Policy [62–64] (POL)	POL1	I think government subsidies have a promoting effect on my purchase of EVs	0.894	0.875	0.641	0.875
	POL2	I think tax reduction and exemption will have a certain promoting effect on my purchase of EVs	0.917			
	POL3	One of the reasons why I purchased EVs is due to some of the road rights policies	0.681			
	POL4	The government's policy support for the construction of charging stations and facilities is one of the reasons why I purchased EVs	0.678			
Purchase Intention [19,65] (PI)	PI1	If it can meet the demand, I will consider purchasing EVs	0.927	0.919	0.794	0.920
	PI2	I will recommend EVs to friends around me for purchase	0.876			
	PI3	There is a high possibility for me to choose an EV when I buy a car next time	0.869			

Note: (-) is a reverse scoring question.

TB was measured with two items adapted from [31]. The sample item read as follows: “I think TFVs are already sufficient for me to use”. The Cronbach's alpha reliability coefficient of TB was 0.813.

IB was measured with two items adapted from [7]. The sample item read as follows: “In my opinion, the new product is often too complicated to be useful”. The Cronbach's alpha reliability coefficient of IB was 0.856.

ENV was measured with three items adapted from [60,61]. The sample item read as follows: “The use of alternative energy sources can mitigate the intensity of the greenhouse effect”. The reliability coefficient of ENV was 0.888.

POL was measured with four items adapted from [62–64]. The sample item read as follows: “I think government subsidies have a promoting effect on my purchase of EVs”. The reliability coefficient of POL was 0.875.

PI was measured with three items adapted from [19,65]. The sample item read as follows: “If it can meet the demand, I will consider purchasing EVs”. The reliability coefficient of PI was 0.919.

4. Results

4.1. Common Method Bias Analysis

Before conducting the data analysis, we conducted an assessment to determine whether there was any presence of common method bias (CMB). To assess this, we utilized Harman's single-factor test, which is a commonly employed method to examine the potential presence of homophily bias in the data. By analyzing the unrotated factors of all the question items, we observed that the first principal component explained 30.89% of the total variance. This percentage was found to be lower than the commonly regarded threshold of 40%, thereby indicating the absence of any significant homophily bias in the data. Based on these results, we can proceed with the data analysis without concerns regarding this specific form of bias.

4.2. Measurement Model Analysis

Prior to testing the research hypotheses, we employed various procedures to evaluate the construct validity of our measurement instruments. Firstly, we examined the convergent and discriminant validity. The average variance extracted (AVE) for each construct ranged from 0.611 to 0.794, surpassing the recommended threshold of 0.5. Moreover, the square root of the AVE values exceeded the correlations among the constructs, ranging from 0.772 to 0.891.

Secondly, we conducted confirmatory factor analysis (CFA) to assess the convergent validity of each construct. The standardized factor loadings of all items ranged from 0.564 to 0.997, all of which were statistically significant at $p < 0.001$. These findings provide support for the convergent validity of the constructs.

Thirdly, we evaluated the discriminant validity by comparing an eight-factor measurement model (including UB, VB, RB, TB, IB, ENV, POL, and PI) with alternative parsimonious models. The CFA results indicated that the eight-factor measurement model demonstrated a good fit to the data, with $\chi^2_{df} = 2.422$, CFI = 0.928 (>0.9), IFI = 0.929 (>0.9), and RMSEA = 0.069 (<0.08). Taken together, these results provide robust evidence supporting the convergent and discriminant validity of our constructs.

4.3. Descriptive Statistics

Table 3 presents the descriptive statistics and correlations among the variables investigated in this study. The results reveal that there are negative correlations between the usage barrier and purchase intention ($r = -0.443$, $p < 0.001$), the value barrier and purchase intention ($r = -0.381$, $p < 0.001$), the risk barrier and purchase intention ($r = -0.198$, $p < 0.001$), the tradition barrier and purchase intention ($r = -0.428$, $p < 0.001$), as well as the image barrier and purchase intention ($r = -0.184$, $p < 0.001$). These findings offer initial support for our research hypotheses.

Table 3. Means, standard deviations, and correlations between the study variables.

	UB	VB	RB	TB	IB	ENV	POL	PI
UB	0.782							
VB	0.357 ***	0.840						
RB	0.136 ***	0.066 *	0.791					
TB	0.287 ***	0.218 ***	0.362 ***	0.833				
IB	0.212 ***	0.146 ***	0.332 ***	0.361 ***	0.853			
ENV	−0.096 ***	−0.151 ***	0.033	−0.004	−0.022	0.772		
POL	−0.168 ***	−0.185 ***	−0.018	−0.092 ***	−0.062 **	0.138 ***	0.801	
PI	−0.443 ***	−0.381 ***	−0.198 ***	−0.428 ***	−0.184 ***	0.124 ***	0.244 ***	0.891
Mean	2.17	1.99	3.62	3.38	2.76	3.97	4.09	3.69
SD	0.78	0.86	0.81	0.86	0.91	0.67	0.65	0.85

Note: * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$. Bold numbers represent AVE square root values.

4.4. Hypothesis Testing

4.4.1. Main Effects Test

To examine the proposed relationships between the three types of functional barriers, two types of psychological barriers, and EV purchase intentions, a binomial logit regression analysis was conducted using SPSS 26.0. The results are presented in Table 4. Specifically, in our approach to handling PI, the following criteria were used: If the mean of the three measurement items is less than 3, PI is assigned a value of 0. If the mean is greater than or equal to 3, PI is assigned a value of 1. Model I represents the logit regression analysis with only control variables included. Model II and Model III include independent variables and pass the Hosmer–Lemeshow test ($p > 0.05$). The classification percentages for Model II and Model III are 67.3 and 74.7, indicating good predictive capability. In the binomial logit regression, the OR value directly reflects the relationship between the independent variables and the dependent variable, as shown in the Exp (B) column of Table 4. In Model II, functional barriers ($B = -1.09$, $p < 0.01$) have a stronger impact on consumer purchase intentions compared to psychological barriers ($B = -0.37$, $p > 0.1$). Holding other variables constant, for each unit increase in functional barriers, the purchase intention decreases by 33.6% (Exp (−1.09)). Similarly, in Model III, usage barriers ($B = -1.011$, $p < 0.01$), value barriers ($B = -0.782$, $p < 0.01$), risk barriers ($B = -0.368$, $p < 0.1$), and tradition barriers ($B = -0.805$, $p < 0.01$) all have a negative impact on purchase intentions. Each additional unit increase in these barriers leads to a decrease in purchase intentions by

36.4% (Exp (−1.011)), 45.8% (Exp (−0.782)), 69.2% (Exp (−0.368)), and 44.7% (Exp (−0.805)), respectively. Therefore, the research results support Hypotheses H1a, H1b, H1c, and H2a.

Table 4. Logit regression.

	Model I			Model II			Model III		
	B	BootSE	Exp (B)	B	BootSE	Exp (B)	B	BootSE	Exp (B)
UB							−1.011 ***	0.25	0.364
VB							−0.782 ***	0.225	0.458
RB							−0.368 *	0.221	0.692
TB							−0.805 ***	0.227	0.447
IB							0.301	0.199	1.351
FB				−1.09 ***	0.276	0.336			
PB				−0.37	0.227	0.691			
Gen	0.384	0.245	1.468	0.366	0.27	1.442	0.195	0.301	1.216
Age	−0.251	0.169	0.778	−0.343 *	0.186	0.709	−0.371 *	0.207	0.690
Edu	−0.056	0.246	0.945	−0.162	0.267	0.85	−0.317	0.293	0.728
Inc	−0.08	0.2	0.923	−0.056	0.217	0.946	0.115	0.246	1.122
Own	−0.666 **	0.301	0.514	−0.683 **	0.323	0.505	−0.688	0.357	0.502
Constant	1.61 *	0.975	5.005	6.663 ***	1.394	782.649	9.382 ***	1.731	11,874.563
R ²		0.033			0.203			0.392	
χ ² (df)		7.223 (5) $p = 0.205$			48.166 (7) $p < 0.001$			101.087 (10) $p < 0.001$	
Hosmer–Lemeshow test		0.88			0.145			0.687	
Classification percentage		60.6			67.3			74.7	

Note: * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$.

4.4.2. Testing the Moderated Hypotheses

To investigate the moderating effect of environmental concern and incentive policies, a hierarchical linear regression analysis was conducted, and the findings are presented in Table 5. The results demonstrate that the interaction coefficient between environmental concern and functional barriers ($B = -0.035$, $p = 0.701$), as well as psychological barriers ($B = -0.018$, $p = 0.791$), was not statistically significant. Additionally, there was no significant change in the R^2 value. Therefore, it can be inferred that environmental concern does not act as a moderator between functional barriers, psychological barriers, and purchase intention. Consequently, Hypotheses 3a and 3b are rejected.

Table 5. Moderating effect of ENV and POL.

	Unstandardized Coefficient	BootSE	t	p	ΔR ²
ENV					
CFB × CENV	−0.035	0.092	−0.385	0.701	0
CPB × CENV	−0.018	0.066	−0.265	0.791	0
POL					
CFB × CPOL	0.153	0.083	1.844 *	0.066	0.006
CPB × CPOL	0.059	0.067	0.884	0.378	0.002

Note: * $p < 0.1$.

On the other hand, it was observed that policy incentives have a positive moderating impact on functional barriers ($B = 0.153$, $p = 0.066$). As the extent of policy incentives increases, the inhibitory effect of functional barriers on purchase intention weakens. In simpler terms, policy incentives have the ability to alleviate consumer functional barriers and stimulate the adoption of EVs. However, the moderating effect of policy incentives on psychological barriers ($B = 0.059$, $p = 0.378$) is not statistically significant. Hence, Hypothesis 4a is supported.

To provide further evidence of the moderating effect, we plotted simple slopes to illustrate the interaction effects for low (−1 SD) and high (+1 SD) values of the moderators; the results are presented in Figure 2. It can be observed that compared with low policy incentives, the high policy incentives reduced the negative effect of functional barriers on EV purchase intention.

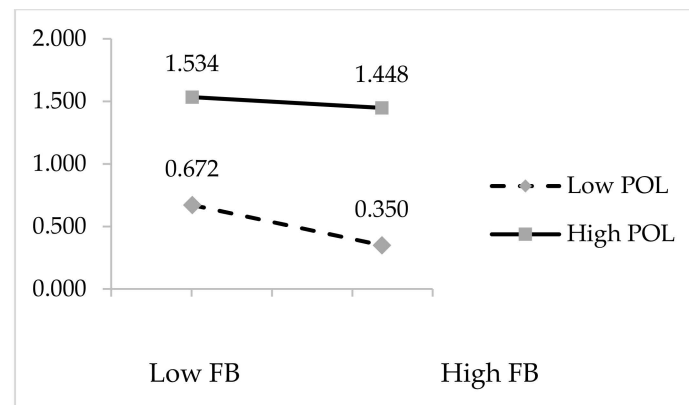


Figure 2. Moderating effect of POL on the link between FB and PI.

4.4.3. Testing the Demographic Characteristics Hypothesis

To further investigate the variations in demographic characteristics, we employed dummy variables to categorize the following variables: gender, age, education level, household disposable income, and ownership of private cars. These variables were subjected to logistic regression analysis, and the findings are outlined in Table 6. The results indicate that, compared to other age groups, consumers from Gen Y (26–35) have an $\text{Exp}(0.636) - 1 = 88.9\%$ higher intention to purchase EVs. Furthermore, the analysis also demonstrates that, compared to households without private cars, households with private cars have an $\text{Exp}(0.629) - 1 = 87.6\%$ higher probability of choosing EVs. Therefore, H5 has been partially supported.

Table 6. Demographic characteristics hypothesis.

	Variable Classification	B	BootSE	Exp (B)
Gender	Male 1, Female 0	−0.395	0.25	0.674
Gen Z (18–25)	1, 0	0.399	0.368	1.49
Gen Y (26–35)	0, 1	0.636 **	0.325	1.889
Gen X (>36)	0, 0			
High school or below	1, 0	0.162	0.528	1.176
Bachelor's degree	0, 1	−0.052	0.466	0.949
Master's degree	0, 0			
Household disposable income	Medium 1, High 0	−0.063	0.258	0.939
Ownership of private car	Yes 1, No 0	0.629 **	0.309	1.876
Constant	/	−0.005	0.522	0.995

Note: ** $p < 0.05$.

4.4.4. Summary of the Hypotheses

In the current study, there are a total of ten hypotheses, as per the empirical insights of the current study; the data were collected from China, with the majority coming from Shanghai. After deploying the statistical techniques, the insights explain that five direct hypotheses and one moderated hypothesis are supported. Below, Table 7 explains the summary of the whole list of hypotheses.

Table 7. Hypotheses summary.

Hypotheses	Description	B	Verification
H1a	Usage barriers have a negative relationship with EV purchase intentions.	−1.011 ***	Support
H1b	Value barriers have a negative relationship with EV purchase intentions.	−0.782 ***	Support
H1c	Risk barriers have a negative relationship with EV purchase intentions.	−0.368 *	Support
H2a	Tradition barriers have a negative relationship with EV purchase intentions.	−0.805 ***	Support
H2b	Image barriers have a negative relationship with EV purchase intentions.	0.301	Rejected
H3a	The relationship between functional barriers and EV purchase intentions will be moderated by environmental concern.	−0.385	Rejected
H3b	The relationship between psychological barriers and EV purchase intentions will be moderated by environmental concern.	−0.265	Rejected
H4a	The relationship between functional barriers and EV purchase intentions will be moderated by incentive policy.	1.844 *	Support
H4b	The relationship between psychological barriers and EV purchase intentions will be moderated by incentive policy.	0.884	Rejected
H5	There are significant differences in EV purchase intentions among consumers with different demographic characteristics.	0.636 ** (Gen Y) 0.629 ** (Ownership of private car)	Partially Support

Note: * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$.

4.5. Analysis of the Gap between Purchase Intention and Purchase Behavior

Purchase intention serves as a crucial determinant of consumers' actual purchasing behavior. Accurately measuring purchase intention enables us to predict consumers' actual purchase decisions. In order to assess the disparity between purchase intention and actual behavior, we employed a binomial logit regression model. We classified consumers who currently own EVs as change adopters, and those who do not own EVs as change non-adopters. The results are presented in Table 8. It can be seen that the logit regression model has passed the Hosmer–Lemeshow test ($p > 0.05$), and the classification percentages are 76.5% and 80.6%, indicating that the model can accurately predict the actual purchasing behavior of consumers. As shown in Table 7, functional barriers ($B = -0.920$, $p < 0.05$) and psychological barriers ($B = -0.734$, $p < 0.05$), both have a negative impact on consumers' actual purchase of EVs, corresponding to usage barriers ($B = -1.239$, $p < 0.01$) and tradition barriers ($B = -0.956$, $p < 0.01$). Usage barriers have the most significant impact, and then are the traditional barriers. When other variables remain unchanged, for every unit increase in functional barriers, psychological barriers, usage barriers, and tradition barriers, the probability of actual purchasing behavior decreases $\text{Exp}(-0.920) = 39.9\%$, $\text{Exp}(-0.734) = 48\%$, $\text{Exp}(-1.239) = 34\%$, and $\text{Exp}(-0.956) = 27.6\%$.

Table 8. Logit regression between purchase intention and purchase behavior.

	B	BootSE	Exp (B)	B	BootSE	Exp (B)	B	BootSE	Exp (B)
FB				−0.920 **	0.387	0.399			
PB				−0.734 **	0.288	0.480			
UB							−1.239 ***	0.34	0.29
VB							0.455	0.283	1.576
RB							−0.383	0.272	0.682
TB							−0.956 ***	0.276	0.385
IB							0.335	0.264	1.398
Gen	0.138	0.319	1.148	−0.056	0.346	0.946	0.128	0.37	1.136
Age	0.085	0.229	1.089	0.195	0.251	1.216	0.021	0.27	1.021
Edu	0.488	0.328	1.629	0.419	0.636	1.520	0.463	0.387	1.589
Inc	−0.249	0.259	0.779	−0.356	0.280	0.701	−0.278	0.297	0.757
Constant	−1.808 *	1.096	0.164	−2.984 **	1.518	19.762	3.54 **	1.609	34.483
R ²		0.019			0.217			0.323	
χ^2 (df)		2.750 (4), $p = 0.600$			34.564 (6), $p < 0.001$			53.567 (9), $p < 0.001$	
Hosmer–Lemeshow test		0.979			0.958			0.232	
Classification percentage		74.7			76.5			80.6	

Note: * $p < 0.1$. ** $p < 0.05$. *** $p < 0.01$.

5. Discussion

This study examines the influence of three functional barriers, two psychological barriers, environmental concern, and incentive policy on EV purchase intention. First, H1a–1c is supported, namely that usage barriers, value barriers, and risk barriers negatively affect the EV purchase intention. As a nascent sustainable transportation technology, the primary functional barrier is related to its usage. Given the distinct usage patterns from TFVs and the incorporation of numerous novel technologies, consumers possess notable concerns regarding usage barriers. The outcomes of this investigation align with previous studies [66,67], corroborating the importance of ease of use and perceived utility as critical determinants of EV purchase intention.

Second, H2a is consistent with previous studies verifying that tradition barriers negatively affect EV purchase intention [68,69]. Despite the significant environmental benefits of EVs, consumers often exhibit a long-standing preference for TFVs, posing a challenge in altering entrenched notions and habits. However, among the five barriers, the image barrier, which is a psychological barrier, does not have a negative effect on the willingness to purchase EVs. Similar results were reported by Chen et al. (2018) [68]. Two factors may underpin this outcome: (1) The incremental penetration and proliferation of EVs have fostered a heightened consumer comprehension of their capacity to safeguard the ecological environment. (2) The widespread adoption of EVs has catalyzed a positive word-of-mouth phenomenon, attenuating image barriers and dispelling consumer misconceptions.

Third, there is no moderating effect of environmental concern between functional barriers, psychological barriers, and purchase intention, demonstrating that H3a–H3b has not been proven. Newton et al. (2015) [70] proposed in their study that while environmental concern may not directly influence consumers' purchase intentions, it could serve to enhance their awareness of the environmental implications of their buying decisions. This observation aligns with the outcomes of the article, indicating that consumers may necessitate comprehensive information and awareness to underpin their environmental evaluations of EVs available for purchase before converting their environmental concerns into intentions to make environmentally conscious purchases. Hence, these results serve as a timely reminder that when incorporating environmental concern into the IRT, it is crucial to integrate the individual's understanding of environmental information or take into account the learning process related to environmental information [71].

Fourth, incentive policy has a positive moderating effect between functional barriers and purchase intention; therefore, H4a is established. This article confirmed the research findings by Jaiswal et al. (2021) [72] and Xue et al. (2023) [17], indicating that policy incentives exert a favorable moderating influence on purchase intentions. An intriguing revelation is that incentive policy does not impact the relationship between psychological barriers and purchase intention; therefore, H4b is rejected. The primary factor contributing to this phenomenon may be the inadequacy of existing policy incentives in meeting consumer needs effectively [50]. This insufficiency could impede the resolution of psychological barriers that consumers encounter concerning EVs, stemming from shifts in usage patterns and prevailing stereotypes [73].

6. Conclusions and Implications

6.1. Conclusions

Based on the IRT, this study aims to investigate the correlation between functional barriers (the usage barrier, value barrier, and risk barrier), psychological barriers (the traditional barrier and image barrier), environmental concern, incentive policy, and EV purchase intention. The findings of this study are as follows: (1) Functional barriers significantly and negatively impact consumers' intentions to purchase EVs. Specifically, the sub-dimensions of usage barriers, value barriers, and risk barriers act as primary factors impeding purchase intentions. Consequently, H1a, H1b, and H1c are supported. (2) Among the psychological barriers encountered by consumers, traditional barriers are found to be the primary hindrance to EV purchases. Therefore, H2a is confirmed.

(3) Incentive policies play a moderating role by positively influencing the relationship between functional barriers and purchase intentions. Hence, H4a is supported. (4) Regarding demographic characteristics, Gen Y and private car owners are more willing to purchase EVs. Therefore, H5 is partially validated.

6.2. Theoretical Implications

This study makes significant theoretical contributions in several ways. Firstly, it demonstrates the applicability of IRT in the sustainable transportation field, particularly in the Chinese EV sector. As low-carbon transition gains greater attention, scholars have increasingly focused on sustainable transportation [70]. Expanding IRT to this field can better explain the relationship between purchase intention barriers and IRT, and also uncover the reasons for innovation resistance in low-carbon transportation, such as EVs.

Secondly, this study adds to the literature on consumer resistance to EV consumption. While previous studies have primarily explored the factors that trigger EV purchase intentions, it is equally important to understand consumers' concerns about EV purchases [71]. Therefore, this study provides a new research perspective that contributes to the further development of EV purchase intentions.

6.3. Practical Implications

6.3.1. Managerial Implications

Firstly, enterprises should prioritize user-centric approaches and streamline the operation processes of EVs. The outcome of the research indicates that the primary factor influencing purchase intention is the presence of usage barriers, particularly concerning the convenience and safety of operating EVs. Many consumers hold the belief that EVs entail more complex operations and certain risks. The respondents in the survey expressed concerns that inexperienced operation might lead to accidental contact and that accidents involving EVs may put the driver and passengers in perilous situations. Consequently, enterprises should refrain from unnecessary "innovation" that significantly escalates the learning costs and potential security risks for EV consumers.

Secondly, it is crucial to establish prices for EVs that are in line with the product positioning and to promote them appropriately. Barriers related to consumer value and risk are specifically apparent in the perception that EVs are excessively expensive compared to TFVs. Moreover, the limited range and anxiety associated with charging EVs have consistently been among the most worrisome factors for consumers, especially during the winter season when the range is further compromised. Therefore, enterprises should set reasonable prices for EVs and engage in targeted technological improvements to address consumer concerns regarding the risks associated with EVs.

Thirdly, automotive enterprises should implement differentiated marketing strategies for EVs based on various demographic characteristics. Research findings indicate that households with private vehicles and Gen Y members are more inclined to purchase EVs. Hence, it is imperative to meticulously delineate the distinct purchasing behaviors exhibited by these two demographic cohorts and devise tailored marketing strategies accordingly. For instance, providing trade-in services to private vehicle owners and extending more favorable pricing to Gen Y can effectively stimulate a surge in electric vehicle purchasing intent.

6.3.2. Policy Implications

Firstly, the construction of both commercial and community charging and swapping stations should be expedited. As indicated by our conclusions, barriers related to value and risk can significantly impede consumers' intentions to purchase EVs, particularly in terms of the charging and swapping infrastructure. Consequently, policymakers should shift their focus toward implementing a range of convenience-oriented policies that address the various pain points experienced by EV users, while also increasing investments in charging and swapping stations to enhance ease of use and promote EV adoption.

Secondly, policymakers should prioritize a diverse range of policies to optimize the policy mix. Particular emphasis should be placed on a combination of information and financial incentive policies for EVs. This involves further implementing financial incentive policies aiming to reduce the purchase and usage costs of EVs. Simultaneously, digital internet platforms should be utilized to enhance information policies, effectively allocating more resources to increase consumer familiarity and understanding of EVs. From the perspective of breaking consumer psychological barriers, it will promote an increase in consumer willingness.

Thirdly, there is a necessity to strengthen regulations within the EV industry regarding the disposal of used batteries. While the moderating effect of environmental concerns is not significant, many survey respondents expressed their views that EVs are not environmentally friendly products. As consumer preferences evolve, individuals tend to be more rational and comprehensively evaluate new advancements. They prioritize considerations regarding the end stage of a product's lifecycle, such as the recycling and disposal of power batteries. Given the inherent issues related to electricity generation and the recycling and treatment of power batteries, it is imperative to develop relevant policies to regulate the EV industry effectively.

7. Limitations and Future Research

Despite the valuable contributions made by this study, it is important to acknowledge its limitations. Firstly, it should be noted that the research was conducted solely in China, primarily in the Shanghai region, due to geographical constraints. However, it is crucial to recognize that other countries, such as the USA and Norway, have also made remarkable advancements in the development of EVs [74]. Therefore, in order to ensure the external validity of the conceptual framework, future studies could include a follow-up survey that encompasses developed countries with different cultural backgrounds. Secondly, it is crucial to emphasize that the deficiencies of this study are primarily attributed to its regional and temporal constraints, accentuating the importance of augmenting sample diversity and capturing sample dynamics. Subsequent research initiatives could leverage specialized questionnaire datasets to boost both sample size and diversity or employ longitudinal tracking methods to monitor the dynamic evolution of consumer behavior over time, thereby effectively addressing this limitation in a comprehensive manner. Thirdly, it is worth noting that this study only focused on the hindering factors of functional and psychological barriers on EV purchase intention, as well as the moderating effects of environmental concern and incentive policy, without exploring other potential direct effects, mediating effects, or other moderating factors. For a more comprehensive understanding, further research can explore the impact of demographic variables on EV purchase intention, while also incorporating variables such as consumer psychological processes into the model to enhance its applicability and universality.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data that have been used are confidential.

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