

Analysis of Antecedent Factors Influencing the Adoption and Conversion of Two-Wheeled Battery Electric Vehicles (BEVs) in East Kalimantan Province

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ARTICLE INFO

Article history

Received August 28, 2025

Revised September 17, 2025

Accepted October 23, 2025

Keywords

Electric Vehicle Ecosystem (EVE);

Field theory;

Theory of Planned Behavior (TPB);

Two-Wheeled Battery Electric Vehicles (BEVs);

ABSTRACT

The rise in motorcycle ownership in Indonesia has increased energy consumption and greenhouse gas emissions, challenging the country's net-zero target by 2060. To mitigate this, the government is promoting the adoption and conversion of two-wheeled Battery Electric Vehicles (BEVs), but implementation remains below target, implying behavioral factors as a major barrier. This study analyzes the determinants influencing consumer and potential consumer behavior in adopting two-wheeled BEVs in East Kalimantan, a strategic region supporting the Indonesian Capital City. Using the Field Theory framework, the model integrates the Theory of Planned Behavior (TPB), which represents personal factors (Attitude, Subjective Norm, Perceived Behavioral Control, and Intention), and the Electric Vehicle Ecosystem (EVE), which represents environmental factors (Performance, Infrastructure, Price, and Features). Data from 400 respondents were analyzed using SEM-PLS, which explained 65.8% of the variance in adoption intention. The results show that Subjective Norms, Perceived Behavioral Control, Performance, Price, and Features significantly influence intention, while Attitude and Infrastructure do not. These findings reveal that consumers view two-wheeled BEVs primarily as functional alternatives to conventional motorcycles, rather than as environmentally friendly innovations. The contributes of this study is that it extends behavioral research by integrating TPB and EVE into Field Theory, and, practically, it highlights the need for policies that combine economic incentives with behavioral interventions to accelerate BEV adoption in Indonesia.

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1. Introduction

Transportation in developing countries, particularly in Southeast Asia, is highly dependent on motorcycles (Balijepalli et al., 2023; Chen et al., 2021; Qin et al., 2021). Due to high population density, the dominance of the middle class, limited road width and length, and insufficient public transport facilities, motorcycles have become the most preferred mode of transportation in this region, especially in Indonesia (Guerra, 2019; Sovacool et al., 2019). In addition to their relatively affordable price, motorcycles also provide flexibility and maneuverability in riding (Chiu & Guerra, 2023; Yeung

et al., 2015), making them well-suited to the congested and narrow urban roads of Indonesia (Chiu, 2022; Murtiningrum et al., 2022; Umniyatun et al., 2021).

From a functional perspective, motorcycles are the most suitable choice for Indonesian society (Fevriera et al., 2021). However, from a statistical standpoint, the rapid growth in motorcycles ownership poses a serious environmental challenge (Bajwa & Sheikh, 2023; Dutta & Chavalparit, 2023; Ho et al., 2023). As seen in Fig. 1 illustrates the significant increase in the number of motorcycles over the years in Indonesia. The transportation sector accounts for approximately 33% of total national energy consumption, of which 99% is still supplied by fossil fuels. This situation has led to a substantial rise in greenhouse gas emissions (Transparency, 2022). If this trend continues, Indonesia risks failing to meet the Paris Agreement target of limiting global temperature rise to below 1.5°C.

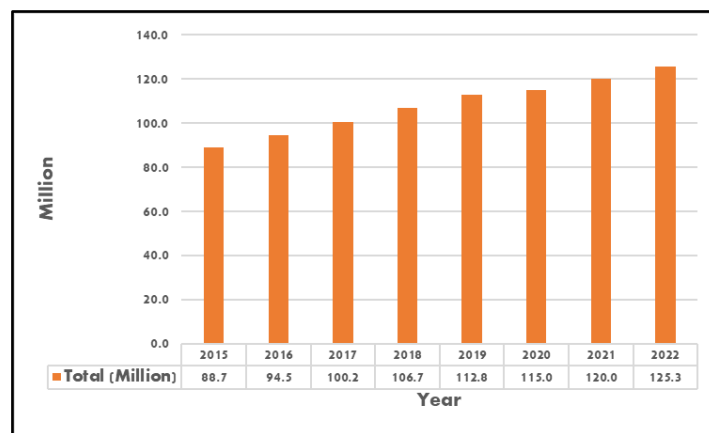


Fig. 1. Annual growth of motorcycles in Indonesia.

To achieve the ambitious target of net zero emissions by 2060, the Indonesian government has undertaken various strategic measures (Humayro & Virgianita, 2024; Siregar, 2024). One key effort is the issuance of Government Regulation No. 79 of 2023, which revises Presidential Regulation No. 55 of 2019 concerning the acceleration of the Battery Electric Vehicle (BEV) program for road transportation (Presidential Regulation of the Republic of Indonesia, 2023). This policy reflects the government's commitment to reducing air pollution and decreasing dependency on petroleum by promoting the adoption and conversion of gasoline-powered vehicles to BEVs, particularly two-wheeled vehicles. This is especially relevant given that the transportation sector is one of the largest contributors to greenhouse gas emissions in Indonesia, as illustrated in Fig. 2.

According to the Regulation of the Minister of Industry of the Republic of Indonesia No. 6 of 2023, the government set an incentive quota for two-wheeled BEVs at 200.000 units in 2023, which increased to 600.000 units in 2024 (Presidential Regulation of the Republic of Indonesia, 2023). This scheme provides price reductions for each beneficiary as a stimulus incentive intended to attract public interest. However, the realization of the program remains far below the established target. In 2023, the number of converted two-wheeled BEVs reached only 180 units (Ministry of Energy and Mineral Resources of the Republic of Indonesia, 2023; Republika Online, 2024). Meanwhile, by September 2024, the purchase of two-wheeled BEVs utilizing the incentive scheme had only reached around 42.800 units (Andi & Perwitasari, 2024; Rajendra & Meilanova, 2025).

This study adopts Field Theory, which conceptualizes behavior through two main dimensions: personality and environment (Kounin, 1963). On the personality dimension, the study applies the Theory of Planned Behavior (TPB), consisting of four key constructs: Attitude, Subjective Norm, Perceived Behavioral Control, and Intention (Ajzen, 1991). On the environmental dimension, the study employs the Electric Vehicles Ecosystem (EVE) model, which comprises four constructs:

Performance, Infrastructure, Price, and Feature (Zulkarnain et al., 2014). By identifying the factors that shape consumer and potential consumer behavior toward two-wheeled BEVs, this study aims to provide insights for designing more targeted and effective market penetration strategies for two-wheeled BEVs in East Kalimantan. This study specifically focuses on the community of East Kalimantan, as its two main cities, Balikpapan and Samarinda, have been designated as super-hubs of the Nusantara Capital City (IKN). Both cities are envisioned to become zero-waste cities, with the ambition of fully utilizing environmentally friendly vehicles, including two-wheeled BEVs (Deputy for Environment and Natural Resources, 2023).

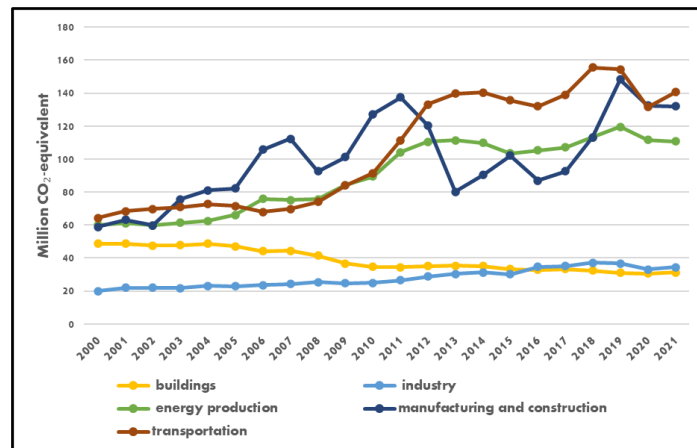


Fig. 2. Annual greenhouse gas emissions in Indonesia by sector, 2000–2022.

Therefore, this study concentrates on the behavioral dimensions of consumers and potential consumers of two-wheeled BEVs, an area that has so far received limited attention from government policies, which predominantly emphasize technical and financial incentives (Fu & Juan, 2017). While consumer behavior is strongly associated with intentions and actual actions, such as product purchases and service utilization, its role has often been underestimated in the policy discourse. A more comprehensive understanding of consumer behavior, along with behavioral engineering efforts, is essential to enhance satisfaction, interest, purchasing decisions, and even customer loyalty (Anderson et al., 1994; Su et al., 2018). Previous studies have consistently shown that consumer behavior positively influences the adoption and conversion of EVs (Chaturvedi et al., 2023; Corradi et al., 2023; Kwon et al., 2020; X. Li et al., 2023). These findings indicate a clear research gap: although government initiatives prioritize infrastructure and subsidies, the behavioral aspect remains underexplored, potentially explaining why adoption rates of two-wheeled BEVs in Indonesia remain below expectations.

2. Method

2.1. Field Theory

Initially, Field Theory was a fundamental principle in physics, stating that interactions and forces create a field that influences objects (Gooding, 1981). Examples can be found in magnetic and gravitational fields. An iron object with a certain mass and weight placed within a magnetic field will behave according to the influence of that field. This principle was later introduced by Kurt Lewin into the field of social sciences. The theory posits that human behavior is influenced by individual capacity or personality (Person) and the environment (Environment). Individual capacity or personality is analogous to the mass and weight of an iron object, while the magnetic force represents the environment. Based on this concept, Lewin formulated *Field Theory* in the social sciences into Eq. (1) (Lewin, 1939).

$$B = f(P, E) \quad (1)$$

Thus, behavior can be realized when individual capacity (P) and the environment (E) mutually support each other and exceed the cognitive threshold required for such behavior. This condition is referred to as the 'life space', a concept first introduced by Brown (Brown, 1936). Within this framework, individuals can only behave within the boundaries of their life space.

2.2. Theory of Planned Behavior (TPB)

The TPB has been widely applied in various studies in the field of psychology, particularly in analyzing consumer behavior tendencies, including purchasing behavior (Alam et al., 2024; Parida & Gadekar, 2024). TPB is an extension of the Theory of Reasoned Action (TRA), which emphasizes that an individual's behavior is determined by the intention to perform it. Such intention is shaped by three main constructs: Attitude, Subjective Norm, and Perceived Behavioral Control (Ajzen, 1991). Over time, TPB has been broadly implemented across multiple academic disciplines, including law (J.-C. Li et al., 2024), economics (Alam et al., 2024), and engineering (Guo & Wang, 2024).

The TPB model explains that individuals process information such as approval, beliefs, thoughts, and ideologies as the basis for forming behavior (Donald et al., 2014). Although TPB has been widely applied, it has not been free from criticism, particularly regarding its low predictive efficacy for actual behavior (Tommasetti et al., 2018). This critique aligns with Lewin's perspective in Field Theory (Lewin, 1939), which emphasizes that behavior results from the interaction between an individual's personality and their environment, rather than being solely an internal psychological construct. Consequently, several studies have attempted to enhance the predictive power of TPB by incorporating relevant external variables (Donald et al., 2014; Tommasetti et al., 2018). Field Theory underscores that behavior emerges from the accumulation of the Personality and Environment dimensions (Kounin, 1963; Lewin, 1939), meaning that the addition of model variables in TPB case studies may vary depending on an individual's behavioral field. For example, in studies on environmental awareness and sustainability, some researchers have incorporated the variable *environmental awareness* to improve the accuracy of the developed model (Y. Li & Shan, 2025; Maulana et al., 2025).

2.3. Electric Vehicles Ecosystem (EVE)

This model is derived from the business ecosystem paradigm, which functions to integrate synergies among companies to generate innovation (Moore, 1993). The ecosystem perspective emphasizes the importance of collaboration among stakeholders to achieve specific objectives (Hearn & Pace, 2006). From the consumer adoption perspective, this model identifies four main variables: Performance, Infrastructure, Price, and Feature (including maintenance, services, payment, and style).

One of the key indicators within the Performance variable is driving range capability, which is a crucial factor in EVs adoption (Ehsan et al., 2024; Franke et al., 2012; Hasib et al., 2024). Driving range refers to the maximum distance that can be covered on a single battery charge (Hasib et al., 2024). This condition also requires the availability of public EVs charging stations (SPKLU) and sufficient battery capacity (Sabarimuthu et al., 2021). Both aspects demand support from various stakeholders to minimize the risk of user dissatisfaction and failure in EVs market penetration (Apata et al., 2023).

From the perspective of the Price variable, in the absence of subsidies, battery costs can be very high, negatively affecting interest in EVs adoption (Maulana et al., 2025; Saputra & Andajani, 2024). Additionally, for the *Infrastructure* variable, factors such as the availability of public EVs charging stations (SPKLU), maintenance facilities, and spare parts also serve as critical determinants (Habich-Sobieghalla et al., 2018; Hakam & Jumayla, 2024).

Government involvement in the development of the EVs ecosystem is also a strategic element (Zulkarnain et al., 2014). Various policies, such as price subsidies, tax incentives, sustainable EVs

battery management, and parking fee privileges, have been shown to increase interest in EVs adoption in several countries (Yuniaristanto et al., 2022; Zulkarnain et al., 2014). However, the effectiveness of these policies varies across different countries. Overall, the variables Performance, Infrastructure, Price, and Feature within the EVE dimension can only be optimized through intensive collaboration among stakeholders (Zulkarnain et al., 2014).

2.4. Hypothesis Development

Based on the discussion in the previous subsection, this study formulates seven hypotheses representing the Personality (P) and Environment (E) dimensions. Each dimension is represented by the TPB and the EVE, respectively. The hypotheses in this study are as follows:

2.4.1. Attitude – Intention

Attitude is the first variable in TPB, reflecting an individual's tendency to respond to a particular behavior (Ajzen, 1991). This variable is also present in other behavioral models, such as the Technology Acceptance Model (TAM) (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). The inclusion of *attitude* across multiple behavioral models indicates a strong relationship between attitude and behavioral intention (Wong et al., 2024). Based on the above discussion, the following hypotheses are proposed:

H₁: An individual's Attitude influences their Intention to use two-wheeled BEVs.

2.4.2. Subjective Norm – Intention

The constructs of Subjective Norm have been shown to be relevant in several studies analyzing general intentions to adopt electric vehicles (Hasan, 2021; Simsekoglu & Nayum, 2019). However, some studies, such as those conducted by Huang & Ge (2019), and Asadi et al. (2021), found that these two variables did not have a statistically significant effect. Based on the above discussion, the following hypotheses are proposed:

H₂: An individual's Subjective Norm influences their Intention to use two-wheeled BEVs.

2.4.3. Perceived Behavioral Control – Intention

Perceived behavioral control refers to an individual's perception of ease or difficulty in performing a behavior (Ajzen, 1991) and is particularly relevant to BEV adoption. Prior studies (Alam et al., 2024; Zhang et al., 2018) confirm its significant effect on intention toward EV adoption. Based on the above discussion, the following hypotheses are proposed:

H₃: An individual's Perceived Behavioral Control influences their Intention to use two-wheeled BEVs.

2.4.4. Performance – Intention

The performance construct captures EV capabilities in terms of safety, maximum speed, and driving range (Zulkarnain et al., 2014). Prior studies highlight that driving range and maximum speed significantly influence adoption intention (Ehsan et al., 2024; Franke et al., 2012; Hasib et al., 2024), while safety, particularly battery safety, also plays a critical role (Simsekoglu & Nayum, 2019; Sopha et al., 2022). Based on the above discussion, the following hypotheses are proposed:

H₄: The Performance of two-wheeled BEVs influences the Intention to use them.

2.4.5. Infrastructure – Intention

The availability of adequate infrastructure has been shown to influence EV adoption intention in several studies (Habich-Sobieghalla et al., 2018; Hakam & Jumayla, 2024; Zulkarnain et al., 2014). In particular, the presence of charging stations (SPKLU), along with battery safety and charging speed, is considered a key factor given that EVs, as an emerging technology, require reliable supporting facilities. Based on the above discussion, the following hypotheses are proposed:

H₅: The Infrastructure supporting two-wheeled BEVs influences the Intention to use them.

2.4.6. Price – Intention

Price significantly affects consumer intention toward EVs and other technologies in general (Anderson et al., 1994; Murtiningrum et al., 2022). Accordingly, one of the most common strategies to promote EV adoption is price subsidies (Shang et al., 2024). Evidence shows that subsidies in several case studies have successfully increased EV purchases (Nunes & Woodley, 2023). Based on the above discussion, the following hypotheses are proposed:

H₆: The Price of two-wheeled BEVs influences the Intention to use them.

2.4.7. Feature – Intention

Supporting features influence consumer intention toward EV adoption (Zulkarnain et al., 2014). These include the ease of maintenance, service availability, payment systems, and design style offered across EV models (Ehsan et al., 2024; She et al., 2017). However, infrastructure availability alone does not guarantee increased adoption; features must be assured to function properly and be well-designed (Zulkarnain et al., 2014). Based on the above discussion, the following hypotheses are proposed:

H₇: The Feature of two-wheeled BEVs influence the *Intention* to use them.

The research construct model is presented in Fig. 3.

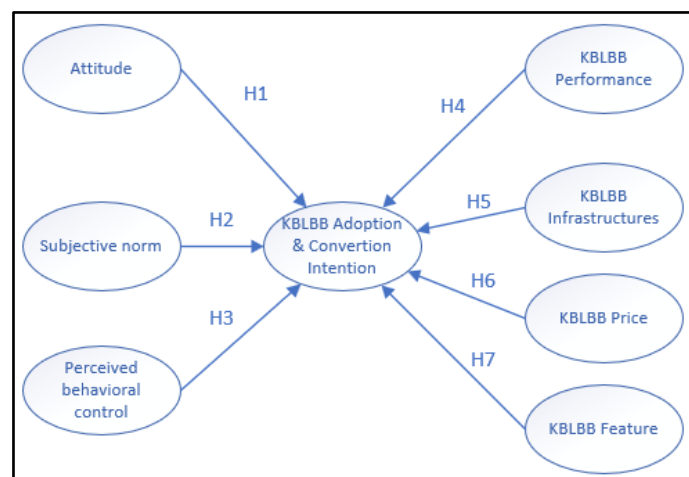


Fig. 3. Hypothesis model of the study integrating TPB and EVE dimensions.

2.5. Questionnaire Design

The research instruments consisted of both online and paper-based questionnaires with closed-ended questions based on a Likert scale. The questionnaire was structured into four sections: (1) introduction, (2) informed consent, (3) demographic characteristics, and (4) Likert-scale questions. The introduction section provided information about the researcher's identity, the research objectives, and instructions for completing the questionnaire. The informed consent section included a statement of the respondent's willingness to participate in the study along with assurances of data confidentiality. The demographic characteristics section contained questions related to the respondents' profiles, as previously described. The final section comprised Likert-scale items covering the research construct indicators. A detailed overview of the construct indicators can be seen in Table 1.

2.6. Data Collection

A purposive sample of 400 respondents was selected to ensure adequate representation across demographic groups and geographical coverage. This sample size exceeds the minimum requirement suggested for SEM analysis (Hair Jr. et al., 2019), thereby ensuring statistical robustness while

capturing sufficient variability in EV adoption behavior. The respondent criteria were defined as follows: (1) residing in East Kalimantan, including Balikpapan, Berau, East Kutai, Kutai Karta Negara, Penajam Paser Utara, Samarinda, Bontang, West Kutai, and Paser; (2) aware of, have seen, or have used two-wheeled BEVs; (3) belonging to specific birth cohorts, namely Baby Boomers (1946-1964), Generation X (1965-1980), Millennial (1981-1996), Generation Z (1997-2009), and Generation Alpha (≥ 2010); and (4) having their own monthly income, measured using the Socio-Economic Status (SES) index in Indonesia.

Table 1. Indicators of the research constructs.

Construct	Indicators	Code	Sources
Attitude	Gain – Loss	ATT1	(Ajzen, 1991; Shalender & Sharma, 2021)
	Positive – Negative	ATT2	
	Desired – Undesired	ATT3	
Subjective Norm	Significant others	SJ1	
	Consideration of close others	SJ2	
	Personal influence	SJ3	
	Reference person	SJ4	
Perceived Behavioral Control	Accessibility	PBC1	
	Price consideration	PBC2	
	Sales service	PBC3	
Intention	Enthusiasm	INT1	
	Future decision	INT2	
	Future recommendation	INT3	
Performance	Safety	PRF1	(Zulkarnain et al., 2014)
	Speed	PRF2	
	Range	PRF3	
Infrastructures	Charging time	INF1	
	Charging point availability	INF2	
	Battery safety	INF3	
Price	High initial price	PRC1	
	Running cost	PRC2	
	Incentive	PRC3	
Feature	Maintenance	FTR1	
	Services	FTR2	
	Payment	FTR3	
	Style	FTR4	

3. Results and Discussion

3.1. Respondent Demographics Characteristic

Respondent demographics provide a general overview of the participants' characteristics in the study. In this research, three demographic characteristics were considered: region of origin, birth cohort, and income. The details of the indicators along with the number of respondents for each characteristic are presented in Table 2.

Table 2. Respondent demographic characteristics.

Characteristics	Indicators	Frequency
Region of origin	1. Balikpapan city	122
	2. Berau regency	3
	3. East Kutai regency	4
	4. Kutai Kartanegara regency	7
	5. Penajam Paser Utara regency	3
	6. Samarinda city	135
	7. Bontang city	117
	8. West Kutai regency	1

Characteristics	Indicators	Frequency
birth cohort	9. Paser regency	8
	10. Mahakam Ulu regency	1
	1. Baby Boomer (1946-1964)	7
	2. Generation X (1965-1980)	18
	3. Millenial (1981-1996)	88
income	4. Generation Z (1997-2009)	280
	5. Generation Aplha (2010-2024)	10
	1. <Rp 1.000.000	51
	2. Rp 1.000.001 - Rp 1.500.000	21
	3. Rp 1.500.001 - Rp 2.000.000	30
	4. Rp 2.000.001 - Rp 3.000.000	51
	5. Rp 3.000.001 - Rp 5.000.000	121
	6. Rp 5.000.001 - Rp 7.500.000	75
	7. > Rp 7.500.000	54

3.2. Convergent Validity

Convergent validity is a type of construct validity that indicates the extent to which the indicators within a construct are highly correlated with each other. There are three main criteria used to assess convergent validity: a factor loading ≥ 0.7 , Composite Reliability (CR) ≥ 0.7 , and Average Variance Extracted (AVE) ≥ 0.5 (Fornell & Larcker, 1981; Hair Jr. et al., 2019).

Table 3. Results of convergent validity test for indicator items.

Variable	Indicators	Factor Loading
Attitude	ATT1	0.918
	ATT2	0.763
	ATT3	0.620
Subjective Norm	SJ1	0.879
	SJ2	0.468
	SJ3	0.876
	SJ4	0.686
Perceived Behavioral Control	PBC1	0.598
	PBC2	0.790
	PBC3	0.860
Intention	INT1	0.899
	INT2	0.911
	INT3	0.858
Performance	PRF1	0.834
	PRF2	0.885
	PRF3	0.860
Infrastructure	INF1	0.782
	INF2	0.744
	INF3	0.878
Price	PRC1	0.901
	PRC2	0.876
	PRC3	0.922
Feature	FTR1	0.850
	FTR2	0.858
	FTR3	0.846
	FTR4	0.803

Based on Table 3, four construct indicators, ATT3, SJ2, SJ4, and PBC1, exhibited factor loadings below 0.70. Consequently, these indicators were removed from the analysis and were not included in subsequent testing stages.

3.3. Discriminant Validity

Discriminant validity assesses the degree to which a construct is empirically distinct from other constructs that it is theoretically expected to differ from (Hair Jr. et al., 2019). This evaluation ensures that each construct in the model captures a unique concept, thereby minimizing potential measurement overlap. A construct is deemed to satisfy discriminant validity if the square root of its Average Variance Extracted ($\sqrt{\text{AVE}}$) exceeds its correlations with all other constructs in the model (Fornell & Larcker, 1981).

Table 4. Results of discriminant validity test for construct variables

	ATT	FTR	INF	INT	PBC	PRC	PRF	SJ
ATT	0.777							
FTR	0.358	0.840						
INF	0.364	0.758	0.803					
INT	0.363	0.688	0.653	0.890				
PBC	0.378	0.603	0.624	0.683	0.757			
PRC	0.365	0.702	0.695	0.681	0.597	0.900		
PRF	0.412	0.626	0.727	0.716	0.782	0.702	0.860	
SJ	0.435	0.611	0.539	0.629	0.601	0.527	0.552	0.796

As shown in Table 4, the $\sqrt{\text{AVE}}$ for each construct exceeds its correlations with all other constructs, indicating that each construct in the model meets the established criteria for discriminant validity.

3.4. Reliability Test

Reliability testing evaluates the internal consistency of a construct to determine the extent to which each indicator produces stable and consistent results in measuring the same concept. Common indicators for assessing reliability include a Cronbach's alpha value of ≥ 0.7 (or ≥ 0.6 under the condition that Composite Reliability (CR) ≥ 0.7 and AVE ≥ 0.5) (Fornell & Larcker, 1981; Hair Jr. et al., 2019).

Table 5. Results of reliability testing for each construct variable.

Variabel	Cronbach's alpha	Composite Reliability	AVE
Attitude	0.744	0.817	0.604
Subjective Norm	0.698	0.830	0.633
Perceived Behavioral Control	0.635	0.798	0.574
Intention	0.868	0.919	0.791
Performances	0.823	0.895	0.739
Infrastructures	0.727	0.844	0.645
Prices	0.883	0.927	0.810
Fitures	0.863	0.905	0.705

Based on Table 5, two construct variables, Subjective Norm and Perceived Behavioral Control, exhibited Cronbach's alpha values below 0.7. However, according to the criteria proposed by Fornell and Larcker (1981), a construct with a Cronbach's alpha below 0.7 can still be considered reliable if its CR is ≥ 0.7 and its AVE is ≥ 0.5 . Therefore, both constructs are deemed reliable based on the Fornell-Larcker criteria.

3.5. Coefficient of Determination (R Square)

The coefficient of determination, or R^2 , is a statistical measure in structural model analysis that indicates the extent to which the independent variables explain the variance of the dependent variable in the model (Sarstedt et al., 2019). There are four categories for interpreting R^2 values: very weak

(< 0.25), weak (≥ 0.25), moderate (≥ 0.50), and substantial (≥ 0.75). Based on the coefficient of determination test, Intention achieved an R^2 value of 0.657, indicating that 65.7% of the variance in intention is explained by the construct variables included in the model.

3.6. Hypothesis Testing

Hypothesis testing was performed to evaluate whether the relationships among constructs in the structural model are statistically significant. The analysis provides the path coefficient, t-statistic, and p-value. The path coefficient reflects both the strength and direction of the effect of exogenous constructs on endogenous constructs, ranging from -1 to +1. Following Cohen (2013), path coefficients of 0.35, 0.15, and 0.02 are interpreted as strong, moderate, and weak effects, respectively. The t-statistic is compared against the critical value corresponding to a 95% confidence level ($t > 1.96$), while the p-value indicates the probability of the relationship being significant, with significance determined at $p < 0.05$.

Table 6. Results of hypothesis significance testing

Construct Relationships	Path Coefficient	t-statistic	p-values	Description
ATT -> INT	-0.017	0.476	0.634	Not significant and cannot be represented
FTR -> INT	0.205	3.897	0.000	Significant, positive, and moderate effect
INF -> INT	0.008	0.149	0.882	Not significant and cannot be represented
PBC -> INT	0.154	2.632	0.009	Significant, positive, and moderate effect
PRC -> INT	0.178	3.573	0.000	Significant, positive, and moderate effect
PRF -> INT	0.240	3.620	0.000	Significant, positive, and moderate effect
SJ -> INT	0.188	3.698	0.000	Significant, positive, and moderate effect

As presented in Table 6, Attitude (ATT) and Infrastructure (INF) were found to have no significant impact on the variance of adoption intention and EV conversion, with ATT showing a p-value of 0.634 (> 0.05) and a t-statistic of 0.476 (< 1.96), and INF showing a p-value of 0.882 (> 0.05) and a t-statistic of 0.149 (< 1.96). Conversely, Perceived Behavioral Control (PBC), Subjective Norm (SJ), Performance (PRF), Price (PRC), and Feature (FTR) exhibited positive and statistically significant effects, with the magnitude of influence classified as moderate.

3.7. Goodness-of-Fit Test

The Goodness-of-Fit test is applied to assess how well the construct model aligns with the observed data. Within the SEM-PLS framework, model fit is commonly evaluated using three key indices: the Standardized Root Mean Square Residual (SRMR), the Normed Fit Index (NFI), and Q^2 predict.

Table 7. Results of goodness-of-fit test for the construct model.

Indices	Value	Cut of value	Description
SRMR	0.081	≤ 0.08 (ideal), ≤ 0.10 (acceptable)	The model is close to the acceptability threshold.
Q^2	0.639	≥ 0.35 (strong); $0.15 \leq n \leq 0.35$ (moderate); $0.02 > n > 0.15$ (weak)	The model exhibits very strong predictive relevance.
NFI	0.655	≥ 0.90 ideal, ≥ 0.80 acceptable	Poor fit

As shown in Table 7, the construct model demonstrates an adequate fit with empirical data, as evidenced by SRMR and Q^2 values within acceptable thresholds, alongside a very strong level of predictive relevance.

3.8. Managerial Analysis

Based on Fig. 4, the model demonstrates an R^2 value of 0.658, indicating that 65.8% of the variance in adoption intention is explained by the constructs included in the model. The analysis revealed five constructs that demonstrated statistical significance: Subjective Norm, Perceived Behavioral Control, Performance, Price, and Feature. Performance (0.232) and Feature (0.196) emerge as the strongest predictors, underscoring the pivotal role of technical performance and product features in driving the adoption and conversion of two-wheeled EVs in East Kalimantan. This highlights the necessity for manufacturers to prioritize research and development efforts aimed at enhancing safety, speed, and range, three critical indicators of performance, to ensure competitiveness with conventional motorcycles (Gunawan et al., 2022; She et al., 2017; Wong et al., 2024).

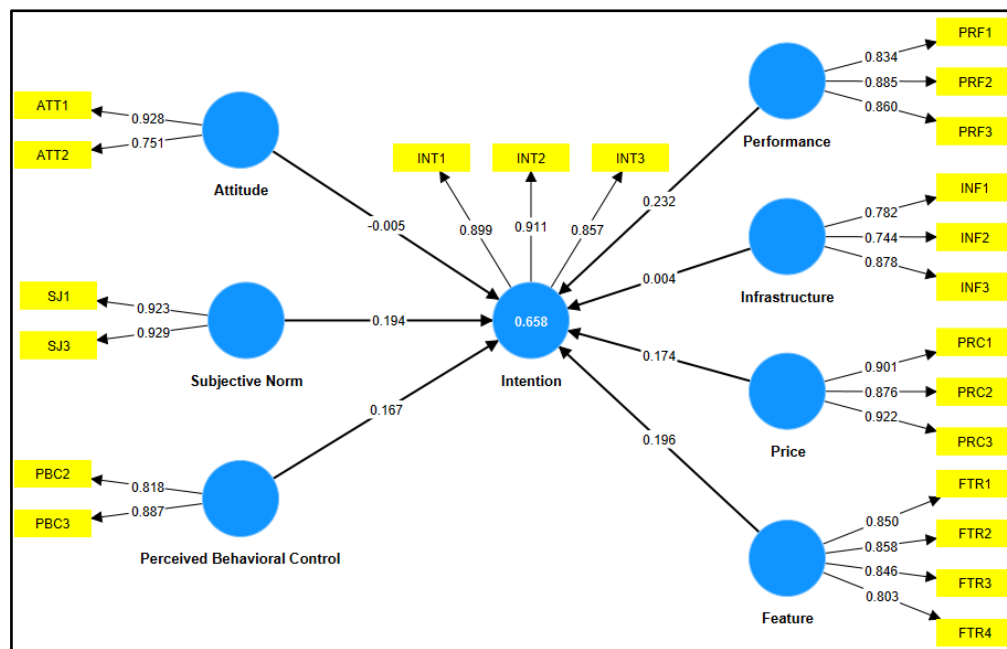


Fig. 4. Construct path loadings for the antecedent factors of two-wheeled EV adoption and conversion.

Despite the growing potential of two-wheeled EVs, safety concerns remain. In Europe, for instance, 29% of users reported accident involvement in 2016, a relatively high figure given the limited adoption rate at the time (Haustein & Möller, 2016). Moreover, accidents involving two-wheeled EVs are often more severe than those involving conventional motorcycles, as exemplified by lithium battery fires that not only pose fatal risks but also incur significant economic losses due to the potential for large-scale fires (Warner-Levy et al., 2024; Weber et al., 2014). Such risks remain a global issue, particularly in high-adoption markets such as the People's Republic of China (Nora, 2024).

Beyond safety, range and speed are equally crucial in shaping user acceptance. Range directly influences both economic efficiency and rider convenience, making it essential to optimize battery capacity relative to maximum vehicle speed (Hasib et al., 2024). Strengthening these three dimensions, safety, speed, and range, requires coordinated stakeholder collaboration to reshape societal perceptions of two-wheeled EVs (X. Li et al., 2023; Zhou et al., 2021). Addressing negative public perceptions through targeted R&D initiatives and tailored marketing strategies is therefore critical to fostering widespread adoption (Gustafsson & Holster Krantz, 2022).

In addition to performance, stakeholders must also address complementary features of two-wheeled EVs, including maintenance facilities, after-sales services, product design, and government-supported payment schemes. Reliable maintenance and accessible after-sales services are critical for

consumer satisfaction, while the lack of such facilities and spare parts access poses challenges to sustaining customer loyalty (Balinado et al., 2021; Borchardt et al., 2018). Simplifying subsidy-related purchasing processes is equally important, as bureaucratic barriers may discourage potential buyers; this is notable given that 70% of EV users in Europe purchased their vehicles due to government subsidy incentives (Nunes & Woodley, 2023; Shang et al., 2024). Moreover, the Infrastructure construct was found to be statistically insignificant, reflecting the limited availability of supporting infrastructure in East Kalimantan. Currently, each major city has only four public charging stations (SPKLU), with no facilities along intercity routes, see Fig. 5, Fig. 6, and Fig. 7.

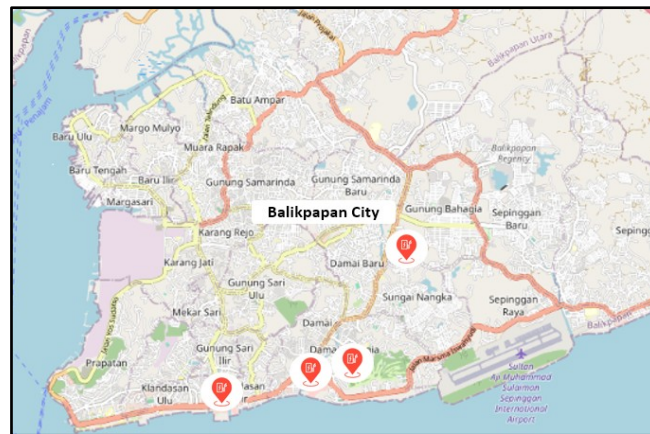


Fig. 5. Locations of EV Charging Stations (SPKLU) in Balikpapan City.

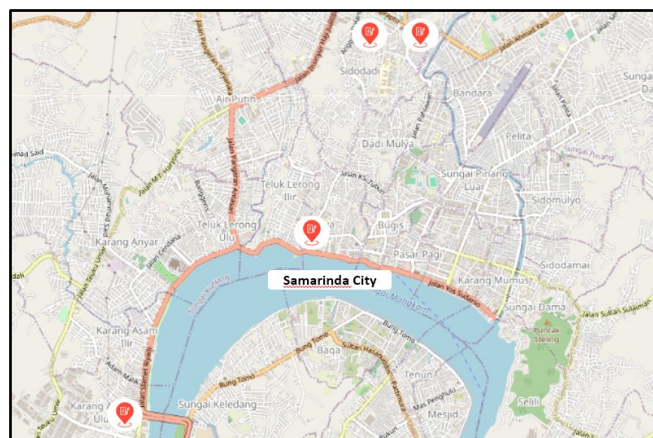


Fig. 6. Locations of EV Charging Stations (SPKLU) in Samarinda City.

Adequate infrastructure is essential to increase consumer interest (She et al., 2017; Yuniaristanto et al., 2022), and issues of driving range are closely tied to charging availability (Hasib et al., 2024). Given the present infrastructure, two-wheeled EVs in East Kalimantan remain suitable primarily for intra-city mobility, while intercity use remains impractical.

In addition to charging infrastructure, manufacturers should also provide battery swapping schemes, whereby a depleted battery is exchanged for a fully charged one at a designated facility (Ahmad et al., 2020). Similar to Indonesia's household gas cylinder distribution, this mechanism shortens charging time and enhances safety, cost-efficiency, and supply chain effectiveness, particularly in handling used batteries (Sopha et al., 2022). Moreover, swapping allows better monitoring of battery conditions, thereby reducing risks of battery-related incidents.

As seen in Fig. 5, also highlights the personality dimension through TPB constructs, namely Attitude, Subjective Norm, and Perceived Behavioral Control. Notably, Attitude is not statistically significant, indicating that environmental awareness and perceived benefits of two-wheeled BEVs are not yet well embedded in East Kalimantan. This aligns with Zhang et al. (2018), who noted that immature BEV markets often show a gap between environmental consciousness and consumer benefits. As a result, consumers still prioritize functional attributes, such as speed, range, maintenance, after-sales services, and price, over environmental values, making Attitude a key target for future interventions to enhance BEV adoption.

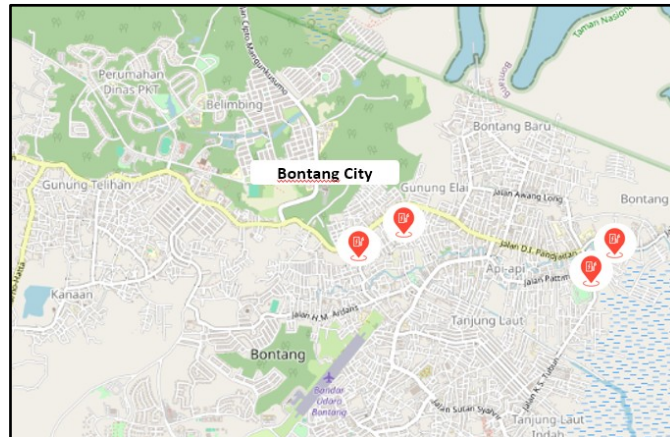


Fig. 7. Locations of EV Charging Stations (SPKLU) in Bontang City.

A meta-analysis of psychological correlates of driving behavior indicates that pro-environmental values exert only weak effects on behavioral outcomes (Gardner & Abraham, 2008). Across four key indicators of environmental awareness, the observed effect sizes were consistently low. In their study, Gardner & Abraham, (2008) found that awareness of environmental and health consequences from fossil-fuel vehicle use was associated with a small-to-moderate negative correlation with driving behavior ($r_+ = -0.24$). Similarly, awareness of risks to personal health and well-being linked to car use produced a small negative effect ($r_+ = -0.21$). These results suggest that, despite heightened awareness of the environmental and health risks posed by conventional vehicles, behavioral adjustments among drivers remain limited. In other words, knowledge of environmental consequences does not necessarily translate into substantial behavioral change in driving practices. This weak relationship highlights a persistent gap between environmental concern and actual behavior, a pattern widely recognized in environmental psychology literature.

Unlike Attitude, the Subjective Norm construct is statistically significant, reflecting Indonesia's collectivist culture in which family, relatives, and role models strongly influence BEV adoption decisions. Positive endorsements from close social circles encourage adoption, while negative evaluations hinder it, consistent with Latimer and Martin Ginis (2005), who emphasized the role of social approval in collectivist societies. Similarly, Perceived Behavioral Control also shows significance, shaped by internal factors (e.g., rational price perceptions) and external conditions (e.g., after-sales services, spare parts availability, and maintenance facilities). These findings align with Ajzen (2002), where self-efficacy reflects belief in one's ability to act, while controllability relates to external conditions such as infrastructure availability. Thus, both rational pricing (internal) and supportive service ecosystems (external) emerge as key determinants of BEV adoption and conversion.

These findings underscore the importance of behavior-oriented interventions through policies that draw upon behavioral economics, nudging, and social influence. Potential strategies include social norming, default options, and benefit framing. Social norming can be implemented by leveraging peer influence, public figures, and two-wheeled EV communities (Latimer & Martin

Ginis, 2005). Default options may be realized through easier access to financing or purchase loans for EV adoption. Meanwhile, benefit framing can be advanced through campaigns that emphasize the functional advantages of EVs over fossil-fuel motorcycles, such as avoiding fuel queues, eliminating oil changes, and reducing maintenance complexity. Furthermore, the study confirms the presence of an attitude–behavior gap in East Kalimantan. Accordingly, policy models that focus solely on external factors, such as infrastructure development, price incentives, or tax reductions, are insufficient to foster greater adoption of two-wheeled BEVs.

4. Conclusion

The model explains 65.8% of the variance in adoption and conversion intentions of two-wheeled BEVs in East Kalimantan. Significant variables include Subjective Norm, Perceived Behavioral Control, Performance, Price, and Features, while Attitude and Infrastructure were not significant. This indicates that consumers perceive two-wheeled BEVs mainly as functional substitutes for conventional motorcycles, with limited consideration of environmental benefits. Effective acceleration of two-wheeled BEV adoption and conversion requires not only infrastructure and financial incentives but also behavior-oriented policies that leverage social norming, default options, and benefit framing. Future research should further investigate the inconsistent roles of Attitude and Infrastructure, which have been shown to be influential in other contexts. Understanding these variations will enable the design of more precise strategies for promoting two-wheeled BEV adoption and conversion. However, this study is limited to urban and regency areas in East Kalimantan, with respondents predominantly from Generation Z. Therefore, the findings may not fully represent other demographic groups or regions, suggesting the need for broader and more diverse samples in future studies.

Author Contribution: All authors contributed equally to the main contributor to this paper. All authors read and approved the final paper.

Funding: This research was funded by Directorate of Research and Community Service (DPPM), Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, under the 2025 Regular Beginner Lecturer Research Grant (Contract No. 132/C3/DT.05.00/PL/2025).

Acknowledgment: The authors gratefully acknowledge the Ministry of Education, Science, and Technology of the Republic of Indonesia for research support, as well as LLDIKTI Region XI and the Institute for Research and Community Service (LPPM) of Universitas Balikpapan for their institutional and administrative support.

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

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