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The Decision-Making Processes for Consumer Electric Vehicle Adoption Based on a Goal-Directed Behavior Model

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Abstract: Electric vehicles (EVs) are increasingly recognized as a viable strategy for mitigating energy consumption and reducing greenhouse gas emissions within the transportation sector. In order to facilitate the advancement of EVs, this study expands upon the model of goal-directed behavior by integrating the novel concept of perceived consumer effectiveness (PCE) to examine the decision-making process of consumers regarding EV adoption. The model was empirically tested using data gathered from 398 participants in China. The results indicate that factors such as attitude, subjective norm, anticipated positive and negative emotions, and PCE significantly enhance consumers' desire to adopt EVs, which subsequently affects their behavioral intentions. Notably, the relationship between desire and behavioral intention is moderated by PCE. The insights derived from this study enhance the understanding of EV adoption behaviors and offer strategic recommendations for promoting electric vehicles.

Keywords: electric vehicles; adoption behavior; model of goal-directed behavior; perceived consumer effectiveness



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1. Introduction

Environmental pollution and energy exhaustion are crucial challenges in the transport sector. The transportation sector is responsible for approximately 23% of global greenhouse gas emissions, a figure that is projected to rise to nearly 50% by the year 2050 in the absence of significant intervention [1]. Additionally, this sector accounts for more than 55% of total oil consumption [2]. A strategy to mitigate carbon emissions and reduce fuel consumption includes the advancement of fuel-efficient and alternative-fuel vehicles, particularly electric vehicles (EVs). EVs are mainly powered by electricity and thus can contribute to reducing carbon emissions and improving energy efficiency from transport [3]. Research indicates that EVs can, on average, decrease carbon emissions by 30–50% in comparison to traditional fuel vehicles, while also realizing enhancements in fuel efficiency ranging from 40 to 60% [4]. Consequently, the advancement of EV technology is an essential element in global initiatives aimed at addressing environmental challenges and the energy crisis.

Governments are implementing strategies to facilitate the introduction and promotion of EVs, with particular emphasis on China, which has emerged as the largest automotive market globally since 2009 [5] and continues to experience rapid growth. The Chinese government has established two key objectives for EV production and sales: (1) to have over 500,000 EVs operational by 2015; and (2) to achieve a total of more than 5 million by 2020 [6]. In pursuit of these goals, the government has enacted a series of policies aimed at enhancing EV research and development, as well as providing subsidies for the production, purchase, and establishment of charging infrastructure for EVs. As a result of governmental support, the advancement of EVs in China has been significant, with production and sales figures reaching approximately 9.5 million each, maintaining the top position globally for

nine consecutive years since 2015. Nonetheless, the growth of the EV sector remains heavily dependent on government subsidies, indicating a lack of competitive viability in the market. Consequently, it is imperative to investigate consumer behavior regarding EV adoption to gain a comprehensive understanding of market demand and to facilitate the transition of EV development from a policy-driven framework to a market-oriented approach.

The adoption of electric vehicles (EVs) has garnered significant scholarly interest. Numerous researchers have employed the Theory of Planned Behavior (TPB) or its extended version to elucidate the intentions behind EV adoption. For instance, reference [7] utilized the TPB framework to explore the motivations and obstacles associated with the procurement intentions of commercial vehicle fleets regarding EVs. Similarly, reference [8] developed an extended TPB model by incorporating two additional antecedents—personal moral norms and environmental concerns—to forecast consumers' intentions to adopt EVs. Furthermore, several scholars have extensively applied the Norm Activation Model (NAM) to predict consumer intentions toward EV adoption. An example of this is the work of reference [9], who proposed a theoretical framework grounded in the NAM to examine consumer intentions to adopt EVs. Additionally, some researchers have integrated the TPB and NAM to investigate EV adoption. For example, reference [10] combined these two models to analyze the antecedents influencing the intention to purchase EVs among Malaysian consumers.

The adoption of EVs is considered a form of pro-environmental behavior, attributable to the ecological benefits associated with these vehicles [11]. The existing literature indicates that pro-environmental behavior encompasses a multifaceted decision-making process that integrates both cognitive and emotional dimensions, with the latter often providing a more comprehensive explanation for such behaviors than the former [12]. This suggests that neglecting emotional factors may inadequately account for the engagement in pro-environmental behaviors, including the adoption of EVs. Nevertheless, current research on EV adoption has predominantly concentrated on cognitive elements, such as attitudes, knowledge, and perceptions (e.g., reference [4,13,14]), while there has been comparatively less emphasis on the influence of emotional factors and a notable deficiency in studies that integrate both cognitive and emotional perspectives.

In light of the preceding discussion, this paper examines consumer adoption of EVs through the lens of the model of goal-directed behavior (MGB), which encompasses both cognitive and emotional dimensions. Furthermore, perceived consumer effectiveness (PCE)—defined as the belief in the efficacy of one's actions in addressing environmental issues—has been recognized as a significant determinant of pro-environmental behaviors [15,16]. Consequently, this study aims to investigate the role of PCE in the context of EV adoption by integrating it into the MGB framework.

In the subsequent sections of this paper, we will begin by reviewing the MGB, followed by the introduction of the research model and the associated hypotheses. Subsequently, we will outline the research methodology and the data analysis procedures employed. This will be succeeded by a discussion of the results, including their theoretical and practical implications, as well as an acknowledgment of this study's limitations and recommendations for future research endeavors.

2. Theoretical Basis and Model Hypotheses

2.1. Model of Goal-Directed Behavior

The model of goal-directed behavior (MGB), formulated by Perugini and Bagozzi (2001) [17], serves as an extension of the Theory of Planned Behavior (TPB). The TPB posits that actual behavior is primarily influenced by behavioral intention, which is in turn shaped by three key factors: attitude, subjective norm, and perceived behavioral control (PBC) [18]. Although the TPB has been extensively applied across various contexts, it has been criticized for overlooking the influence of motivational, emotional, and habitual processes, which are essential for a comprehensive understanding of human behavior, as suggested by reference [19]. In response to these limitations, the MGB enhances the

TPB by incorporating additional constructs such as desire, anticipated emotions, and past behavior, thereby highlighting the significance of motivations, emotions, and habits in influencing human actions. Desire, defined as “a state of mind whereby an agent has a personal motivation to perform an action or to achieve a goal” [20] (p. 71), is identified as a predictor of behavioral intention and is pivotal within the MGB framework. Anticipated emotions, which encompass two dimensions—positive anticipated emotions and negative anticipated emotions—are also integral to the MGB. Positive anticipated emotions arise from the expectation of achieving a goal, while negative anticipated emotions stem from the fear of failing to achieve that goal. Both types of anticipated emotions serve to motivate individuals to engage in behaviors that facilitate goal attainment and mitigate the risk of failure [21]. Furthermore, past behavior, which reflects the frequency and recency of prior experiences, is considered a crucial determinant of both desire and behavioral intention [20].

The MGB has been recognized as more effective than the Theory of Planned Behavior (TPB) in terms of its predictive capabilities and explanatory strength [21,22]. Consequently, it has been extensively utilized to analyze various human behaviors, including gambling [23], tourism [24], and pro-environmental actions [25]. Scholars frequently enhance the MGB by incorporating additional significant variables into the original framework. For instance, reference [26] augmented the MGB by integrating belief constructs and other critical factors to investigate the post-purchase decision-making process. Furthermore, reference [27] expanded the MGB by introducing three moderating factors—problem awareness, affective commitment, and non-green alternative attractiveness—to explore the decision-making process within the context of museum visits.

In order to understand consumer EV adoption behavior, this study added PCE, which is instrumental in fostering pro-environmental behavior, as an additional element of the EMGB, complementing the original framework of the MGB.

2.2. Model Hypotheses

Building upon the preceding discussion, we propose a research model by extending the MGB to examine factors affecting EV adoption. The research model, along with its associated hypotheses, is illustrated in Figure 1.

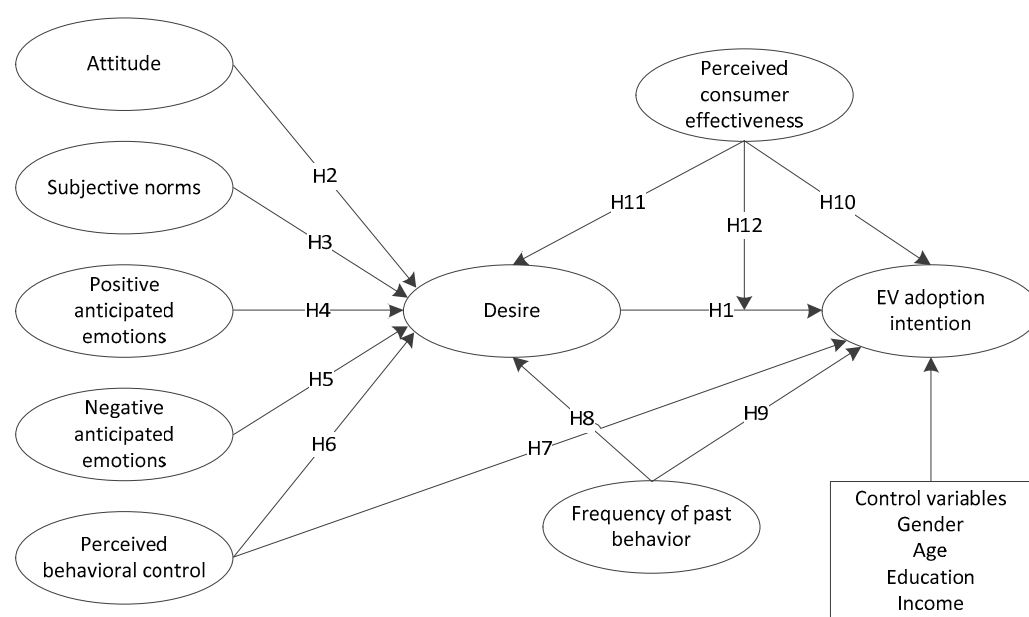


Figure 1. Research model.

2.2.1. Desire and EV Adoption Intention

Desire is considered a mental state of the motivation to implement particular behaviors or attain particular objectives [20]. It contains motivational content, which is often omitted

in past behavioral theories. A substantial body of research has indicated that desire plays a crucial role in shaping behavioral intentions. For example, according to reference [28], desire serves as a significant predictor of the behavioral intentions of attendees at the Boryeong Mud Festival. Reference [29] demonstrated that the desires of airline passengers have a positive effect on their willingness to engage in carbon-offset programs.

In this paper, desire refers to consumers having the motivation to adopt EVs for achieving the goal of environmental protection. If consumers have the desire to adopt EVs for environmental protection, they will have the impetus to perform the adoption behavior. In contrast, if consumers lack desire, they may be disinclined to adopt EVs due to the absence of a compelling incentive for such behavior. Therefore, we propose the following hypothesis:

H1. *The desire to adopt EVs for environmental protection positively influences EV adoption intention.*

2.2.2. Antecedents of Desire

(1) Attitude

Attitude refers to the extent to which an individual evaluates a specific behavior positively or negatively [18]. When individuals have a positive/negative evaluation of an action, they tend to have a favorable/unfavorable attitude toward the action. In the MGB, attitude serves as a significant precursor to desire, a relationship that has been substantiated by various studies. For instance, reference [30] demonstrated that attitude positively influenced desire in the context of intentions related to physical activity. Similarly, reference [31] found that the attitudes of older adults positively affected their desire to utilize mobile devices. Drawing from these prior investigations, we propose that if consumers evaluate the outcomes associated with EV adoption positively, they are likely to exhibit a strong desire to engage in this behavior. Conversely, if consumers hold a negative evaluation of the behavior, their desire to adopt EVs will likely be diminished. Therefore, we hypothesize the following:

H2. *Attitude positively influences the desire to adopt EVs.*

(2) Subjective norm

Subjective norm is conceptualized as the perceived social pressure an individual experiences based on the expectations of significant others [18]. The decision-making process regarding the performance of specific behaviors is notably affected by the views of individuals within one's social circle, including family, friends, and colleagues [32]. Empirical research has consistently demonstrated that subjective norm plays a crucial role in shaping an individual's desires. For instance, reference [33] found that subjective norm exerts a significant positive influence on an individual's inclination toward slow tourism. In a similar vein, the desire to adopt electric vehicles (EVs) may be enhanced when individuals perceive that their close associates wish or expect them to pursue EV adoption. Consequently, we propose the following hypothesis:

H3. *Subjective norm positively influences the desire to adopt EVs.*

(3) Anticipated emotions

Emotions are conceptualized as the mental states experienced by individuals as a result of their evaluations of events or thoughts [34]. Based on the valence of emotion, it can be classified into two dimensions: positive emotion and negative emotion [35]. Research has indicated that the inclusion of emotional variables can enhance the explanatory power of behavioral decision-making models [36], underscoring the significant influence of emotions on human behavior.

Anticipated emotions are defined as the pre-experiential positive or negative feelings associated with the potential outcomes of achieving or failing to achieve a goal. The MGB

posits that both positive and negative anticipated emotions serve as critical predictors of desire, as these emotions reflect the hedonic motivation to foster favorable outcomes while avoiding adverse ones [37]. Numerous empirical studies have corroborated the assertion that both positive and negative anticipated emotions exert a substantial positive impact on desire. For instance, reference [19] demonstrated a positive correlation between positive anticipated emotions and the desire to participate in the Oriental medicine festival. Similarly, reference [38] found that both positive and negative anticipated emotions significantly influence individuals' desire to engage in environmentally responsible travel via cruise options. Building upon the insights gleaned from prior research, we propose that consumers who experience positive or negative emotions in response to the success or failure of their goal to adopt EVs for environmental protection are more likely to express a desire to adopt such vehicles. Therefore, we hypothesize the following:

H4. *Positive anticipated emotion positively influences the desire to adopt EVs.*

H5. *Negative anticipated emotion positively influences the desire to adopt EVs.*

(4) Perceived behavioral control

Perceived behavioral control (PBC) is conceptualized as the extent to which an individual perceives the ease or difficulty associated with engaging in a particular behavior. In the context of EV adoption, PBC encompasses factors such as the affordability of EVs, the accessibility of maintenance services, and the operational simplicity of EVs. It is posited that PBC serves as a predictor of behavioral intention; specifically, a higher level of PBC correlates with a stronger intention to engage in the behavior [18]. Individuals who possess confidence or the requisite skills to undertake a specific action are more inclined to develop a corresponding behavioral intention. Numerous scholars have investigated the relationship between PBC and the intention to adopt EVs, consistently finding a positive correlation. For instance, reference [1] demonstrated that consumers who perceive greater control over the adoption of EVs exhibit stronger behavioral intentions compared to those with less perceived control.

Furthermore, the MGB posits that PBC can enhance an individual's desire [17]. A variety of studies have established a significant and positive association between PBC and desire. For example, reference [39] found that PBC positively affects the desire of bicycle travelers. Drawing on the empirical findings from prior research, we anticipate that consumers' motivation to adopt EVs for the purpose of environmental protection will be heightened when they perceive themselves as having adequate resources or capabilities to engage in the adoption behavior. Consequently, we propose the following hypotheses:

H6. *PBC positively influences the desire to adopt EVs.*

H7. *PBC positively influences EV adoption intention.*

(5) Frequency of past behavior

Frequency of past behavior (FPB) is widely regarded as an indicator of habit, which serves as a key theoretical variable highlighting the influence of previous actions [37]. Within the framework of the MGB, FPB is recognized as a significant predictor of both desire and behavioral intention [21]. Numerous empirical studies utilizing the MGB have demonstrated that individuals who consistently and habitually engage in a particular behavior exhibit heightened desire and intention to continue that behavior. For instance, reference [8] examined the water conservation behaviors of urban residents through a modified MGB, revealing that individuals who had frequently engaged in water conservation in the past were more inclined to express desire and intention toward such behaviors. Consequently, we posit that increased frequency of consumers' use of EVs will correlate

with a stronger desire to adopt EVs, thereby enhancing their intention to do so. Therefore, we hypothesize the following:

H8. *FPB positively influences the desire to adopt EVs.*

H9. *FPB positively influences EV adoption intention.*

(6) Perceived consumer effectiveness

Perceived consumer effectiveness (PCE) is conceptualized as the extent to which individuals believe they can contribute to the mitigation of environmental pollution [40]. It serves as an indicator of individuals' capacity to enhance environmental conditions [41]. A higher sense of PCE correlates with an increased consideration of the social ramifications of consumer behavior. PCE is posited to be a critical factor in elucidating pro-environmental behavior, as consumers who perceive their actions as effective in promoting environmental protection are more likely to engage in proactive measures.

Numerous studies have established PCE as a direct determinant of pro-environmental behavior. For instance, reference [42] demonstrated that PCE exerts a direct positive influence on consumers' ecologically conscious actions. Other research has indicated that PCE may have an indirect effect on pro-environmental behavior. For example, reference [43] proposed that the relationship between PCE and the consumption of environmentally sustainable textiles and apparel is mediated by attitudes and PBC. Similarly, reference [44] found that PCE indirectly affects the intention to adopt EVs through personal norms. Additionally, some studies have explored the moderating role of PCE in relation to other variables, including environmental attitudes [45], ethical concerns [46], and self-identity [47].

In the present study, PCE is defined as consumers' belief in their ability to mitigate the adverse effects of gasoline vehicles on the environment through the adoption of EVs. Building on prior research, we hypothesize that if consumers perceive that their adoption of EVs can contribute to environmental protection, they are likely to develop a desire for this behavior and an intention to engage in EV adoption. Furthermore, we propose that PCE may negatively moderate the relationship between desire and EV adoption. This relationship is predicated on the notion that adoption behavior is motivated by individual incentives. However, the environmental characteristics of EVs may instill a sense of moral obligation in consumers to adopt such vehicles. Consequently, PCE may diminish the necessity for motivation, as consumers might choose to adopt EVs in response to internal moral imperatives. Thus, we hypothesize the following:

H10. *PCE positively influences the desire to adopt EVs.*

H11. *PCE positively influences EV adoption intention.*

H12. *PCE negatively moderates the effect of desire on EV adoption intention.*

3. Methodology

3.1. Measurement Development

In this study, all constructs were assessed using multiple items to enhance measurement validity. The majority of these items were adapted from the existing literature. Specifically, items related to EV adoption intention were derived from the reference [48]. Items measuring desire were adapted from reference [17,38], while those assessing attitude were sourced from reference [48,49]. The subjective norm items were adapted from reference [50], and items for positive and negative anticipated emotions were taken from reference [17,23]. Furthermore, items for PBC were adapted from reference [8,50], while items for FPB were sourced from reference [17]. Lastly, items for PCE were adapted from reference [51].

Given that the original items were in English, a back-translation method was employed to develop the questionnaire. Initially, a native Chinese researcher translated the items into Chinese, followed by a second researcher who translated them back into English. The first Chinese version of the questionnaire was established by comparing the two English versions. Prior to the formal survey, two researchers specializing in EV adoption and three EV consumers were consulted to review the questionnaire, leading to refinements based on their feedback. A pilot study involving 65 respondents was conducted to identify any ambiguities in wording and format, as well as to assess the reliability and validity of the scale. Minor adjustments were made in response to the feedback received from the pilot study participants. The final scales are detailed in Appendix A, with all items measured using seven-point Likert scales ranging from strongly disagree (1) to strongly agree (7).

3.2. Data Collection

An online survey was conducted utilizing the Wenjuanxing platform (<http://www.sojump.com/>, (accessed on 14 February 2021)) to gather data for this study. Wenjuanxing is recognized as a leading platform for online questionnaires, boasting over 2.6 million sample resources, with an average of more than 1 million active users daily who are randomly invited to participate in surveys. We provided a hyperlink to our questionnaire on the Wenjuanxing website and specifically invited individuals knowledgeable about EVs to partake in the survey. Participants were incentivized with the possibility of receiving a monetary reward for their involvement.

A total of 500 questionnaires were distributed, and all returned responses were meticulously examined. After excluding responses that were incomplete, exhibited uniform answers across all questions, were completed in an unusually short time frame, or were submitted by individuals lacking knowledge about EVs, we eliminated 102 invalid responses. Consequently, we obtained 398 valid responses, resulting in an effective response rate of 79.6%. Table 1 presents the demographic characteristics of the sample. Approximately 55.3% of the respondents identified as male, while 44.7% identified as female. According to data from China's seventh national population census, the male population is approximately 723.34 million, representing 51.24%, and the female population is approximately 688.44 million, accounting for 48.76% [52]. Overall, the demographic profile of the sample aligns closely with the actual population distribution in China. Notably, 59.3% of respondents were aged between 26 and 40 years. Additionally, more than half of the respondents reported a monthly income exceeding CNY 5000 (approximately USD 730), and the majority possessed a high level of education.

Table 1. Sample demographics.

Measure	Item	Count	Percentage (%)
Gender	Male	220	55.3
	Female	178	44.7
Age	<18	7	1.8
	18–25	94	23.6
	26–30	93	23.4
	31–40	143	35.9
	>40	61	15.3
Personal monthly income	<CNY 1000	41	10.3
	CNY 1000–CNY 5000	118	29.6
	CNY 5000–CNY 10,000	166	41.7
	>CNY 10,000	73	18.3
Education	High school or below	34	8.5
	Two-year college	81	20.4
	Four-year college	252	63.3

Table 1. Cont.

Measure	Item	Count	Percentage (%)
Occupation	Graduate school or above	31	7.8
	Student	37	9.3
	Corporation employee	286	71.9
	Others	75	18.8

3.3. Common Method Variance

The data utilized in this study were self-reported and derived from a single source, which raises the potential issue of common method variance, attributed to the measurement approach rather than the constructs represented by the measures. To address this concern, we employed two methodologies to assess common method bias.

Initially, we conducted Harman's one-factor test by inputting all constructs into an unrotated principal component analysis and analyzing the resulting variance, following the guidelines established by reference [53,54]. If the variance explained by the first factor does not constitute a majority of the total variance, it can be inferred that common method variance is not a significant issue. Our findings revealed the extraction of nine factors, which collectively accounted for 77.97% of the variance, with the most prominent factor explaining 41.86% of the total variance. This result indicates that common method variance does not pose a substantial concern in our study.

Secondly, we applied the method proposed by reference [55] to evaluate common method bias within the context of partial least squares (PLSs). In accordance with reference [55], we introduced a common method factor that encompassed all indicators of the principal variables in the model, subsequently calculating the variance explained by both the method and the principal constructs. When the loadings of the method factor are found to be insignificant and the substantive variances in the indicators are significantly greater than their method variances, the likelihood of common method bias being a serious issue is diminished. As illustrated in Table 2, the ratio of the average substantive variance in the indicators (0.761) to the average method-based variance (0.005) was approximately 152:1. Furthermore, the majority of the loadings associated with the common method factor were not statistically significant. Given the minimal magnitude and insignificance of the method variance, we conclude that common method bias does not represent a significant problem in our research.

Table 2. Common method bias analysis.

Construct	Indicator	Substantive Factor Loading (R_1)	R_1^2	Method Factor Loading (R_2)	R_2^2
Attitude	ATT1	0.961 ***	0.924	−0.109 *	0.012
	ATT2	0.739 ***	0.546	0.170 ***	0.029
	ATT3	0.937 ***	0.878	−0.063	0.004
Desire	DES1	0.945 ***	0.893	−0.080	0.006
	DES2	0.773 ***	0.598	0.124 *	0.015
	DES3	0.913 ***	0.834	−0.048	0.002
Frequency of past behavior	FPB1	0.890 ***	0.792	0.006	0.000
	FPB2	0.892 ***	0.796	−0.006	0.000
Negative anticipated emotions	NAE1	0.937 ***	0.878	−0.057	0.003
	NAE2	0.879 ***	0.773	0.037	0.001
	NAE3	0.922 ***	0.850	−0.024	0.001
	NAE4	0.860 ***	0.740	0.042	0.002
Positive anticipated emotions	PAE1	0.902 ***	0.814	−0.015	0.000
	PAE2	0.920 ***	0.846	−0.014	0.000
	PAE3	0.869 ***	0.755	0.002	0.000
	PAE4	0.831 ***	0.691	0.028	0.001

Table 2. Cont.

Construct	Indicator	Substantive Factor Loading (R_1)	R_1^2	Method Factor Loading (R_2)	R_2^2
Perceived behavioral control	PBC1	0.833 ***	0.694	−0.049	0.002
	PBC2	0.817 ***	0.667	−0.005	0.000
	PBC3	0.723 ***	0.523	0.057	0.003
Perceived consumer effectiveness	PCE1	1.011 ***	1.022	−0.136 ***	0.018
	PCE2	0.713 ***	0.508	0.112 *	0.013
	PCE3	0.709 ***	0.503	0.134 **	0.018
	PCE4	0.991 ***	0.982	−0.090 **	0.008
EV adoption intention	AI1	0.889 ***	0.790	−0.020	0.000
	AI2	0.930 ***	0.865	−0.024	0.001
	AI3	0.878 ***	0.771	0.043	0.002
Subjective norm	SN1	0.860 ***	0.740	0.033	0.001
	SN2	0.822 ***	0.676	−0.017	0.000
	SN3	0.853 ***	0.728	−0.018	0.000
Average		0.869	0.761	0.000	0.005

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4. Data Analysis and Result

In this section, structural equation modeling (SEM) was employed to assess both the measurement and structural models utilizing partial least squares (PLSs) methodology. Adhering to the conventional two-step procedure proposed by reference [56], we initially examined the measurement model before proceeding to evaluate the structural model using SmartPLS (version 3.0).

4.1. Measurement Model Test

We performed analyses to assess the reliability and validity of the measurement model. As presented in Table 3, the factor loadings for all items exceeded the threshold of 0.7. Additionally, all Cronbach's alpha coefficients and composite reliabilities (CRs) were above 0.7, signifying strong reliability of the scales, as suggested by reference [57]. Furthermore, the average variance extracted (AVE) for each construct was substantially greater than 0.5, demonstrating robust convergent validity of the scales, in accordance with the criteria established by reference [58].

Table 3. Scale properties.

Construct	Item	Loading	Cronbach's Alpha	CR	AVE
ATT	ATT1	0.865	0.852	0.910	0.771
	ATT2	0.883			
	ATT3	0.886			
DES	DES1	0.873	0.848	0.908	0.767
	DES2	0.883			
	DES3	0.872			
FPB	FPB1	0.853	0.739	0.882	0.790
	FPB2	0.923			
NAE	NAE1	0.885	0.921	0.944	0.808
	NAE2	0.909			
	NAE3	0.903			
	NAE4	0.899			
PAE	PAE1	0.886	0.904	0.933	0.776
	PAE2	0.909			
	PAE3	0.871			
	PAE4	0.858			

Table 3. Cont.

Construct	Item	Loading	Cronbach's Alpha	CR	AVE
PBC	PBC1	0.794	0.702	0.834	0.626
	PBC2	0.801			
	PBC3	0.779			
PCE	PCE1	0.881	0.883	0.919	0.740
	PCE2	0.823			
	PCE3	0.835			
	PCE4	0.899			
AI	AI1	0.875	0.881	0.927	0.808
	AI2	0.910			
	AI3	0.911			
SN	SN1	0.880	0.799	0.882	0.713
	SN2	0.800			
	SN3	0.852			

Discriminant validity assesses whether two factors are statistically distinct, as articulated by reference [59,60]. In this study, we evaluated discriminant validity by comparing the square roots of the average variance extracted (AVE) with the inter-construct correlation coefficients. The results presented in Table 4 indicate that the square roots of the AVEs for all constructs exceeded their respective inter-construct correlation coefficients, thereby suggesting that the scale demonstrates robust discriminant validity.

Table 4. Factor correlation coefficients and square roots of AVE.

	ATT	DES	FPB	NAE	PAE	PBC	PCE	AI	SN
ATT	0.878								
DES	0.787	0.876							
FPB	0.122	0.136	0.889						
NAE	0.450	0.524	−0.037	0.899					
PAE	0.707	0.699	0.050	0.583	0.881				
PBC	0.399	0.374	0.058	0.208	0.433	0.791			
PCE	0.625	0.637	0.109	0.420	0.610	0.386	0.860		
AI	0.507	0.566	−0.095	0.561	0.562	0.318	0.454	0.899	
SN	0.532	0.590	0.007	0.590	0.587	0.293	0.481	0.612	0.845

Furthermore, the standardized root mean square residual (SRMR), which quantifies the square root of the sum of the squared discrepancies between the model-implied and empirical correlation matrices, serves as a criterion for model fit in partial least squares (PLSs) path modeling [61]. Reference [61] stipulate that an SRMR value below 0.08 signifies an acceptable model fit. As illustrated in Table 5, the SRMR values for both the saturated model (0.048) and the estimated model (0.062) are below the threshold of 0.08, indicating a favorable fit between the proposed research model and the empirical data.

Table 5. Result of model fit.

Fit Summary	Saturated Model	Estimated Model
SRMR	0.048	0.062
d_ULS	1.300	2.152
d_G	1.271	1.319

4.2. Structural Model Test

A bootstrap analysis comprising 5,000 resamples was conducted to execute a path analysis, with the findings presented in Figure 2 and Table 6. As anticipated, the variables of desire ($\beta = 0.465$, $p < 0.001$), PBC ($\beta = 0.092$, $p < 0.05$), and PCE ($\beta = 0.12$, $p < 0.05$) demonstrated a positive influence on the intention to adopt EVs, thereby corroborating

hypotheses H1, H7, and H11. Among the seven antecedents of desire, five were supported. Specifically, the constructs of attitude ($\beta = 0.481, p < 0.001$), subjective norm ($\beta = 0.127, p < 0.01$), positive anticipated emotions ($\beta = 0.134, p < 0.05$), negative anticipated emotions ($\beta = 0.094, p < 0.05$), and PCE ($\beta = 0.144, p < 0.05$) exhibited positive correlations with desire, collectively accounting for 69.9% of its variance. Consequently, these results validated hypotheses H2, H3, H4, H5, and H10. Conversely, the variable of FPB was found to have a negative relationship with EV adoption intention ($\beta = -0.167, p < 0.001$), thus failing to support hypothesis H9. Furthermore, the impacts of PBC ($\beta = 0.099, p > 0.05$) and FPB ($\beta = 0.056, p > 0.05$) on desire were not statistically significant, leading to the rejection of hypotheses H6 and H8. The overall model accounted for 38.7% of the variance in EV adoption intention. Additionally, an examination of four control variables—gender, age, income, and education—revealed no significant effects on EV adoption.

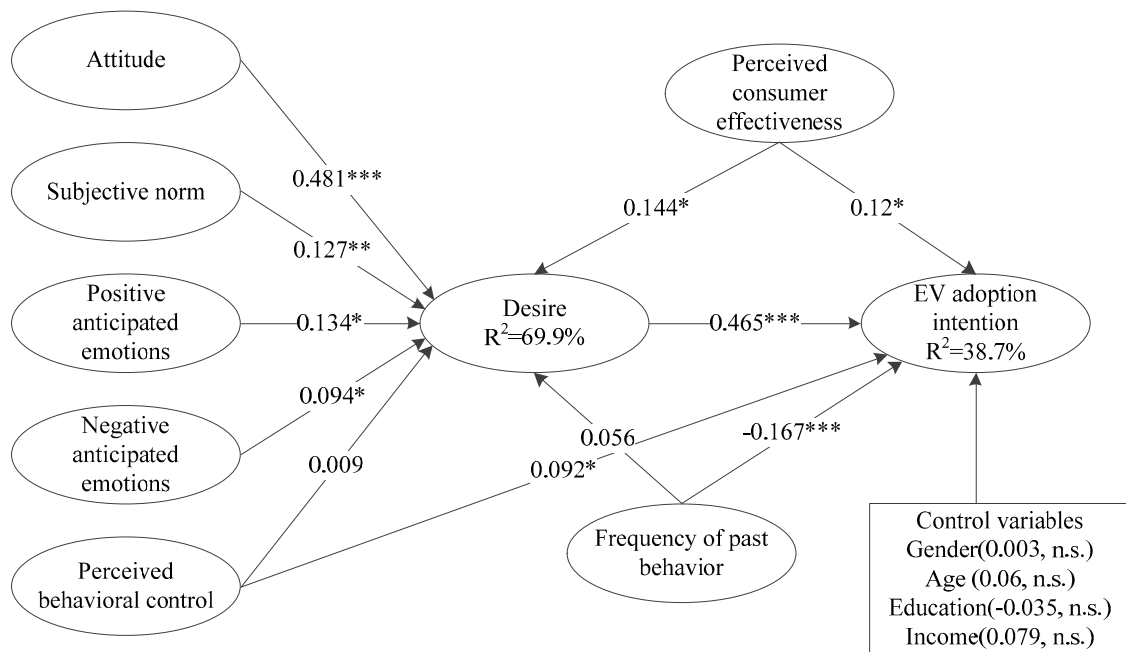


Figure 2. The testing results of the research model. Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 6. Summary of hypothesis testing results.

Hypothesis	Coefficient	Supporting
H1: Desire→EV adoption intention	0.465 ***	Yes
H2: Attitude→desire	0.481 ***	Yes
H3: Subjective norm→desire	0.127 **	Yes
H4: Positive anticipated emotions→desire	0.134 *	Yes
H5: Negative anticipated emotions→desire	0.094 *	Yes
H6: PBC→desire	0.009	No
H7: PBC→EV adoption intention	0.092 *	Yes
H8: FPB→desire	0.056	No
H9: FPB→EV adoption intention	−0.167	No
H10: PCE→desire	0.144 *	Yes
H11: PCE→EV adoption intention	0.12 *	Yes

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

To investigate the moderating effect of PCE within the proposed model, the complete sample was stratified into two groups based on the mean score of the latent variable PCE, as outlined by reference [62]. The high-PCE group comprised 216 cases, while the low-PCE group included 182 cases. Subsequently, a comparative analysis was performed to assess the differences in the strength of path coefficients between desire and EV adoption intention

for each group. The findings presented in Table 7 indicate that the influence of desire on EV adoption intention is more pronounced among individuals with a low level of PCE ($\beta = 0.516$, $p < 0.001$) compared to those with a high level of PCE ($\beta = 0.437$, $p < 0.001$). Consequently, Hypothesis 12 is supported.

Table 7. Results of moderation effect analysis for PCE.

Constructs N = 398	PCE = Low R ² = 34.1% (n = 216)		PCE = High R ² = 32.9% (n = 182)		Statistical Comparison of Paths t-Value
	Standardized Path Coefficient	t-Value	Standardized Path Coefficient	t-Value	
DES→AI	0.516 ***	13.478	0.439 ***	9.730	18.894

Note: *** $p < 0.001$.

In order to gain a deeper understanding of this study, we analyzed the mediation effects within the research model by employing the bootstrap testing procedures as outlined by reference [63]. According to their framework, the primary criterion for establishing mediation is the significance of the indirect effect, which is determined by whether the confidence interval excludes zero. If the confidence interval does not encompass zero, it indicates that the indirect effect is significant, thereby suggesting the presence of a mediation effect. The nature of the mediation effect is assessed as follows: if both the indirect and direct effects are significant, the mediation is classified as partial; conversely, if the indirect effect is significant while the direct effect is not, the mediation is considered full. As presented in Table 8, all confidence intervals, with the exception of that for FPB, do not include zero. This finding indicates that all indirect effects were significant at the 95% confidence level, with the sole exception of the indirect effect of FPB on the intention to adopt EVs. Consequently, this implies that apart from FPB, desire serves as a mediator in the relationships between its antecedents and EV adoption behavior. Furthermore, the direct effect of attitude on the intention to adopt EVs was found to be non-significant, suggesting a full mediation effect of desire in this relationship.

Table 8. Bootstrapping analysis for the mediation effects of desire.

IV	M	DV	Direct Effect	Indirect Effect	95% (CI)	Mediating Effect
ATT	DES	AI	0.115	0.247	[0.153, 0.350]	Full
SN	DES	AI	0.385 ***	0.104	[0.063, 0.151]	Partial
PAE	DES	AI	0.284 ***	0.159	[0.098, 0.233]	Partial
NAE	DES	AI	0.343 ***	0.099	[0.061, 0.150]	Partial
PBC	DES	AI	0.091 *	0.075	[0.032, 0.123]	Partial
FPB	DES	AI	−0.167 ***	0.027	[−0.083, 0.070]	No
PCE	DES	AI	0.120 *	0.267	[0.194, 0.351]	Partial

Note: CI = confidence interval; 5000 bootstrap samples. * $p < 0.05$; *** $p < 0.001$.

5. Discussion and Implications

5.1. Interpretation of Results

This study developed an extended MGB model that integrated PCE into the MGB to understand consumers' behavioral intentions regarding the adoption of EVs. The major findings are discussed below.

First, the results of our study show that all antecedents in the MGB are significantly associated with the behavioral intention to adopt EVs. Specifically, the desire was identified as having a notably positive impact on consumers' intentions to adopt EVs (H1). This result is consistent with previous research, which posits that desire is a critical predictor of individuals' behavioral intentions [23]. Furthermore, desire was established as a significant mediator, influencing the effects of all antecedents in the MGB on EV adoption intention,

with the exception of FPB. This finding corroborates the existing literature indicating that attitude, subjective norm, anticipated emotions (both positive and negative), and PBC exert an indirect influence on behavioral intention through desire [17,24]. Additionally, both PBC and FPB were found to have direct effects on consumers' intentions to adopt EVs, albeit with differing outcomes. The effect of PBC was positive (H7), aligning with prior studies that suggest PBC enhances an individual's behavioral intention [19]. In contrast, the effect of FPB was negative, which diverges from the findings of reference [25] (H8). A high frequency of past behavior implies more experience with EVs; from the perspective of consumers' EV experience, consumers with no EV experience are more likely to be anxious, while a satisfying and enjoyable EV experience encourages consumers' continued usage [64]. After EV experience, the perception of vehicle attributes and the symbolic meaning of EVs will affect consumers' decision; consumers will choose EVs that are consistent with their identity [65,66]. This suggests that a high frequency of past behavior has a negative effect on adoption if it does not lead to a positive experience. This means that if the relevant technologies of EVs are not mature enough, consumers who have often used EVs are more likely to recognize the disadvantages of using EVs, such as limited cruising range and inconvenient charging, which prevents consumers from adopting EVs.

Second, four of the six antecedents of desire within the MGB were identified as having a significant effect on it. Specifically, two of the three cognitive factors (attitude and subjective norm) positively influence consumers' desire to adopt EVs (H2 and H3). These findings are consistent with the existing literature, which posits that both attitude and subjective norm are critical components in the development of desire [38]. Additionally, two emotional factors—positive and negative anticipated emotions—were also shown to positively affect the desire for EV adoption (H4 and H5), corroborating previous research that suggests the formation of desire is significantly influenced by both positive and negative anticipated emotions [27]. However, unlike the findings of reference [33], the effects of PBC and the habitual factor (FPB) on desire were not significant. This might be because the activation of motivation to achieve the goal of environmental protection depends on the environmental attributes of EVs. Consumers whose environmental awareness is weak might not form the desire to adopt EVs, which is the motivational process, even if they have abilities to afford EVs and feel that it is easy to operate and maintain an EV, or frequently use EVs.

Third, the role of PCE was identified to be significant in pro-environmental behavior. The significance of PCE in influencing pro-environmental behavior has been established. Our findings indicate that PCE exerts a direct positive influence on the intention to adopt EVs (H11), aligning with previous research that identifies PCE as a critical predictor of pro-environmental behavior [67]. Additionally, we discovered that PCE indirectly affects the intention to adopt EVs through the mediating variable of desire (H10). This may be attributed to the environmental attributes serving as a motivating factor for EV adoption. Consumers with elevated levels of PCE are more adept at recognizing the effectiveness of their adoption behaviors in contributing to environmental protection, thereby increasing their propensity to develop a desire for EVs. Notably, PCE was found to negatively moderate the relationship between desire and EV adoption behavior (H12). This suggests that the correlation between desire and behavioral intention is diminished among consumers with a high PCE compared to those with lower levels. This phenomenon may be explained by the tendency of PCE to activate individuals' moral norms regarding EV adoption, which can steer them toward pro-environmental actions [44]. Consequently, a heightened level of PCE may diminish the significance of desire in the adoption process, as consumers may choose to adopt EVs based on their intrinsic moral values and internalized beliefs.

5.2. Research Implications

5.2.1. Theoretical Implications

This study presents several noteworthy theoretical contributions regarding consumer adoption of EVs. Firstly, in contrast to previous studies that predominantly concentrated on cognitive factors derived from the TPB [8], this investigation integrates cognitive,

motivational, emotional, and habitual elements into a comprehensive framework informed by the MGB. While the existing literature has explored the individual effects of these factors on EV adoption, few studies have synthesized them into a singular model. This integrative approach enhances the current understanding of consumer behavior related to EVs and facilitates an examination of the combined effects of these factors on consumers' intentions to adopt EVs. The findings indicate that all components of the MGB significantly influence behavioral intention, with the motivational factor of desire emerging as a crucial predictor of EV adoption, mediating the effects of cognitive and emotional factors on behavioral intention.

Secondly, this study proposes an extended version of the MGB to elucidate intentions to adopt EVs. Although the original MGB encompasses a wide range of factors, it overlooks the significance of PCE in pro-environmental behaviors. Consequently, this study enhances the MGB by incorporating PCE as a precursor within the model, thereby enriching the understanding of consumer intentions to adopt EVs. The results reveal that PCE exerts a direct positive influence on consumers' intentions to adopt EVs and can also indirectly affect behavioral intention through desire. This finding further reinforces the importance of PCE in the context of pro-environmental behavior.

Lastly, the present study investigates the boundary conditions surrounding the influence of desire on intentions to adopt EVs. Previous research has indicated that the relationship between desire and behavioral intention may be moderated by various factors (e.g., reference [27]). This study specifically examines the moderating effect of PCE on the relationship between desire and EV adoption intention, given that the moderating role of PCE has been previously identified (e.g., reference [68]). The results suggest that when consumers exhibit a high level of PCE, the effect of desire on their behavioral intention diminishes. This finding enhances our comprehension of the interplay between PCE, desire, and pro-environmental behavior.

5.2.2. Practical Implications

This study presents several practical implications for the promotion of EV adoption. Firstly, it underscores the critical role of consumer desire in the intention to adopt EVs. Both governmental bodies and enterprises should acknowledge the significance of fostering consumer desire in the development of EVs and implement strategies to facilitate this desire. When consumers cultivate a desire to adopt EVs, they are more likely to engage in this behavior due to intrinsic motivation.

Secondly, the findings of this study provide guidance for stakeholders in stimulating consumer desire, as the positive influences of attitude, subjective norms, anticipated emotions (both positive and negative), and PBC on desire have been established. Specifically, stakeholders can enhance consumer attitudes toward EVs by effectively communicating their attributes, performance, utility, and associated benefits [69]. Utilizing social media platforms to highlight the advantages of EVs—such as environmental benefits, technological sophistication, and cost-effectiveness—can improve consumer perceptions and evaluations. Consumers who develop a positive attitude toward EVs are more likely to cultivate a desire to adopt them. Furthermore, with the rise of the internet as a marketing tool, stakeholders can identify key referents within social networking sites to foster favorable perceptions of EVs and encourage positive discourse while mitigating negative feedback. Additionally, the emotional aspect of EV promotion should not be overlooked; stakeholders should provide information that effectively elicits consumer emotions in advertising campaigns [70]. Tailoring advertising strategies to accommodate the diverse preferences of consumers is essential. Marketers may also leverage endorser appeal in their communication strategies to activate subjective norms that subsequently enhance the desire for EVs. Moreover, stakeholders should emphasize the environmental benefits of EV adoption, such as reductions in fossil fuel consumption and carbon emissions, to persuade consumers that their choices can contribute to environmental protection.

Thirdly, the significant positive relationship between PBC and EV adoption suggests that barriers to adoption must be addressed. Stakeholders could consider reducing the purchase price of EVs through subsidies, enhancing battery range to meet consumer travel requirements, and expanding charging infrastructure. Advertising efforts should aim to bolster consumer confidence in their ability to utilize and control EVs [71]. Notably, the findings related to frequency of past EV use indicate that consumers with prior experience may be more acutely aware of the barriers to adoption, leading to unfavorable experiences that deter future adoption. Therefore, stakeholders must implement effective strategies to enhance consumers' positive experiences with EVs.

Finally, the moderating role of PCE in the relationship between desire and EV adoption intention suggests the necessity for differentiated marketing strategies tailored to various target demographics. Stakeholders could employ personalization and recommendation features to deliver tailored information about EVs to consumers. For instance, consumers with lower levels of PCE may be more inclined to adopt EVs compared to those with higher levels; thus, stakeholders should focus on conveying information that fosters motivation for adoption among this group. Additionally, policymakers could demonstrate to EV consumers the personal environmental benefits they can achieve, thereby enhancing their PCE.

5.3. Limitations and Future Research

This study presents several limitations that warrant consideration in subsequent investigations. Firstly, similar to the biases commonly associated with web survey-based research, our sample does not encompass consumers who lack internet access. Future research endeavors could benefit from incorporating both online and offline data collection methods to reassess our research model and findings. Secondly, the data for this study were exclusively gathered from China, which may render our results contextually specific to that region. Given the significant cultural disparities between China and other nations, particularly those in the Western context, caution is advised when attempting to generalize these findings. Future studies should aim to extend our model to different countries to bolster external validity. Thirdly, the explained variance in the dependent variable in this study is 38.7%, indicating that additional factors influencing the intention to adopt EVs remain unidentified. Future research should investigate further constructs that are essential for comprehending consumers' behavioral intentions regarding EV adoption. Lastly, our study encompasses all categories of EVs; therefore, future research may benefit from analyzing the results with a focus on specific types of EVs.

6. Conclusions

In this study, we constructed a theoretical model that incorporates perceived consumer effectiveness (PCE) within the framework of the model of goal-directed behavior (MGB) to elucidate consumer intentions regarding electric vehicle (EV) adoption. The current study investigated the effects of PCE alongside various components of the MGB on consumer intention to adopt EVs. The components of the MGB examined include motivational factors (desire), cognitive factors (attitude, subjective norm, and perceived behavioral control [PBC]), emotional factors (anticipated positive and negative emotions), and habitual factors (frequency of past behavior [FPB]). Our findings indicate that desire significantly influences consumers' intentions to adopt EVs, with this relationship being moderated by PCE. Furthermore, both PBC and PCE positively affect consumer intention to adopt EVs, whereas FPB negatively impacts this intention. Additionally, cognitive and emotional factors were found to exert an indirect influence on behavioral intention through the mediating role of desire.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/wevj15090386/s1>.

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Data Availability Statement: The original contributions presented in the study are included in the article/Supplementary Materials, further inquiries can be directed to the corresponding author/s.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Scale

Construct		Items
Attitude [48,49]	ATT1	I like the idea of buying/driving an electric car
	ATT2	Buying/driving an electric car is a good idea
	ATT3	I have a good attitude towards buying/driving an electric car
Desire [17,38]	DES1	I desire to purchase/adopt electric vehicles in the future to protect the environment
	DES2	My desire for purchasing/adopting electric vehicles in the future to protect the environment is very strong
	DES3	I want to purchase/adopt electric vehicles in the future to protect the environment
Frequency of past behavior [17]	FPB1	How often did you drive electric vehicles during the past year?
	FPB2	How often did you drive electric vehicles during the past month?
Negative anticipated emotions [17,23]	NAE1	If I buy a gasoline car instead of an eco-friendly electric car, I will be angry
	NAE2	If I buy a gasoline car instead of an eco-friendly electric car, I will be disappointed
	NAE3	If I buy a gasoline car instead of an eco-friendly electric car, I will be worried
	NAE4	If I buy a gasoline car instead of an eco-friendly electric car, I will be guilty
Positive anticipated emotions [17,23]	PAE1	If I buy an eco-friendly electric car, I will be excited
	PAE2	If I buy an eco-friendly electric car, I will be glad
	PAE3	If I buy an eco-friendly electric car, I will be satisfied
	PAE4	If I buy an eco-friendly electric car, I will be proud
Perceived behavioral control [8,50]	PBC1	The price of an EV is important to me, and I can afford it when I decide to adopt
	PBC2	I am confident that it is easy to maintain and operate an EV
	PBC3	EV will accommodate my travel needs even with the limited battery range
Perceived consumer effectiveness [51]	PCE1	Each person's behavior can have a positive effect on society by buying/purchasing an electric car
	PCE2	I feel I can help solve natural resource problem by buying/driving an electric car
	PCE3	I can protect the environment by buying/driving an electric car
	PCE4	There is not much that I can do about the environment (Reverse)

Construct		Items
EV adoption intention [48]	AI1	Next time I buy a car, I will consider buying an eco-friendly electric car
	AI2	I expect to drive an eco-friendly electric car soon
	AI3	I have the intention to drive an eco-friendly electric car soon
Subjective norm [50]	SN1	Some people who are important to me think I should purchase an EV
	SN2	I feel some social pressure to purchase an electric vehicle
	SN3	People who are close to me think that it is important to consider the environment when I purchase a vehicle

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