Shifting Toward Sustainability: Examining Customer Intention to Use EV-Based Delivery Services

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Abstract

The rapid expansion of e-commerce highlights the importance of sustainable and efficient last-mile delivery solutions. The electric vehicles (EVs) offer potential environmental benefits, such as reducing CO_2 emissions, yet their adoption in last-mile logistics remains limited. This study aims to investigate the key factors influencing customers' intention to use electric vehicle (EV)-based delivery services. The authors integrate the extended Theory of Planned Behaviour (TPB) model, comprising attitude, subjective norm, and perceived behavioral control over EV delivery, with two additional variables: willingness to pay and environmental concern. A quantitative methodology was utilized, with 331 data samples collected for analysis and hypothesis testing. Hierarchical multiple regression was conducted using SPSS. The findings indicate that perceived behavioral control emerged as the strongest predictor, while environmental concern and willingness to pay significantly enhanced the model's explanatory power. Notably, environmental concern replaced traditional TPB factors like attitude and subjective norms in predicting intention, suggesting a value-driven mindset among users. This research fills a gap in existing literature by focusing on customer perspectives on EV delivery and offers practical insights for policymakers and service providers, emphasizing the roles of environmental messaging, service accessibility, and affordability in promoting EV-based delivery adoption and shaping more sustainable logistics strategies.

Keywords: Electric Vehicle; EV-based Delivery; Last Mile Delivery; Theory of Planned Behavior (TPB); Willingness to Pay; Environmental Concern.

1. Introduction

The delivery and courier industry has experienced significant growth in recent years. This expansion is mainly due to the rising popularity of e-commerce businesses among customers worldwide [1]. Additionally, the food delivery sector has become one of the fastest-growing areas. The online food delivery market stands out as one of the fastest-growing areas, with projected revenues expected to grow at a compound annual growth rate (CAGR) of 7.64% from 2025 to 2030, reaching an estimated market size of US$2.02 trillion by 2030 [2]. This growth is expected to continue and change over time, depending on factors such as technological advancement, customer demand, and urbanization

[1, 3]. However, this growth has also brought challenges. The increasing demand for fast, reliable delivery services has significantly contributed to higher carbon emissions and broader environmental impacts [4]. Moreover, most delivery services rely on road-based transportation and logistics using conventional engines. These types of engines are often linked to air pollution [5-8], which makes them harmful to the environment. As urbanization accelerates and consumer expectations evolve, last-mile delivery has become a critical focus in the pursuit of sustainable transportation solutions. To address this, many companies are adopting green logistics practices such as the use of Electric Vehicles (EVs), alternative fuels, eco-friendly packaging, and route optimization. In response, EVs are gaining momentum as one of the most widely adopted solutions, as the vehicles produce zero tailpipe emissions, have strong potential in reducing global CO_2 emissions, and have potential cost savings over the vehicles' lifespans [9-11]. In Thailand, the use of electric vehicles (EVs) for personal transportation has begun to increase and is expected to grow further in the future. It is estimated that EV production capacity will reach approximately 400,000 to 500,000 units per year. Although the number of EV users has increased in recent years, most of them are still private users or households. However, it has been suggested that EVs are also suitable for transportation services, especially in local delivery. Kaplan et al. [12] noted that urban commercial vehicles should be a main target group for adopting EVs in the form of Electric Commercial Vehicles (ECVs), as they are widely used in urban areas and contribute significantly to pollution from traditional engine use. In addition, replacing conventional delivery vehicles with EVs in courier and last-mile parcel services may help reduce emissions in many urban zones [13].

Many studies have examined EV adoption in four areas, including sustainability, electric micro-mobility, electric vehicle performance/operational efficiency, and charging infrastructure/technological innovations [14]. Although there is a growing trend in research on electric vehicles in last-mile delivery, which is encouraging for the future of e-commerce, there have been limited empirical studies that particularly examine consumers' intents and willingness to pay for EV-based delivery services, which is crucial for fostering the expansion and promotion of EV use in the courier and delivery sector [14]. In addition, the National Electric Vehicle Policy Committee has introduced the 30@30 policy, which aims for at least 30% of all vehicle production in Thailand to be Zero Emission Vehicles (ZEVs) by the year 2030 [15]. These policies demonstrate strong readiness to promote EV adoption in the country's delivery sector. At the same time, it is also important to study customer perspectives, as these insights can help delivery companies develop effective strategies for adopting EVs in their operations.

Thus, this study aims to close this gap by investigating the factors that influence customers' intention to use EV-based delivery services in Thailand. The purpose is to identify key factors that affect customers' decisions to choose delivery services that primarily operate using electric vehicles. In addition to this, this research tries to pinpoint insights that inspire customers to contribute more to using EV-based delivery services, which can be applied by courier and delivery service companies in Thailand to develop strategic plans for implementing EVs in their businesses. Additionally, the study can help fill existing gaps for policymakers by providing insights to support the creation of policies that promote EV usage. The findings may contribute to environmental conservation while supporting the sustainable development of the delivery business in the future. With this foresight in mind, this investigation is conducted to determine the answer to the question, "What are the factors that influence the consumer's intention towards the use of EV-based delivery services?"

This research includes 7 sections. The remainder of this paper is organized as follows. Section 2 presents the literature review and theoretical framework, highlighting factors influencing customer intention to use EV-based delivery services. Section 3 describes the research methodology, including instrument development and measures, sample and data collection, and data analysis. Section 4 reports the results of the empirical analysis. Section 5 discusses the findings in relation to prior research. Section 6 proposes theoretical and managerial contributions. Finally, section 7 presents the conclusion and outlines future research directions.

2. Literature Review

Several studies have focused on predicting the level of intention to adopt electric vehicles (EVs). However, most of them mainly examine the perspective of customers who purchase EVs for household use or from the viewpoint of service providers [12, 16-19]. Therefore, the authors reviewed these previous works to develop a conceptual framework that fits better with the target group in this study, which is customers who intend to use EV-based services in the delivery business. This approach aims to ensure that the framework is more suitable for the specific context of this research.

2.1. The Theory of Planned Behavior and Intention to Use EV-Based Delivery Services

The Theory of Planned Behavior (TPB), introduced by Ajzen [20], suggests that a person's behavior can often be predicted through their intention to perform that behavior. Therefore, TPB emphasizes the importance of analyzing how people make decisions to act or change their behavior. In simple terms, an individual's action can be forecasted by their behavioral intention. The basic idea of TPB connects beliefs and evaluations to explain behavior. This model

is commonly used in research that examines intention and environmental responsibility among consumers or service users [17]. Many studies have also applied and adapted TPB to suit environmental research contexts [17, 19, 21-23]. In this study, the authors adopted the original structure of TPB, which includes three key components: attitude, subjective norm, and perceived behavioral control. These were chosen as the main predictors expected to influence customers' intention to use EV-based delivery services before introducing other variables into the model.

The first component of the TPB is attitude toward behavior. It is defined as the result of a person's perception or awareness of the possible outcomes that may occur from performing a certain behavior [24]. In environmental contexts, attitude is considered one of the key factors that influence behaviors related to environmental conservation. Previous studies have shown that attitude can affect people's decisions to adopt green products, especially EVs, both at the individual and organizational levels [12, 17, 19, 25]. For instance, Shalender & Sharma [17] and Egbue & Long [10] found that if customers or service users have positive attitudes toward EVs, they are more likely to purchase or become users of these products. Furthermore, Boo & Tan [16] suggested that giving proper advice and information about eco-friendly products, such as EVs, can encourage individuals to develop a positive attitude, which may lead to their decision to adopt the products. However, Moser [26] found that environmental attitude did not always influence green purchasing behavior. Similarly, Nayum et al. [27] argued that having a high attitude does not necessarily lead to behavioral intention, especially when incentives are involved. Therefore, in studying customers' decisions to use EV-based delivery services, it is important to examine whether attitude has any influence on their choice. This leads to the following hypothesis.

H1: Attitude toward EV-based delivery (AT) has a positive influence on customers' intention to use EV-based delivery services (CI).

Subjective norms are another important factor in predicting behavioral intention according to the TPB. Ajzen [20] explained that subjective norms refer to a person's sense of pressure from others around them to perform certain behaviors. Basically, subjective norm represents the expectations from society that encourage an individual to act in a particular way [28]. This shows that subjective norm is an external factor that can influence behavior, unlike attitude, which is internal and personal. Many studies have found a relationship between subjective norm and environmentally friendly behaviors, such as the intention to adopt electric EVs [17, 19] or the intention to adopt green IT [25]. In the context of this study, which aims to examine factors influencing intention to use EV-based delivery services, the subjective norm is considered critical. This is because individuals are more likely to use eco-friendly services if people around them do so or if their environment, such as regulations, policies, or social groups, aims to support such behavior. However, Boo & Tan [16] pointed out that subjective norms may not always be the main driver. Some research suggests that when social pressure or environmental support is missing, individuals may lose interest in green products and return to their previous behavior. Therefore, this study proposes the following hypothesis related to subjective norms.

H2: Subjective norm regarding EV delivery (SN) has a positive influence on customers' intention to use EV-based delivery services. (CI).

The final component of the TPB model is perceived behavioral control, which refers to a person's perception of how easy or difficult it is to perform a particular behavior [20]. Moser [26] also explained that perceived behavioral control reflects the level of personal awareness and belief in one's ability to carry out a desired behavior. In the context of EVs and environmentally friendly transport services, Shalender & Sharma [17] suggested that perceived behavioral control includes factors such as price, access to technology, the complexity of using the technology, and the user's confidence in using EVs. Although several studies have found a strong relationship between perceived behavioral control and intention to adopt EVs [16, 17, 19], perceived behavioral control is also used to explain environmental behavior in general [21, 29]. However, the role of perceived behavioral control still remains uncertain. It is possible that factors such as income, incentives, or purchasing ability may have a stronger influence than perceived behavioral control in the context of choosing environmentally friendly vehicles [27]. Based on this, the following hypothesis is proposed.

H3: Perceived behavioral control over EV delivery (PBC) has a positive influence on customers' intention to use EV-based delivery services (CI).

2.2. Willingness to Pay (WP) for EV Delivery

Willingness to pay refers to the extent to which an individual is ready to spend money on a particular product or service. It is often influenced by a person's income background and the overall cost of the product. However, it is well known that environmentally friendly products often come with higher costs, which makes their prices higher as well. According to Boo and Tan [16], the price of EVs tends to be high because of the production costs, expensive batteries, and the cost of installing charging stations and related infrastructure. These findings are consistent with studies by Ehrler & Hebes [13] and Gass et al. [30]. In addition, based on previous research, willingness to pay appears to be an

important factor that can influence the decision to choose environmentally friendly vehicles or products [26, 31]. However, the level of willingness to pay does not always depend directly on income. Shao et al. [32] suggested that while high-income individuals may show greater willingness to pay for eco-friendly products, a rise in income alone does not guarantee a higher willingness to pay. It is also possible that personal characteristics influence willingness to pay more than income does. For example, Achtnicht [33] found that German consumers were willing to pay more for environmentally friendly vehicles as long as they felt they were fulfilling their moral responsibility to the environment. Furthermore, age may also affect willingness to pay. Dardanoni & Guerriero [34] observed that children can play a key role in encouraging families to pay for eco-friendly products. This may be because today's younger generation is not only more aware of environmental issues but also more willing to spend their own money on green products compared to older age groups [34, 35]. Thus, it can be concluded that the level of income or price alone does not directly determine the decision to purchase or use environmentally friendly services. What matters is the individual's willingness and personal readiness to support eco-friendly products [36]. This leads to the hypothesis developed in this study related to WP.

H4: Willingness to pay for EV-based delivery (WP) has a positive influence on customers' intention to use EV-based delivery services (CI).
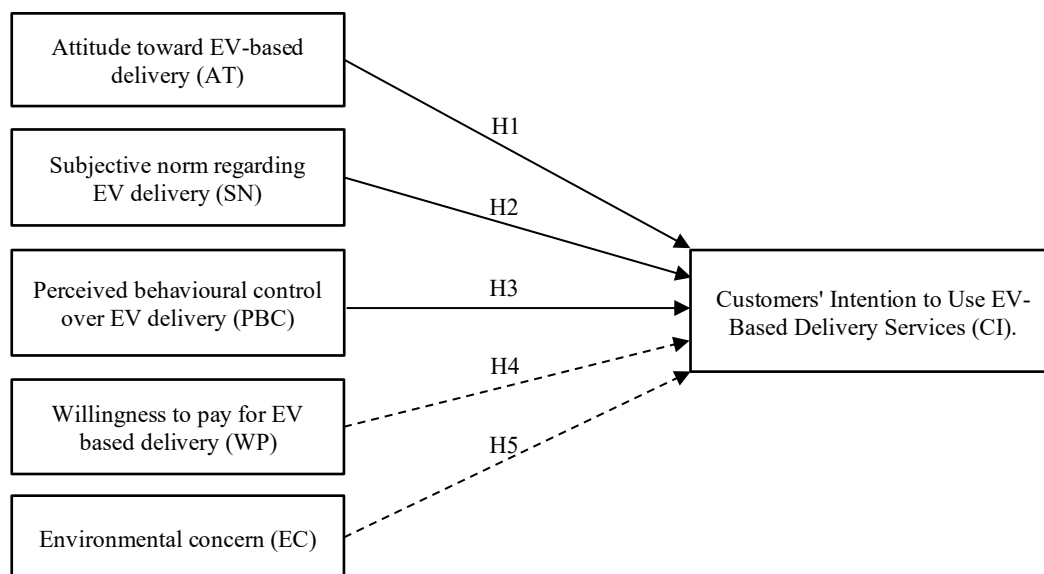
2.3. Environmental Concern

When individuals make decisions to perform certain behaviors, the three core components of the TPB framework may not always be sufficient. Ajzen [20] pointed out that in some situations, decision-making may also involve moral norms, which are influenced by external values and ideas that can affect a person's internal awareness. In this context, environmental awareness becomes an important factor in shaping pro-environmental behavior. This leads to the inclusion of environmental concern as an additional variable. Lai et al. [37] defined environmental concern as the level of awareness a person has regarding environmental issues, along with their willingness to take part in solving those problems. Environmental concern is closely related to the mindset of environmentalists, who show strong pro-environmental behavior and tend to care more about protecting the environment [21, 38]. People with high environmental concern are often more likely to choose eco-friendly products and support environmental efforts. Therefore, it can be suggested that individuals with a high level of environmental concern are more likely to adopt EVs than those with low or no concern at all [37-39]. Past studies also showed both direct and indirect relationships between EC and the intention to adopt or support EV use [19, 37]. For this reason, measuring environmental concern among customers who consider using eco-friendly transportation is considered a critical factor. This leads to the final hypothesis in this study.

H5: Environmental concern (EC) has a positive influence on customers' intention to use EV-based delivery services (CI).

2.4. Conceptual Framework

Drawing on the concepts from literature reviews, this research posits that the five identified factors are correlated with CI, as illustrated in Figure 1.

Note: The solid lines represent classic TPB constructs, and the dotted lines represent extended constructs.

Figure 1. Hypothesised structural model development based on the extended TPB framework

3. Research Methodology

This study uses a quantitative research method. Figure 2 shows the flowchart diagrams of the research methodology processes as follows.

3.1. Instruments Development and Measures

In terms of measurement, authors employ quantitative research methodology, using the extended theory of planned behavior (TPB) as a base theoretical concept. The model includes attitude, subjective norms, and perceived behavioral control as original constructs. Furthermore, the authors added two other constructs, willingness to pay and environmental concern, which were synthesized from the literature review, as additional constructs to the model in order to predict customers' intention to use EV-based delivery services. A five-point Likert scale, from 1 ('strongly disagree') to 5 ('strongly agree'), was utilized as the measurement instrument to determine the main content of each questionnaire. The questionnaire comprises a total of 19 items designed to assess all six factors, encompassing both independent and dependent variables. The measurement of the constructs is elaborated further.

To begin with, the chosen questions were designed to assess intention to use EV-based delivery services developed by Permasih et al. [40], which comprises three items (e.g., 'I plan to use EV-based delivery services'). The reliability, based on Cronbach's alpha, is 0.903.

Furthermore, integrating the questionnaires derived from the original TPB Model [20]. A three-item questionnaire, adapted to the context of EV-based delivery services, was employed to assess attitude (e.g., 'I like using EV-based delivery services.'). Moreover, the authors utilize three questions designed to assess the subjective norm concerning EV (e.g., 'Important people to me think I should use EV-based delivery services'). Finally, three items were employed to assess perceived behavioral control regarding EV-based delivery services (e.g., 'I try to use EV-based delivery services'). Cronbach's alpha indicates reliability coefficients of 0.770, 0.871, and 0.990, respectively.

In addition, the authors employed four items from Thamrongsinthavorn [41] as measurement scales for the willingness to pay for EV-based delivery (e.g., 'I am willing to pay more for EV-based delivery services'). Cronbach's alpha represents reliability coefficients of 0.933.

Finally, in order to measure an individual's environmental concern, the authors adapted three items from Thamrongsinthavorn [41] as measurement scales (e.g., 'I am willing to support EV-based delivery services to protect nature'). The reliability coefficient of the variable is 0.937. See details of items of the questionnaire in Appendix I.

3.2. Sample and Data Collection

After being approved by Walailak University's Ethics Committee in Human Research (WUEC-25-046-01). The questionnaire was submitted online through Google Forms, which contained the written consent to participate statement, and was directly disseminated to all respondents via social media platforms, including Line, Facebook, and Instagram.

Because the aim of this study is to examine the variables that affect customers' intention to utilize EV-based delivery services. Consequently, the authors utilized an open sampling framework for participant selection through non-probability sampling, specifically adopting the purposive sampling method. This method entailed selecting individuals aged over 18 years who possess occasional experience with delivery services in Thailand and give consent to be part of the study. To determine the appropriate sample size, G*Power 3.1 software was used. The method selected was an *F-test* for linear multiple regression. Cohen [42] suggests proper parameters for statistical power as follows: alpha level ($\alpha = 0.05$), medium effect size ($f^2 = 0.15$) as the parameter is fit to the context of a study, and power ($1 - \beta = 0.80$), which is balanced for five predictors. The result suggested a minimum sample size of 92 participants to detect a medium effect. However, to increase the power of the analysis and ensure the robustness of findings, the authors collected data from a total of 426 respondents, which exceeds the required minimum sample. Subsequently, after eliminating outliers and incomplete information, 331 valid responses were utilized for analysis. Respondents comprised 70.1% female, 21.1% male, and 8.8% LGBTQIA+ individuals. The most common age range was 18 to 30 years, comprising 89.7%, followed by the 31 to 50 years group at 8.8% and those over 50 years at 1.5%. The educational background reveals that 80.7% of respondents possess a bachelor's degree, 16.6% have not completed undergraduate education, and 2.7% hold an advanced degree beyond a bachelor's. The monthly income distribution of respondents is as follows: less than 20,000 baht at 87.9%, 20,001-50,000 baht at 10.9%, and more than 50,000 baht at 1.2%.

3.3. Data Analysis

To determine customers' intention to use delivery with EVs, the data analysis was conducted in several stages. First, Confirmatory Factor Analysis (CFA) was performed to evaluate the validity and reliability of the measurement

model, ensuring that the observed variables adequately represented the underlying constructs. Next, Pearson product-moment correlation coefficients were then employed to evaluate the interrelationship among the study's variables. Finally, a hierarchical multiple regression analysis was conducted to evaluate the degree to which each variable contributes to the variance in the intention to utilize EV-based delivery services. In Model 1, attitude, subjective norm, and perceived behavioral control related to the use of EV-based delivery services were entered. In Model 2, willingness to pay was added as an additional predictor. In Model 3, environmental concern was included as the final predictor. All analyses were performed using SPSS 26.0.
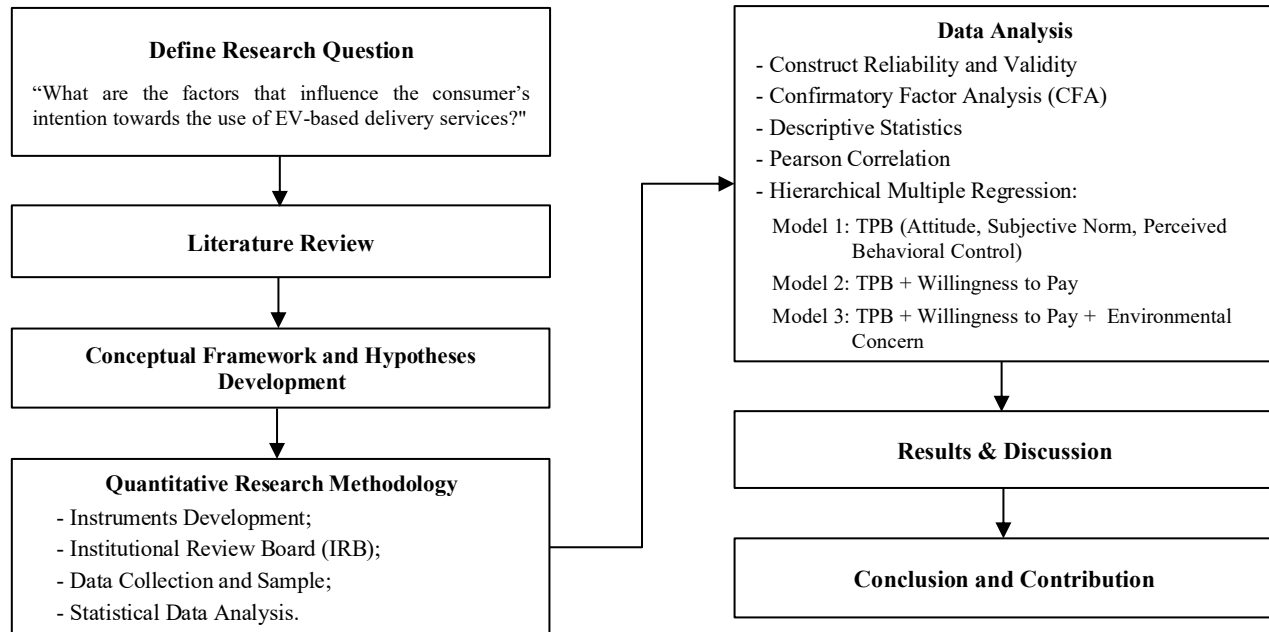
Define Research Question

"What are the factors that influence the consumer's intention towards the use of EV-based delivery services?"

↓

Literature Review

↓

Conceptual Framework and Hypotheses Development

↓

Quantitative Research Methodology

- Instruments Development;
- Institutional Review Board (IRB);
- Data Collection and Sample;
- Statistical Data Analysis.

→

Data Analysis

- Construct Reliability and Validity
- Confirmatory Factor Analysis (CFA)
- Descriptive Statistics
- Pearson Correlation
- Hierarchical Multiple Regression:

  Model 1: TPB (Attitude, Subjective Norm, Perceived Behavioral Control)

  Model 2: TPB + Willingness to Pay

  Model 3: TPB + Willingness to Pay + Environmental Concern

↓

Results & Discussion

↓

Conclusion and Contribution

Figure 2. A flowchart of quantitative research methodology processes

4. Results

4.1. Factor Analysis

To confirm the structure of variables as defined by the theoretical model, the authors carried out a confirmatory factor analysis. The results for Composite Reliability (CR) ranged between 0.789 and 0.942. These values are higher than the accepted criteria [43], indicating that the items move in the same direction and are consistent with the proposed model. In addition, the analysis of Average Variance Extracted (AVE) showed values between 0.563 and 0.825, which supports the validity of the variance [43]. The Variance Inflation Factors (VIFs) were found to be between 2.82 and 4.42, suggesting that multicollinearity was not a problem in the model [44]. Furthermore, the authors tested discriminant validity using the Heterotrait-Monotrait Ratio (HTMT). As presented in Table 1, the HTMT values ranged from 0.794 to 0.895. Although the pairs AT-SN, AT-PBC, and PBC-WP showed values as high as 0.895, overall results indicate that all pairs met the commonly accepted threshold [45].

Table 1. Heterotrait-Monotrait Ratio (HTMT)

	AT	SN	PBC	WP	EC	CI
AT						
SN	0.895					
PBC	0.895	0.852				
WP	0.822	0.832	0.895			
EF	0.851	0.824	0.867	0.806		
CB	0.814	0.794	0.886	0.828	0.866	

Note: Attitude toward EV-based delivery (AT), Subjective norm regarding EV delivery (SN), Perceived behavioral control over EV delivery (PBC), Willingness to pay for EV based delivery (WP), Environmental concern (EC), Customers' intention to use EV-based delivery services (CI).

4.2. Pearson's Correlation Analysis

Table 2 shows that the correlation among the six examined variables was evaluated using the Pearson coefficient, which ranged from 0.68 to 0.82, indicating a statistically significant positive relationship ($p < 0.001$). The five

independent variables exhibited a significant positive correlation with CI. The constructs with the highest correlation were PBC (r = 0.80, p < 0.001) and EC (r = 0.80, p < 0.001), followed by WP (r = 0.76, p < 0.001), SN (r = 0.70, p < 0.001), and AT, which had the lowest correlation (r = 0.68, p < 0.001).

In summary, the bivariate correlations suggest a significant correlation between both the original TPB components (attitude, subjective norm, and perceived behavioral control) and the additional components (willingness to pay and environmental concern) in predicting customers' intention to use the EV-based delivery service. The significance of these values was subsequently assessed through multiple regression analysis.

4.3. Descriptive Analysis

The mean (M) and standard deviation (SD) for each variable are present in Table 2. The average scores of all six variables ranged from 4.35 to 4.51. The highest mean score was for environmental concern (M = 4.51), followed by attitudes toward EV-based delivery service (M = 4.47) and customers' intention to use EV-based delivery services (M = 4.41). The mean score for willingness to pay for EV-based delivery services was the lowest (M = 4.35). The SD scores ranged from 0.54 to 0.67. The maximum standard deviation score was observed in willingness to pay for EV-based delivery services (SD = 0.67). The minimum score pertained to attitudes toward EV-based delivery service (SD = 0.54). The remaining scores were primarily ranging between 0.58 and 0.63. The internal consistency coefficients for each variable, assessed using Cronbach's Alpha, ranged from 0.77 to 0.94. All variables exceeded the cutoff of 0.7, indicating their reliability [46].

Table 2. Pearson's correlation

	CI	AT	SN	PBC	WP	EC
Customers' intention to use EV based delivery services (CI).	1					
Attitude toward EV-based delivery (AT)	0.68***	1				
Subjective norm regarding EV delivery (SN)	0.70***	0.73***	1			
Perceived behavioural control over EV delivery (PBC)	0.80***	0.75***	0.76***	1		
Willingness to pay for EV based delivery (WP)	0.76***	0.70***	0.75***	0.82***	1	
Environmental concern (EC)	0.80***	0.72***	0.74***	0.80***	0.75***	1
M	4.41	4.47	4.38	4.38	4.35	4.51
SD	0.62	0.54	0.59	0.63	0.67	0.58

Note: 2-tailed correlation is significant (***p < 0.001).

4.4. Multiple Regression Analysis

Multiple Regression Analysis (MRA) is a method used to study how a group of independent variables (predictors) with at least two values influence a dependent variable (criterion). The principal aims of MRA in research can be divided into two categories: prediction, which entails analyzing how independent variables forecast the dependent variable, and explanation, which investigates the regression coefficients and elucidates the impact of the independent variables within a theoretical framework. Consequently, a hierarchical multiple regression analysis was conducted in this study to ascertain the extent of additional variance elucidated by each set of five independent variables, as shown in Table 3.

Initially, Model 1 consists of three basic variables that were entered: attitude toward EV-based delivery (AT), subjective norm regarding EV delivery (SN), and perceived behavioral control over EV delivery (PBC). The result of the regression analysis indicated that these three variables accounted for 66.7% of the variance in customers' intention to use EV-based delivery services (CI) (p < 0.001, R^2 = 0.67, Adjusted R^2 = 0.67). All three variables are shown to have significant contributions to CI. According to model 1, PBC is shown to be the strongest predictor of CI (β = 0.56, p < 0.001), followed by SN (β = 0.19, p < 0.001) and AT (β = 0.12, p < 0.01), respectively.

Next, the authors added willingness to pay for EV-based delivery (WP) to Model 2. The results of the regression analysis showed that these four variables explained 68.3% of the variance in CI (p < 0.001, R^2 = .68, Adjusted R^2 = .68), indicating that the new variable contributes to the model, which remained statistically significant. However, in this model, only three variables remained significant predictors of CI, which are PBC (β = 0.43, p < 0.001), WP (β = 0.24, p < 0.001), and SN (β = 0.12, p < 0.05). Conversely, AT is shown to have no predictive contribution to CI (β = 0.10, p > 0.05).

Finally, in Model 3, environmental concern (EC) was added. The regression analysis accounted for 72.1% of the variance in CI (p < 0.001, R^2 = 0.72, Adjusted R^2 = 0.72), showing that EC added contribution to the model. From this final model, it is clear that all five variables were significant contributions to CI. Accordingly, the best predictor of CI

was EC (β = 0.36, p < 0.001), followed by PBC (β = 0.30, p < 0.001), and the least predictor was WP (β = 0.18, p < 0.01). Surprisingly, two variables shown to have no significant prediction to CI are AT (β = 0.04, p > 0.05) and SN (β = 0.05, p > 0.05).

The results support three out of five hypotheses consistently across the models. H3 (PBC → CI), H4 (WP → CI), and H5 (EC → CI) were supported in all relevant models. H2 (SN → CI) was supported only in Models 1 and 2 but became non-significant in Model 3. H1 (AT → CI) was supported only in Model 1 and dropped in significance in subsequent models. These findings suggest that customers' perceived behavioral control, environmental concern, and willingness to pay play pivotal roles in shaping their intention to adopt EV-based delivery services. In contrast, subjective norm and attitude alone may not sustain predictive power when value-driven factors are considered.

Table 3. Hierarchical regression analysis (N = 331)

Variables	B	95% CI for B		SE B	β	R^2	Adjust R^2	ΔR^2
		LL	UL					
Model 1								
Constant	0.488	0.153	0.823	0.170	-			
Attitude toward EV-based delivery (AT)	0.143	0.024	0.262	0.061	0.124**			
Subjective norm regarding EV delivery (SN)	0.195	0.087	0.303	0.055	0.187***	0.667	0.663	0.667***
Perceived behavioural control over EV delivery (PBC)	0.556	0.450	0.661	0.054	0.564***			
Model 2								
Constant	0.500	0.174	0.827	0.166	-			
Attitude toward EV-based delivery (AT)	0.116	-0.001	0.233	0.059	0.100			
Subjective norm regarding EV delivery (SN)	0.128	0.017	0.238	0.056	0.122*	0.683	0.679	0.017***
Perceived behavioural control over EV delivery (PBC)	0.424	0.304	0.544	0.061	0.430***			
Willingness to pay for EV based delivery (WP)	0.225	0.118	0.332	0.054	0.243***			
Model 3								
Constant	0.239	0.118	0.332	0.161	-			
Attitude toward EV-based delivery (AT)	0.046	-0.078	0.555	0.057	0.039			
Subjective norm regarding EV delivery (SN)	0.048	-0.066	0.157	0.054	0.046			
Perceived behavioural control over EV delivery (PBC)	0.297	-0.058	0.154	0.061	0.301***	0.721	0.717	0.038***
Willingness to pay for EV based delivery (WP)	0.167	0.177	0.416	0.052	0.181**			
Environmental concern (EC)	0.384	0.065	0.269	0.058	0.357***			

Note: CI: Confidence Interval; LL:Lower Limit; UL: Upper Limit.; *p < 0.05, **p < 0.01, ***p < 0.001

5. Discussion

The aim of this study is to examine the factors influencing customers' intention to use EV-based delivery services (CI) among delivery service users in Thailand. Previous research has mostly focused on the adoption of EVs either in the context of end-users or service providers. However, studies exploring this issue from the customers' perspective are still limited or almost absent. This gap presents an interesting research opportunity, which leads to the current study. The authors apply the extended TPB as the main framework. The core model includes attitude toward EV-based delivery (AT), subjective norms regarding EV delivery (SN), and perceived behavioral control over EV delivery (PBC). In addition, two more variables, which are willingness to pay (WP) and environmental concern (EC), were included to enhance the depth of the investigation. For the findings to offer useful insights and a clear analysis, the authors choose to use hierarchical multiple regression analysis to explore the relationships and effects between the independent variables and the dependent variable. Based on the findings, the authors identify several interesting insights, which will be discussed in the following section:

Firstly, findings from the original model show that AT, SN, and PBC all have an influence on CI. This is consistent with previous studies [12, 16, 17, 19]. However, most of those studies focus on the firm's intention or individual customers of EVs, rather than customers of delivery services. When analyzing in more detail, it is clear that PBC has the strongest influence on CI, followed by SN and AT. This result suggests that customers are more likely to use EV-based delivery services if they feel the service is accessible and easy to use, especially in Thailand, where infrastructure and accessibility issues still present challenges to EV adoption. In addition, stakeholders can help to increase PBC in customers in order to support their intention. According to Boo & Tan [16], government support is an important tool that can increase PBC and promote customer intention through public policy that encourages EV adoption. This is similar to the findings of Kaplan et al. [12] and Ng et al. [31], who showed that government

involvement helps to expand EV usage. Shalender & Sharma [17] also explain that EV price subsidies are a way to increase accessibility and reduce the complexity of using EV-related services and products, which can eventually lead to customer intention. These findings indicate that improving accessibility to EV-based delivery services, reducing complexity, and managing pricing so that customers can afford it, whether through the service provider or government support, are key strategies to support CI in the delivery sector. However, even though PBC is the most influential factor, attitude (AT) and social pressure (SN) still have some influence and should not be overlooked in shaping customer behavior.

Secondly, WP became a critical variable after it was added to the original model. The findings show that WP has a direct and undeniable influence on CI. This result is consistent with previous research that examined WP in the context of green products and EV users [26, 31, 32, 34, 47]. The inclusion of WP in the model helped increase the explanatory power and had a noticeable effect on CI. This shows that customers who are willing or ready to pay for EV-based delivery services are more likely to use them. However, an interesting point is that after WP was added, the variable AT no longer made a significant contribution to CI. This suggests that the strength of WP's influence is high enough to weaken or replace the role of AT. This is in line with Moser [26], who showed that WP could reduce the effect of AT in predicting green purchasing behaviors. However, the current study finds that WP replaces AT, while PBC remains the most influential factor on CI, followed by WP and then SN. This result indicates that in the context of customer intention to use EV-based delivery, customers still prioritize the ease of use of the service, such as using the application or accessing EV delivery channels. If customers perceive the service as easy to use and not complicated, and they are willing to pay, then attitude is no longer necessary in influencing their intention to use the service. Moreover, the results provide valuable insights into WP within a predominantly lower-income sample, as over 80% of respondents reported earning less than 20,000 THB per month. While the sample's income homogeneity limits the ability to compare WP across income brackets, the findings underscore that affordability is a key factor in EV delivery adoption for this demographic. This aligns with [48], who found that although customers often express price sensitivity toward EV-related services, environmental values can mitigate this concern when activated. Despite the income limitation, the concentration on lower-income consumers offers rare insight into affordability thresholds, a perspective often under-represented in WP studies. Given that this segment likely represents a substantial portion of the delivery market, understanding their pricing sensitivity is vital. Future research could expand this inquiry by targeting higher-income groups and exploring differentiated pricing models. Nevertheless, social expectations or pressure still have some influence on customer intention, even though the impact is smaller compared to other factors.

Thirdly, when EC was added to the model, the results showed that all five variables together explained and influenced CI at a higher level compared to the two previous models. Moreover, EC became the most influential factor on CI. This finding supports previous studies that have linked EC with green behavior and the decision to adopt EVs [10, 37, 38, 49]. It suggests that individuals with high levels of environmental awareness are more likely to choose EV-based delivery services. Surprisingly, in the final model, although all five variables were included, AT and SN no longer had significant effects on CI. This finding indicates that the influence of EC may substitute the role of personal attitudes and social norms in deciding to use EV-based delivery services. This is similar to the view of Alzubaidi et al. [21], who proposed that EC can be seen as a general type of attitude that affects pro-environmental behavior. In addition, Boo & Tan [16] suggested that providing clear and useful information about eco-friendly products, such as EVs, can promote a positive attitude and also influence CI. However, considering that only EC, WP, and PBC significantly affected CI in the final model, it can be implied that personal characteristics may play a key role in the decision to use EV-based delivery services. These include environmental awareness, readiness to pay, and ease of access to EV services without complexity. Due to research data gathered from 89.7% of the age range of 18 to 30 years old. This result is consistent with Gomes et al. [47] and Cattapan et al. [50], who noted that Generations Y and Z are more likely to use and pay for green products, as they tend to have higher environmental concern. Therefore, if this group feels that eco-friendly services are accessible and affordable, CI is likely to happen, even without social pressure or the influence of attitude.

Finally, when EC was added to the model, both AT and SN lost their statistical significance in predicting CI. This outcome suggests that EC, as a deeply held value, exerts a dominant influence over customer decisions regarding EV-based delivery services. In the Thai context, this finding can be attributed to the cultural orientation of collectivism, where shared concerns, such as environmental sustainability, are often internalized more deeply than individual preferences or social expectations [51, 52]. Moreover, environmental values in Thailand have been reinforced through public discourse, education, and government initiatives such as the ZEV30@30 policy [15], which frames EV adoption as a national priority. As such, customers who are environmentally concerned may not need additional motivation from attitudes or social pressure to form a behavioral intention. This aligns with Moser [26], who found that environmental concern can replace traditional TPB variables in predicting sustainable behaviors, and with [53], who emphasized the role of shared cultural values in collectivist societies. Thus, in promoting EV-based delivery, it may be more effective for service providers and policymakers to focus on value activation, such as emphasizing environmental benefits, rather than solely targeting personal preferences or peer influence. Thus, for service providers,

delivery companies, policymakers, and other stakeholders, it is important to first promote environmental awareness among customers. After that, efforts should focus on making green products and services easy to access and use. Ultimately, these factors may encourage willingness to pay and lead to an increase in CI.

To summarize, the hierarchical regression results show that while the core TPB variables, particularly perceived behavioral control, are initially strong predictors, the inclusion of willingness to pay and environmental concern significantly improves model fit. Furthermore, environmental concern, in particular, emerges as a critical determinant of customer intention to use EV-based delivery services, suggesting a value-driven, sustainability-conscious mindset among potential users without any need for attitude and norms. However, samples collected for the study consisted of young and female respondents as well as those in lower-income groups, which might affect generalizability. Therefore, expanding more diverse demographic participation is in order to examine potential differences in perception, willingness to pay, and environmental concern across age and gender groups. This will help provide more comprehensive insights for service providers and policymakers.

6. Contributions

6.1. Theoretical Contributions

This study aimed to assess the level of Thai customers' intention to use delivery services that operate with EVs. The TPB was applied as the main framework for this research. The findings confirm the suitability of the three core TPB components in predicting customer intention in the context of EV-based delivery services. In addition, the study showed that extending the TPB model by including willingness to pay and environmental concern helped improve the model's explanatory power compared to the original version. Notably, the results reveal that environmental concern may serve as a substitute for traditional TPB constructs such as attitude and subjective norm. This finding suggests a shift from an attitude-driven to a more value-driven decision-making process when customers evaluate sustainable services like EV-based delivery. Such a pattern deviates from conventional TPB applications and indicates the need to reconsider how personal values influence behavioral intention in pro-environmental contexts. These insights contribute to the growing literature on green consumer behavior and propose a more nuanced application of the TPB framework. The extended TPB model used in this study can serve as a foundation for future research in related areas, including sustainable transportation, green logistics, and consumer adoption of environmentally responsible innovations.

6.2. Managerial Contributions

The findings from this study highlight two key contributions in managerial contexts. First, policymakers, as those who enforce and support the use of EVs in the delivery or courier industry, particularly with the goal of promoting environmental protection, can apply these results by developing policies that support basic infrastructure. This would help reduce complexity and increase convenience for customers. For instance, the government should subsidize EV charging stations in logistics hubs and offer tax incentives for private logistics firms transitioning to EV fleets. In addition, cost-reduction measures for service providers could help lower the price barrier for customers when choosing EV-based delivery services. Furthermore, promoting environmental campaigns to raise customer awareness and concern can also drive usage behaviors. The public, such as the Ministry of Energy and the Office of Transport and Traffic Policy and Planning, can partner with logistics firms to launch awareness campaigns promoting EV delivery as a national green initiative. Second, in the business sector, service providers or companies can use the findings to guide their marketing strategies. These should focus on improving access to EV-based services and clearly communicating environmental benefits to match customers' environmental concerns. This may help encourage greater use of EV delivery options. Pilot projects should begin with urban areas, where EV fleets are more feasible due to infrastructure and delivery density. Delivery companies can introduce EV-based delivery as a value-added option at a modest price premium targeted toward environmentally conscious customers. In addition, use tiered pricing models or offer EV delivery as a default option in sustainable product lines, such as organic food delivery and eco-packaging, to create alignment between product and delivery values. However, further discussion is still needed on the practical methods and steps for implementation; the findings offer a basic direction for supporting the use of EVs in delivery services and for advancing sustainable business practices in the long term.

7. Conclusion and Future Research

This study investigated the factors influencing customers' intention to adopt electric vehicle (EV)-based delivery services in Thailand by extending the Theory of Planned Behavior (TPB) with two additional constructs: willingness to pay and environmental concern. The results provided consistent support for three of the five proposed hypotheses across all models, identifying perceived behavioral control, willingness to pay, and environmental concern as the most significant predictors of customer intention. These findings suggest that consumers' decisions are primarily driven by practical capability, financial readiness, and value-driven environmental motivations.

In contrast, subjective norm was significant only in the early models but lost influence once environmental concern was added, while attitude was significant only in the baseline TPB model. This shift indicates that when value-oriented constructs are included, they may supersede traditional TPB predictors like attitude and social pressure. In other words, consumers appear to make more autonomous, values-based decisions rather than being influenced by general opinion or social norms, particularly in the context of sustainable delivery options. These insights provide actionable implications for both policymakers and service providers. Strategies that focus on promoting environmental benefits, improving usability and accessibility of EV-based services, and addressing pricing concerns are likely to be more effective than efforts based solely on awareness campaigns or social influence mechanisms.

Despite its contributions, the study has limitations. It relied on non-probability purposive sampling, and the sample was skewed toward younger, lower-income female respondents, potentially limiting the generalizability of the findings. Future research should include more diverse demographic groups and consider using longitudinal designs to examine changes in behavior over time. Additionally, exploring intergenerational or regional differences could yield more nuanced insights into EV service adoption and inform targeted strategies for expanding sustainable last-mile logistics.

8. Declarations

8.1. Author Contributions

Conceptualization, N.H., S.V., W.W., S.A., I.S., and P.B.; methodology, N.H., S.V., W.W., S.A., I.S., and P.B.; formal analysis, N.H., S.V., W.W., S.A., I.S., and P.B.; investigation, N.H. and S.V.; data curation, S.V.; writing—original draft preparation, N.H., S.V., W.W., S.A., I.S., and P.B.; writing—review and editing, S.V. and A.S. All authors have read and agreed to the published version of the manuscript.

8.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

8.3. Funding

8.4. Institutional Review Board Statement

Not applicable.

8.5. Informed Consent Statement

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

8.6. Declaration of Competing Interest

The authors declare that there are no conflicts of interest concerning the publication of this manuscript. Furthermore, all ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I: Questionnaire

Part 1: Screening Questions

1. Are you 18 years old or older?

☐ Yes　☐ No (End of survey)

2. Have you ever used delivery services?

☐ Yes　☐ No (End of survey)

Part 2: Demographic Information

1. Gender

☐ Male　　　　　☐ Female　　　　　☐ LGBTQIA+

2. Age

☐ 18–25　　　☐ 26–30 ☐ 31–35 ☐ 36–40 ☐ 41–45

☐ 46–50　　　☐ 51–55 ☐ 56–60 ☐ 61 or above

3. Education Level

☐ Below Bachelor's ☐ Bachelor's　　　☐ Higher than Bachelor's

4. Occupation

☐ Student　　　☐ Government official/public employee　　　☐ Private company/SOE employee

☐ Business owner/freelancer ☐ Homemaker　☐ General labor　☐ Unemployed

5. Monthly Income (THB)

☐ ≤10,000　　　　☐ 10,001–20,000　　　☐ 20,001–30,000　　　☐ 30,001–40,000

☐ 40,001–50,000　　☐ 50,001–60,000　　　☐ ≥60,001

Part 3: Factors Affecting Customer Intention to Use EV-based Delivery Services

1 = Strongly disagree　　2 = Disagree　　3 = Neutral　　4 = Agree　　5 = Strongly agree

Questions	Levels of Agreement				
	1	2	3	4	5
Attitude					
1. I like using EV-based delivery services.					
2. I would choose services that use EV-based delivery services.					
3. I believe humans have a duty to protect nature.					
Subjective Norm					
4. People who influence me may influence my decision to use EV-based delivery services.					
5. Important people to me think I should use EV-based delivery services.					
6. My friends and family think it's a good idea to use EV-based delivery services.					
Perceived Behavioural Control					
7. I try to use EV-based delivery services.					
8. I am confident I can use EV-based delivery services.					
9. I have the financial means and opportunities to do so.					
Willingness to Pay					
10. I am willing to pay more for EV-based delivery services.					
11. I am happy to pay more for alternative EV-based delivery services.					
12. I am willing to pay more if it reduces carbon emissions.					
Environmental Concern					
13. I am willing to support EV-based delivery services to protect nature.					
14. Promoting EV-based delivery services is essential today.					
15. EV-based delivery can reduce unsustainable resource use.					
16. I am aware of the environmental impacts of non-eco-friendly vehicles and tend to prefer greener options.					
Customer Intention to Use					
17. I plan to use EV-based delivery services.					
18. I will consistently use EV-based delivery services.					
19. I intend to use EV-based delivery services more frequently in the future.					