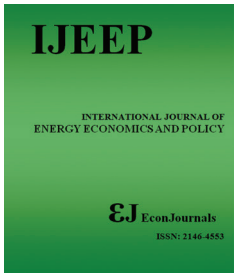

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(1), 517-523.

Investigating Individual's Energy Saving Behavior in Using Electric Vehicles: Extended Theory of Planned Behavior

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Received: 27 September 2023 **Accepted:** 29 December 2023 **DOI:** https://doi.org/10.32479/ijeep.15478

ABSTRACT

The rapid climate change and its negative impacts have garnered global attention towards carbon emission mitigation efforts. The use of electric vehicles and individual energy-saving behaviors plays a crucial role in reducing carbon emissions from the transportation sector. The aim of this research is to analyze the influence of individual attitudes towards behavior, subjective norms, and perceived behavioral control on the intention and behavior of energy-saving, particularly in the context of electric vehicle usage. This study employs a quantitative approach and a survey method using a Likert-scale questionnaire. The sample of respondents consists of electric vehicle users selected through random sampling. Data was collected through questionnaires with a scale ranging from 1 to 5, and a total of 313 samples were used for analysis. Data analysis was conducted using Structural Equation Model (SEM) with the assistance of SmartPLS 4 software. The results of the analysis indicate that an individual's attitude towards behavior plays a significant role in influencing the intention and behavior of energy-saving. Perceived behavioral control also directly influences energy-saving behavior. However, subjective norms do not have a significant impact on intention and energy-saving behavior. These findings suggest that to promote individual energy-saving behavior, there should be an emphasis on cultivating positive attitudes towards energy-saving practices and factors affecting behavioral control. This research provides valuable insights into the factors influencing individual energy-saving behavior in the context of electric vehicle usage. With a better understanding of these factors, we can contribute to global efforts to reduce carbon emissions and mitigate climate change.

Keywords: Attitude towards Behavior, Electric Vehicles, Perceived Behavioral Control, Intention, Energy Saving Behavior
JEL Classifications: Q42, O18, D12

1. INTRODUCTION

The primary cause of climate change is the increase in carbon dioxide (CO_2) and greenhouse gas emissions. CO_2 emissions, primarily from the burning of fossil fuels such as coal, oil, and natural gas, are the major drivers of global climate change (Mikhaylov et al., 2020; Yoro and Daramola, 2020). Conventional internal combustion engine vehicles are one of the largest contributors to carbon emissions. These vehicles produce emissions through the combustion of fossil fuels when the engine operates (Towoju and Ishola, 2020). The rising concentration of carbon emissions contributes to the greenhouse effect, leading to global temperature increases and widespread climate change with serious environmental consequences (Verma et al., 2022). Given the increasingly evident and threatening impacts of climate change, it is essential to reduce carbon emissions by adopting policies and actions to reduce dependence on fossil fuels, enhance energy efficiency, and promote the use of renewable energy sources (Kawamoto et al., 2019; Cardoso et al., 2021).

Energy-saving behavior is a key element in efforts to reduce carbon emissions and mitigate climate change. Energy-saving behavior involves actions aimed at reducing energy consumption that has the potential to generate carbon emissions (Jakučionytė-Skodienė et al., 2020). Therefore, choosing more energy-efficient vehicles like electric vehicles (EVs) is one action that can reduce carbon

emissions in the transportation sector. Electric vehicles replace internal combustion engines with electric motors powered by batteries (Ghosh, 2020; Carrus et al., 2021; Yu et al., 2021). In addition to directly reducing carbon emissions during operation, electric vehicles also have the potential to reduce dependence on fossil fuels as power can be sourced from renewable energy sources such as solar and wind energy. The use of electric vehicles can also reduce urban air pollution, help maintain better air quality, and support environmental sustainability (Küfeoğlu and Hong, 2020; Costa et al., 2021).

The Theory of Planned Behavior is a theoretical framework commonly used in behavioral research. In the Theory of Planned Behavior, an individual's behavior can be predicted by their intention to perform that behavior, influenced by three main factors: attitude towards behavior, subjective norms, and perceived behavioral control (Ajzen, 2020). The use of the Theory of Planned Behavior is to analyze the factors influencing an individual's intention to adopt electric vehicles (Purwanto et al., 2022). Understanding attitudes, social norms, and perceived behavioral control can assist in designing effective strategies to encourage electric vehicle adoption, which, in turn, will contribute to carbon emission reduction and climate change mitigation (Ghosh, 2020). Thus, this study aims to analyze individual energy-saving behavior in using electric vehicles using the framework of the Theory of Planned Behavior. Electric vehicles are considered a crucial solution in reducing greenhouse gas emissions and mitigating climate change. However, many individuals have not yet switched to electric vehicles. Therefore, it is important to understand the factors influencing individual energy-saving behavior in using electric vehicles, focusing on the three main variables in the Theory of Planned Behavior: attitude towards behavior, subjective norms, and perceived behavioral control.

2. LITERATURE REVIEW

2.1. Theory of Planned Behavior

In the Theory of Planned Behavior, the role of perceived behavioral control is one of the essential aspects in understanding individual behavior. Ajzen (2020) divides perceived behavioral control into two main factors, namely self-efficacy and facilitating conditions. Self-efficacy refers to an individual's belief in their ability to perform a specific behavior, while facilitating conditions refer to the environment and external factors that can ease or hinder that action. Ngafeeson and Gautam (2021) consider self-efficacy as an intrinsic factor that facilitates external conditions. This means that an individual's belief in their ability to take specific actions can influence how they respond to external conditions. This reflects the view that self-efficacy is a crucial component of perceived behavioral control. Yuriev et al. (2020) interpret perceived behavioral control as a form of self-efficacy. This implies that regardless of how individuals perceive control or capability to perform a specific action, it can also be considered their self-efficacy level in the context of behavior change. Sun (2020) interprets perceived behavioral control as a definition of facilitating conditions in an interpersonal behavior model. This indicates that external factors that support or hinder behavior can also be included in the concept of perceived behavioral control.

Theory of Planned Behavior is a psychological framework that is highly useful for understanding individual behavior in various contexts, including efforts to reduce carbon emissions and mitigate climate change (Tan et al., 2022). This theory emphasizes three main factors that influence a person's behavior: attitude toward the behavior, subjective norms, and perceived behavioral control. Attitude toward the behavior refers to an individual's view of the use of electric vehicles. Individuals who have a positive attitude toward electric vehicles, seeing them as an environmentally friendly and efficient solution for reducing carbon emissions (Gkargkavouzi et al., 2019; Choi and Johnson, 2019), are more likely to have a stronger intention to adopt them. Subjective norms reflect the influence of social pressure perceived by individuals. It means that individuals consider how others view the use of electric vehicles (Costa et al., 2021). Individuals who feel positive support or pressure from their social environment to adopt electric vehicles will have a positive impact on their intention to use them. In addition, perceived behavioral control measures how much individuals feel they have control over the action (Yu et al., 2021; Verma et al., 2022). This includes considerations of electric vehicle accessibility, the availability of adequate charging infrastructure, and other practical factors. When individuals feel that adopting electric vehicles is easy and feasible, they will have a stronger intention to do so (Kautish and Sharma, 2020).

2.2. Hypothesis Development

Attitude towards behavior refers to an individual's inner experience related to a certain inclination or action under consideration. It encompasses the feelings, judgments, and personal views of an individual regarding a specific behavior (Dalila et al., 2020). Attitude towards behavior is a key element in the Theory of Planned Behavior because it plays a crucial role in understanding and predicting individual actions. Attitude towards behavior includes aspects such as attitudes, beliefs, values, and personal evaluations of the behavior to be taken (Hua and Wang, 2019; Godbersen et al., 2020). These attitudes can be positive, negative, or neutral depending on how individuals evaluate the action. Additionally, attitude towards behavior can also be influenced by information, experiences, and an individual's culture. These factors can shape an individual's outlook on a particular behavior. Understanding attitude towards behavior is important because individual attitudes are one of the main predictors of intentions and actions (Fischer and Karl, 2022). In the context of carbon emissions reduction and climate change mitigation, understanding individual attitudes toward more environmentally friendly behavioral actions is crucial in designing communication and educational strategies that can help change attitudes and encourage more sustainable actions (Ajzen, 2020; Jakučionytė-Skodienė et al., 2020). Therefore, attitude towards behavior is a central element in behavioral psychology that helps us understand what motivates people to change their behavior for the benefit of the environment (Mikhaylov et al., 2020).

Subjective norms are a crucial concept in understanding consumer behavior. This concept reflects the evaluative influence of society or reference groups on individuals when considering or adopting a particular behavior. Bosnjak et al. (2020) identified two aspects of subjective norms, namely peer influence and superior

influence. Peer influence reflects the extent to which individuals feel compelled to follow the examples or advice of others. On the other hand, superior influence reflects the influence of people with authority or superiors. La Barbera and Ajzen (2021) divided subjective norms into primary and secondary groups. Primary groups include individuals with closer relationships to the person, while secondary groups encompass external factors like mass media, expert opinions, and non-interpersonal information that may influence an individual's perceptions. Ali et al. (2021) deconstructed subjective norms into two components: normative behavior and motivation to comply. Normative behavior reflects the extent to which individuals feel that significant people in their lives support or oppose certain behaviors. Meanwhile, motivation to comply refers to an individual's motivation to adhere to social norms or social pressures from their reference groups.

Deconstructing subjective norms into two exogenous variables, namely interpersonal influence and external influence, has significant implications for understanding the influence of social and external factors in consumer decision-making (Li et al., 2020). Interpersonal influence includes the impact of groups that regularly interact with consumers, such as family, friends, and colleagues. External influence refers to the impact of mass media, expert opinions, and other non-interpersonal information sources. This includes news, reviews, and information presented by the media, as well as the views and judgments made by experts. These factors can influence consumer perceptions and intentions (Alam et al., 2019; Choi and Johnson, 2019). In the context of climate change and efforts to reduce carbon emissions, understanding how interpersonal and external influences operate in consumer decision-making is crucial. The roles of close individuals and information from external sources like media and experts can be key motivating factors for consumers (Sun, 2020; Yuriev et al., 2020).

Perceived behavioral control is a key element in the Theory of Planned Behavior and is crucial for understanding individual behavior. Perceived behavioral control is based on the combination of two essential aspects: control beliefs and perceived power (Godbersen et al., 2020; Si et al., 2022). Control beliefs refer to an individual's perception of whether there are factors that can facilitate or inhibit the performance of a specific behavior. This includes an individual's assessment of how much control or ability they have to carry out that action (Küfeoğlu and Hong, 2020). Perceived power is about how important these control factors are to the individual. In other words, to what extent these factors influence intentions and decisions. If individuals feel that certain factors are very important and significant in decision-making, it will affect how much control they perceive over the action (Bhutto et al., 2020).

Intention is one of the key concepts in the Theory of Planned Behavior and has a significant impact on understanding individual behavior. A person's behavior is predicted by their intention to engage in that behavior, which, in turn, is influenced by two main factors: attitude and subjective norms (Hua and Wang, 2019). Intention reflects the extent to which an individual is willing and plans to engage in a specific behavior. Subjective norms are another factor that influences individual intentions. It refers to the expected social pressure an individual receives when performing a particular behavior (Dalila et al., 2020; Fischer and Karl, 2022). Understanding the influence of intention in the theory of planned behavior helps identify the factors that motivate individuals to take specific actions. It also aids in designing communication and interventions aimed at influencing individual intentions. Thus, the hypotheses in this study can be proposed as follows:

H_1: Attitude towards behavior has an influence on intention
H_2: Attitude towards behavior has an influence on energy saving behavior
H_3: Subjective norms have an influence on intention
H_4: Subjective norms have an influence on energy saving behavior
H_5: Perceived behavioral control has an influence on intention
H_6: Perceived behavioral control has an influence on energy saving behavior
H_7: Intention has an influence on energy saving behavior
H_8: Intention mediates the relationship between attitude towards behavior and energy saving behavior
H_9: Intention mediates the relationship between subjective norms and energy saving behavior
H_{10}: Intention mediates the relationship between perceived behavioral control and energy saving behavior

2.3. Research Method

This research adopts a quantitative research method focused on the analysis of individual energy-saving behavior (Figure 1). The survey method using questionnaires serves as the primary means of data collection from respondents. The questionnaire is designed using a Likert scale ranging from 1 to 5, allowing respondents to assess the extent to which they agree or disagree with statements related to the research variables. The respondents in this study are electric vehicle users selected using random sampling techniques. A total of 450 questionnaires were distributed to respondents as samples, but during the data analysis phase, only 328 questionnaires could be collected. Fifteen questionnaires were not completed. Therefore, the number of questionnaires used as samples in this study is 313. Data analysis is conducted using the Structural Equation Model (SEM) method with the support of the SmartPLS 4 software. The SEM approach enables the analysis of relationships between the variables present in this study, such as attitudes, subjective norms, behavioral intentions, and perceived behavioral control influence. This helps in identifying the extent to which these variables contribute to the adoption of electric vehicles.

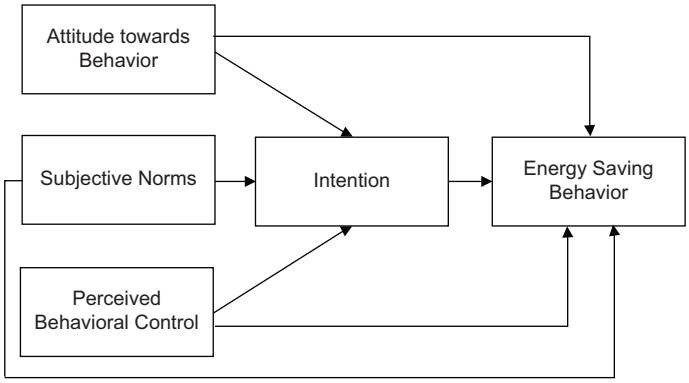
3. RESEARCH RESULTS

The initial analysis in this research is to test the indicators used to measure latent variables. The purpose of this testing is to determine whether the chosen indicators are suitable and adequate for measuring the intended latent variables. This evaluation is done by examining the standard loading factor values for each indicator. Standard loading factors indicate the level of contribution of indicators to the latent variable being measured. To be considered good and relevant, the standard loading factor values of the indicators should exceed 0.6. In addition, another important aspect in this analysis is to measure the indicators' reliability and the overall validity of the variables. Reliability can

be tested using methods such as the Cronbach's Alpha coefficient or Composite Reliability. This helps assess how consistent and reliable the indicators used are in measuring the latent variable. If the Cronbach's Alpha value is greater than 0.6 or the Composite Reliability exceeds 0.7, the indicators are considered consistent and reliable. Furthermore, variable validity is evaluated through validity tests, which measure the extent to which the indicators correlate with the intended latent variable. This validity evaluation includes the calculation of the Average Variance Extracted (AVE). AVE values exceeding 0.6 indicate that the latent variables used in the study have adequate validity (Figure 2).

The standard loading factor values indicate the level of contribution of each indicator to the latent variable (Table 1). Attitude towards behavior consists of five indicators (ATB1; ATB2; ATB3; ATB4; ATB5) used to measure individuals' attitudes toward the behavior under investigation. The standard loading factor values for all of these indicators are quite high, ranging from 0.714 to 0.882. This indicates that these indicators are relevant and contribute significantly to measuring the attitude toward behavior variable. Subjective norms consist of three indicators (SN1; SN2; SN3) measuring individuals' subjective norms related to the behavior. The standard loading factor values for all of these indicators are also high, ranging from 0.842 to 0.910, indicating that these indicators are relevant in measuring the subjective norm variable. Perceived behavioral control consists of four indicators (PBC1; PBC2; PBC3; PBC4) measuring individuals' perceptions of their control over the behavior under investigation. All of these indicators have fairly high standard loading factor values, ranging from 0.728 to 0.890, showing that these indicators are relevant in measuring the perceived behavioral control variable.

Figure 1: Conceptual framework



Intention consists of four indicators (INT1; INT2; INT3; INT4) measuring individuals' intentions to engage in a specific behavior. All of these indicators also have fairly high standard loading factor values, ranging from 0.786 to 0.870, indicating that these indicators are relevant in measuring the intention to behave variable. Energy-saving behavior consists of four indicators (ESB1; ESB2; ESB3; ESB4) measuring individual energy-saving behaviors. All of these indicators also have fairly high standard loading factor values, ranging from 0.706 to 0.878, showing that these indicators are relevant in measuring the energy-saving behavior variable. The results of this analysis support the use of these indicators in measuring the intended latent variables in the study and indicate that these indicators make a significant contribution to measuring the intended constructs.

The results of the testing in Table 2 above show that attitude towards behavior has a good level of reliability with a Cronbach's alpha value of 0.88. This value indicates that the indicators used to measure individuals' attitudes toward behavior have high consistency. The Composite reliability (rho_a) is also high, with

Figure 2: Full Model

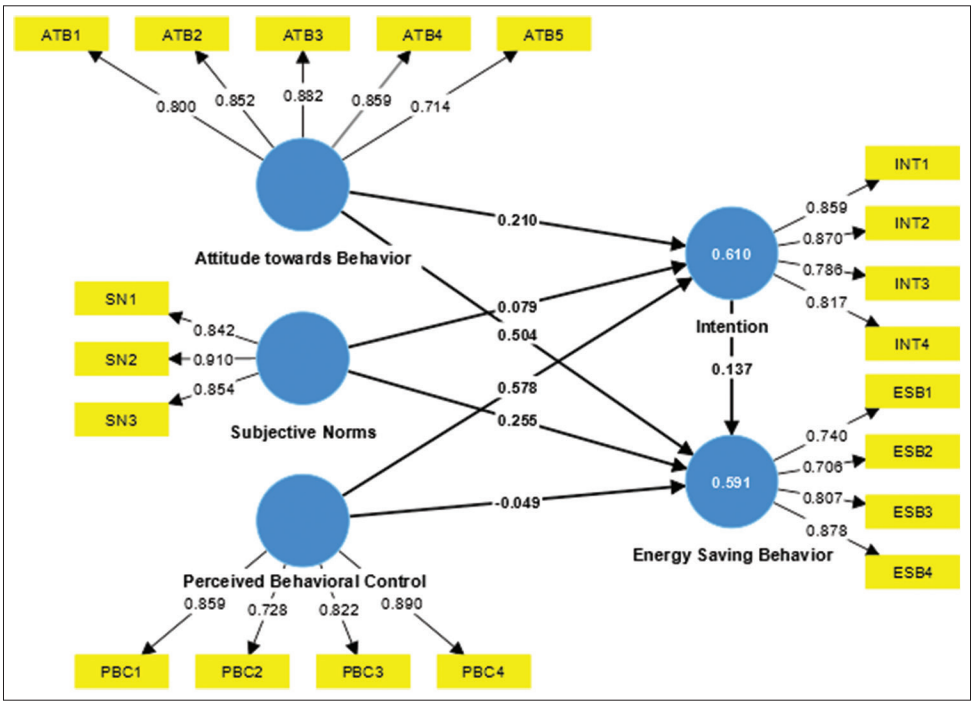


Table 1: Standard loading factor

Variable	Indicator	Standard loading factor
ATB	ATB1	0.800
	ATB2	0.852
	ATB3	0.882
	ATB4	0.859
	ATB5	0.714
SN	SN1	0.842
	SN2	0.910
	SN3	0.854
PBC	PBC1	0.859
	PBC2	0.728
	PBC3	0.822
	PBC4	0.890
INT	INT1	0.859
	INT2	0.870
	INT3	0.786
	INT4	0.817
ESB	ESB1	0.740
	ESB2	0.706
	ESB3	0.807
	ESB4	0.878

ESB: Energy-saving behavior, ATB: Attitude towards behavior, SN: Subjective norms, PBC: Perceived behavioral control, INT: Intention

Table 2: Reliability and validity

Variable	Cronbach's alpha	Composite reliability (rho_a)	AVE
ATB	0.88	0.885	0.678
SN	0.839	0.864	0.756
PBC	0.843	0.846	0.683
INT	0.853	0.855	0.695
ESB	0.794	0.821	0.617

AVE: Average variance extracted, ESB: Energy-saving behavior, ATB: Attitude towards behavior, SN: Subjective norms, PBC: Perceived behavioral control, INT: Intention

a value of 0.885. The Average Variance Extracted (AVE) is 0.678, indicating that this variable has adequate validity. Subjective norms have good reliability with a Cronbach's alpha value of 0.839. The Composite reliability (rho_a) is quite high, at 0.864. The AVE is 0.756, showing that this variable has good validity. Perceived behavioral control has adequate reliability with a Cronbach's alpha value of 0.843. The Composite reliability (rho_a) is also quite high, at 0.846. The AVE is 0.683, indicating that this variable has sufficient validity. Intention has good reliability with a Cronbach's alpha value of 0.853. The Composite reliability (rho_a) is high, at 0.855. The AVE is 0.695, indicating that this variable has adequate validity. Energy-saving behavior has sufficient reliability with a Cronbach's alpha value of 0.794. The Composite reliability (rho_a) is also quite high, at 0.821. The AVE is 0.617, showing that this variable has adequate validity.

In this study, to determine the significance of the relationships between variables, the researcher conducted hypothesis testing. Hypotheses in the study were used to test assumptions or predictions based on the conceptual framework or research theory. To determine whether hypotheses were accepted or rejected, the researcher used the P-value (probability value) generated from the relevant statistical tests. If the $P < 0.05$, it means that the relationship between variables has a significant influence, and the hypothesis can be accepted.

Table 3: Hypothesis testing

Hypothesis	T statistics	P	Information
ATB→INT	2.362	0.020	Significant
ATB→ESB	3.366	0.001	Significant
SN→INT	1.125	0.263	Not significant
SN→ESB	1.557	0.123	Not significant
PBC→INT	0.388	0.699	Not significant
PBC→ESB	2.371	0.020	Significant
INT→ESB	2.278	0.025	Significant
ATB→INT→ESB	1.985	0.033	Significant
SN→INT→ESB	2.085	0.008	Significant
PBC→INT→ESB	1.977	0.041	Significant

From the results of hypothesis testing in Table 3 above, it is found that the first hypothesis, the relationship between attitude towards behavior and behavioral intention, has a $P = 0.020$. This P-value is less than the significance level of 0.05, so this relationship is considered significant. The second hypothesis, the relationship between attitude towards behavior and energy-saving behavior, has a $P = 0.001$, which is also less than the significance level of 0.05, so this relationship is considered significant. Futhermore, the third hypothesis, the relationship between subjective norms and behavioral intention, has a $P = 0.263$, which is greater than the significance level of 0.05, so this relationship is considered not significant. The fourth hypothesis, the relationship between subjective norms and energy-saving behavior, has a $P = 0.123$, which is also greater than the significance level of 0.05, so this relationship is considered not significant. The fifth hypothesis, the relationship between perceived behavioral control and behavioral intention, has a P-value of 0.699, which is significantly greater than the significance level of 0.05, so this relationship is considered not significant. The sixth hypothesis, the relationship between perceived behavioral control and energy-saving behavior, has a $P = 0.020$, which is less than the significance level of 0.05, so this relationship is considered significant. The seventh hypothesis, the relationship between behavioral intention and energy-saving behavior, has a $P = 0.025$, which is less than the significance level of 0.05, so this relationship is considered significant. As for the eighth hypothesis, which analyzes behavioral intention mediating the relationship between attitude towards behavior and energy-saving behavior, it has a P-value of 0.033, which is less than the significance level of 0.05, so this relationship is considered significant. The ninth hypothesis, which examines behavioral intention mediating the relationship between subjective norms and energy-saving behavior, has a $P = 0.008$, which is less than the significance level of 0.05, so this relationship is considered significant. Additionally, the tenth hypothesis, which investigates behavioral intention mediating the relationship between perceived behavioral control and energy-saving behavior, has a $P = 0.041$, which is less than the significance level of 0.05, so this relationship is considered significant.

4. CONCLUSION

The results of this study reveal significant findings regarding the factors influencing individual energy-saving behavior, especially in the context of electric vehicle usage. Therefore, this research concludes that an individual's attitude towards behavior plays a

crucial role in influencing the intention and actual energy-saving behavior. A positive attitude towards energy-saving practices increases the likelihood that individuals have the intention to adopt them and actually implement such behaviors. Hence, strategies focusing on fostering a positive attitude towards energy-saving behavior are key to changing consumer behavior, including the adoption of electric vehicles. Perceived behavioral control has a direct impact on energy-saving behavior. Factors affecting an individual's ability to control their behavior, such as access to electric vehicles and adequate charging infrastructure, play a significant role in promoting energy-saving behavior. This underscores the need for collaboration between governments, infrastructure developers, and service providers to create an environment supportive of electric vehicle usage and energy-saving practices. Subjective norms, which encompass the influence of social groups and references, have a less significant impact in this study. Although this influence is not significant, subjective norms can still play a role in influencing behavior, albeit to a lesser extent than individual attitudes. Therefore, in efforts to change consumer behavior, consideration should be given to how subjective norms can be strengthened or leveraged in awareness campaigns.

These findings can serve as the foundation for designing more effective strategies and campaigns to promote the adoption of electric vehicles and other energy-saving behaviors. A comprehensive approach that integrates attitude, subjective norms, and perceived behavioral control factors can provide a basis for more effective awareness and education programs aimed at changing consumer behavior.

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