Jurnal Akuntansi, Keuangan, dan Manajemen (JAKMAN)
ISSN: 2716-0807, Vol 7, No 4, 2026, 513-533 https://doi.org/10.35912/jakman.v7.n4.p513-533.2026

Understanding Electric Vehicle Adoption Through Willingness to Buy, Technology Perceptions, and Ownership Costs

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Article History
Received on 30 June 2026
1st Revision on 01 July 2026
2nd Revision on 06 July 2026
3rd Revision on 08 July 2026
Accepted on 10 July 2026

Abstract

Purpose: This study aims to examine the effects of technology perceptions and total cost of ownership on electric motorcycle adoption in Indonesia, with willingness to buy as a mediating variable. It seeks to explain consumer decision-making factors in adopting electric motorcycles within an emerging market context.

Research Methodology: This study employs a quantitative approach using a cross-sectional survey of 400 electric motorcycle users in Indonesia. The proposed model was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine direct and indirect relationships among variables.

Results: The findings show that compatibility and total cost of ownership significantly influence willingness to buy and electric motorcycle adoption. Relative advantage significantly affects willingness to buy but does not directly affect adoption. Perceived ease of use, perceived usefulness, and vehicle performance have no significant effects on willingness to buy or adoption. Willingness to buy significantly mediates the relationships between compatibility, total cost of ownership, and adoption.

Conclusions: Consumers prioritize economic value and lifestyle compatibility over technological attributes in adopting electric motorcycles.

Limitations: The study is limited to Indonesian users and a cross-sectional design.

Contribution: This study contributes by integrating the Technology Acceptance Model, Innovation Diffusion Theory, vehicle performance, and total cost of ownership while highlighting willingness to buy as a key mechanism in electric motorcycle adoption.

Keywords: *Electric Vehicle Adoption, Sustainable Transportation, Technology Acceptance Model, Total Cost of Ownership, Willingness to Buy*

How to Cite: Ratnasari, I., Hurriyati, R., Disman, D., & Hendrayati, H. (2026). Understanding Electric Vehicle Adoption Through Willingness to Buy, Technology Perceptions, and Ownership Costs. *Jurnal Akuntansi, Keuangan, dan Manajemen*, 7(4), 513-533.

1. Introduction

The transition from fossil fuel-based transportation to Electric Vehicles (EVs) has become a key strategy for mitigating climate change and achieving sustainable development. The transportation sector remains one of the largest contributors to global greenhouse gas emissions because it is still heavily dependent on fossil fuels (Prates et al., 2022). In response, many countries have accelerated the adoption of electric mobility as part of their decarbonization strategies. Indonesia has also committed to reducing greenhouse gas emissions by 29% from the business-as-usual scenario by 2030 and achieving net-zero emissions by 2060 (Firmansyah et al., 2023; Lomi et al., 2022). Consequently, expanding the adoption of electric vehicles has become an important policy priority to support sustainable transportation and reduce environmental impacts.

Electric vehicles are increasingly recognized as environmentally friendly alternatives because they produce lower emissions and offer greater energy efficiency than conventional internal combustion engine vehicles (Aziz et al., 2020). Among various EV segments, electric motorcycles represent the largest market opportunity in Indonesia due to their affordability and suitability for daily mobility. Government incentives, technological progress, and growing environmental awareness have strengthened public interest in electric motorcycles (PricewaterhouseCoopers, 2023). Deloitte (2023) reported that 69% of Generation Z and 73% of Millennials intend to reduce their environmental impact by purchasing electric vehicles, and approximately 44% plan to purchase one in the future. Despite this positive outlook, actual ownership remains only 15-16%, revealing a considerable gap between consumers' willingness to purchase and their actual adoption behavior.

Several barriers continue to hinder the transition from purchase intention to actual adoption. High purchase prices, limited charging infrastructure, concerns about battery durability, and uncertainty regarding vehicle performance remain major obstacles for potential users (Adiyanto et al., 2025; Tjokrosaputro & Indrawan, 2025). This challenge is also reflected in Indonesia's relatively low electric vehicle penetration compared with neighboring ASEAN countries. GoodStats (2025) reported that Singapore achieved an electric vehicle market share of 45.45%, followed by Vietnam (37.90%) and Thailand (21.27%), whereas Indonesia reached only 14.66%. These figures suggest that significant market potential remains untapped and that a better understanding of the factors driving actual adoption is required.

Previous studies have primarily explained electric vehicle adoption using technological, environmental, or economic perspectives. The Technology Acceptance Model (TAM) emphasizes perceived ease of use and perceived usefulness as determinants of technology acceptance, whereas Innovation Diffusion Theory (IDT) highlights the roles of relative advantage and compatibility in innovation adoption. In addition, ownership-related factors such as Total Cost of Ownership (TCO) and vehicle performance have been identified as important determinants of adoption decisions because they influence consumers' perceptions of long-term economic value and product reliability (Lewicki et al., 2021; Liu et al., 2021; Richnák et al., 2020). However, empirical evidence remains inconsistent. While some studies reported significant effects of perceived usefulness, relative advantage, and ownership costs on adoption, others found weak or insignificant relationships, particularly in developing countries where contextual and economic conditions differ substantially (Dutta & Hwang, 2021; Karpurapu & Venkata Raghuram, 2024).

Despite these contributions, three important research gaps remain. First, existing studies predominantly examine purchase intention or purchasing decisions rather than actual adoption behavior, providing limited evidence on how consumers' willingness to buy is translated into real adoption. Second, previous research generally investigates technology acceptance, innovation characteristics, vehicle performance, or ownership costs independently, resulting in fragmented explanations of electric vehicle adoption. Third, empirical studies that simultaneously integrate these determinants into a comprehensive framework remain scarce, particularly in developing countries such as Indonesia, where economic conditions, infrastructure readiness, and consumer behavior differ from those of developed markets (Hassan et al., 2024; Hidayati et al., 2025; Jayasingh et al., 2021;

Suhadi & Sumiyati, 2026). Addressing these gaps is essential for developing a more holistic understanding of electric motorcycle adoption behavior.

Accordingly, this study investigates the effects of perceived ease of use, perceived usefulness, relative advantage, compatibility, vehicle performance, and total cost of ownership on electric motorcycle adoption, with willingness to buy acting as the mediating mechanism. Using a quantitative approach and Partial Least Squares Structural Equation Modeling (PLS-SEM), this study offers three main contributions. First, it shifts the focus from purchase intention to actual adoption behavior. Second, it integrates the Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), vehicle performance, and total cost of ownership into a single comprehensive framework. Third, it empirically demonstrates the mediating role of willingness to buy in explaining how technological perceptions and economic considerations are translated into actual adoption in an emerging market. These contributions extend the electric vehicle adoption literature and provide practical insights for policymakers and manufacturers seeking to accelerate electric motorcycle adoption in Indonesia and other developing economies.

2. Literature Review and Hypotheses Development

2.1 Electric Vehicle Adoption

Electric vehicle adoption represents the actual use and integration of electric vehicles into consumers' daily mobility rather than merely their purchasing decisions (Permana et al., 2023). Unlike purchase intention, adoption reflects realized behavior after consumers evaluate technological, economic, social, and environmental considerations. Previous studies consistently suggest that adoption is a multidimensional outcome influenced by cognitive evaluations, innovation perceptions, and contextual factors (Shankar et al., 2024; Tjokrosaputro & Indrawan, 2025). In the context of electric motorcycles, adoption is commonly reflected through switching from conventional motorcycles, frequency of use, integration into everyday transportation, and continued usage after initial purchase (Shetty & Rizwana, 2024; Suwignjo et al., 2023). Accordingly, this study positions electric vehicle adoption as the ultimate behavioral outcome explained by consumers' willingness to buy and by their evaluations of technological and economic attributes.

2.2 Willingness to Buy

Willingness to buy represents consumers' readiness to purchase a product after evaluating its expected benefits and costs. Although frequently treated as synonymous with purchase intention, willingness to buy reflects a stronger psychological commitment because it incorporates consumers' cognitive evaluations together with their readiness to act (Kim, 2025; Mat Hussin et al., 2021). In the electric vehicle context, willingness to buy has been recognized as an important antecedent of actual adoption because consumers typically progress from evaluating the technology to forming purchase readiness before making the final adoption decision (Javid et al., 2022; Jou et al., 2023; Suvittawat, 2024). Therefore, willingness to buy is expected to mediate the effects of technological perceptions and economic evaluations on actual electric motorcycle adoption.

2.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) proposes that technology adoption is primarily driven by Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). PEOU refers to consumers' beliefs that a technology can be learned and operated with minimal effort, whereas PU reflects the extent to which using the technology improves performance or provides meaningful benefits. In the context of electric motorcycles, these benefits include operational simplicity, energy efficiency, cost savings, and environmental advantages (Mukesh, & Narwal, 2023; Rachmawati, & Rahardi, 2023). Although TAM has consistently explained technology acceptance across various domains, empirical findings regarding electric vehicles remain mixed. Jaiswal, Kant, Singh, and Yadav (2022) reported significant positive effects of PEOU and PU on adoption intentions, whereas others found insignificant relationships, suggesting that technological perceptions alone may not sufficiently explain adoption decisions in emerging markets (Ozili, 2025). This inconsistency indicates that consumers may first translate positive technological evaluations into willingness to buy before deciding to adopt electric motorcycles. Therefore, perceived ease of use and perceived usefulness are hypothesized to positively influence willingness to buy and electric vehicle adoption.

2.4 Innovation Diffusion Theory (IDT)
Innovation Diffusion Theory (IDT) argues that innovation adoption depends on how consumers perceive the characteristics of an innovation, particularly its relative advantage and compatibility. Relative advantage describes the perceived superiority of electric motorcycles over conventional vehicles in terms of efficiency, environmental performance, and technological innovation, whereas compatibility reflects the degree to which the technology fits consumers' existing values, lifestyles, and mobility needs (Arpaci et al., 2025; Lashari et al., 2021). Previous research generally supports positive effects of these innovation attributes on consumer acceptance; however, their influence on actual adoption varies across countries because contextual and economic conditions shape consumers' evaluations differently (Chen et al., 2021; Wongsunopparat & Cherian, 2023). Consequently, consumers who perceive electric motorcycles as advantageous and compatible are expected to demonstrate stronger willingness to buy and higher adoption behavior.

2.5 Vehicle Performance
Beyond technology acceptance and innovation characteristics, consumers also evaluate the functional performance of electric motorcycles before making adoption decisions. Vehicle performance includes driving range, battery durability, charging efficiency, acceleration, and operational reliability (Wongsunopparat & Cherian, 2023). These attributes reduce functional uncertainty and increase consumers' confidence that electric motorcycles can satisfy their daily transportation needs. Previous studies have reported that superior vehicle performance positively affects consumers' evaluations and adoption intentions because it enhances perceived functional value (Anjana & Rajan, 2025; Olayode et al., 2024). Accordingly, this study proposes that favorable vehicle performance strengthens consumers' willingness to buy and encourages actual electric motorcycle adoption.

2.6 Total Cost of Ownership (TCO)
Total Cost of Ownership (TCO) extends consumers' evaluation beyond the initial purchase price by considering all costs incurred throughout the ownership period, including maintenance, charging, operating, and replacement expenses (Febransyah, 2021; Kumar & Chakrabarty, 2020). From an economic perspective, consumers compare these long-term ownership costs with those of conventional motorcycles when assessing the overall value of electric vehicles. Electric motorcycles are generally perceived as economically attractive because lower operating and maintenance costs can compensate for their relatively high purchase price, particularly when supported by government incentives (Mukesh & Narwal, 2023; Yadav, 2024). Since economic evaluations strongly influence consumer decision-making, lower perceived total ownership costs are expected to increase willingness to buy and ultimately promote electric motorcycle adoption.

This study develops a conceptual framework by integrating the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT) to explain electric vehicle adoption behavior through the mediating role of willingness to buy. The framework positions willingness to buy as a mediating variable that links consumers' perceptions and evaluations with actual electric vehicle adoption behavior. Therefore, this study proposes that perceived ease of use, perceived usefulness, relative advantage, compatibility, vehicle performance, and total cost ownership positively influence willingness to buy and subsequently encourage electric vehicle adoption behavior.

Based on the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT), this study proposes a conceptual framework for explaining electric motorcycle adoption. The research model is presented in Figure 1.

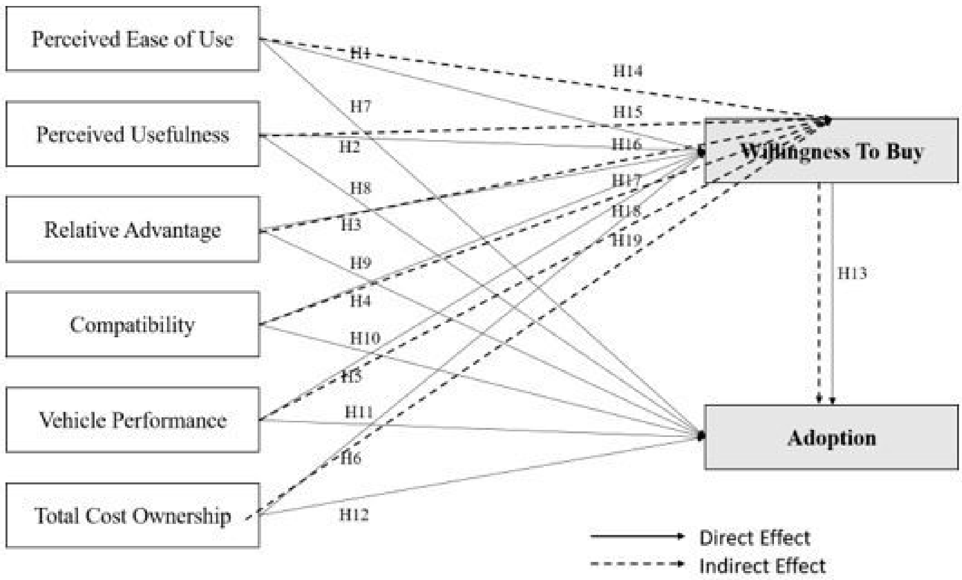

Figure 1. Research model

Figure 1 presents the proposed research model, illustrating the relationships among technology perceptions, total cost ownership, willingness to buy, and electric vehicle adoption. The model includes six exogenous variables, one mediating variable, and one endogenous variable to test the proposed hypotheses.

2.7 Hyphoteses

Drawing upon the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT), this study proposes an integrated framework in which technological perceptions and economic evaluations influence electric vehicle adoption both directly and indirectly through willingness to buy. Accordingly, the hypotheses are organized into three groups.

2.7.1 Direct Effects On Willingness To Buy

H_1: Perceived ease of use has a significant positive effect on willingness to buy electric vehicles

H_2: Perceived usefulness has a significant positive effect on willingness to buy electric vehicles

H_3: Relative advantage has a significant positive effect on willingness to buy electric vehicles

H_4: Compatibility has a significant positive effect on willingness to buy electric vehicles

H_5: Vehicle performance has a significant positive effect on willingness to buy electric vehicles

H_6: Total cost of ownership has a significant positive effect on willingness to buy electric vehicles

2.7.2 Direct Effects On Electric Vehicle Adoption

H_7: Perceived ease of use has a significant positive effect on electric vehicle adoption

H_8: Perceived usefulness has a significant positive effect on electric vehicle adoption

H_9: Relative advantage has a significant positive effect on electric vehicle adoption

H_{10}: Compatibility has a significant positive effect on electric vehicle adoption

H_{11}: Vehicle performance has a significant positive effect on electric vehicle adoption

H_{12}: Total cost of ownership has a significant positive effect on electric vehicle adoption

H_{13}: Willingness to buy has a significant positive effect on electric vehicle adoption

2.7.3 Mediating Effects Of Willingness To Buy

H_{14}: Willingness to buy mediates the relationship between perceived ease of use and electric vehicle adoption

H_{15}: Willingness to buy mediates the relationship between perceived usefulness and electric vehicle adoption

H_{16}: Willingness to buy mediates the relationship between relative advantage and electric vehicle adoption

H_{17}: Willingness to buy mediates the relationship between compatibility and electric vehicle adoption

H_{18}: Willingness to buy mediates the relationship between vehicle performance and electric vehicle adoption

H_{19}: Willingness to buy mediates the relationship between total cost of ownership and electric vehicle adoption

3. Methodology

3.1 Population and Sample

This study employed a quantitative, cross-sectional research design to examine the determinants of electric motorcycle adoption and the mediating role of willingness to buy. The target population consisted of Indonesian consumers who were familiar with electric motorcycles and possessed sufficient knowledge to evaluate the technology, regardless of whether they had already adopted an electric motorcycle. This population was considered appropriate because the proposed model seeks to explain both consumers' purchase readiness and actual adoption behavior. The unit of analysis was individual consumers, as adoption decisions are shaped by individual perceptions of technological, functional, and economic attributes.

A non-probability purposive sampling technique was employed because the study required respondents who could meaningfully assess electric motorcycles as a transportation alternative. To ensure this capability, respondents were required to be at least 17 years of age, have prior knowledge or awareness of electric motorcycles, and have experience using or owning a conventional motorcycle, enabling them to compare conventional and electric motorcycles based on actual mobility experience. Purposive sampling is widely recommended in behavioral studies when respondents must satisfy specific characteristics relevant to the research objectives and when probability sampling is impractical for emerging technology adoption research.

The minimum sample size was determined based on the recommendation of Hair, Hult, Ringle, and Sarstedt (2022) for Partial Least Squares Structural Equation Modeling (PLS-SEM), which suggests a minimum sample of ten times the largest number of structural paths directed at an endogenous construct. Because the proposed model includes six exogenous constructs predicting the endogenous variables and comprises 29 measurement indicators, the minimum required sample size was 290 respondents. To improve statistical power, parameter stability, and the robustness of the structural model, data were collected from 400 valid respondents, exceeding the recommended minimum. Respondent characteristics, including gender, age, educational attainment, occupation, and previous experience with electric motorcycles, were summarized using descriptive statistics to provide contextual information about the sample and support the interpretation of the empirical findings.

3.2 Data Collection

Primary data were collected through a structured questionnaire administered online using Google Forms. Online distribution was selected due to its efficiency in reaching respondents from various regions in Indonesia and its suitability for technology-related consumer research. The questionnaire link was distributed through social media platforms, online communities, and personal networks during the data collection period. Before the main survey, a pilot test was conducted with a small group of respondents to ensure clarity, readability, and comprehensibility of the questionnaire items. Feedback obtained from the pilot study was used to refine the wording and structure of the questionnaire. Participation was voluntary, and respondents were informed that their responses would remain anonymous and be used solely for academic purposes.

3.3 Measurement

The study employed a structured questionnaire consisting of seven constructs: Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Relative Advantage (RA), Compatibility (COM), Vehicle Performance (VP), Total Cost Ownership (TCO), Willingness to Buy (WTB), and Electric Vehicle Adoption (AEM). All measurement items were adapted from previously validated studies to ensure content validity and construct reliability.

Perceived Ease of Use and Perceived Usefulness were adapted from the Technology Acceptance Model. Relative Advantage and Compatibility were adapted from Innovation Diffusion Theory. Vehicle Performance and Total Cost Ownership were measured based on previous electric vehicle adoption studies focusing on technical performance and ownership costs. Willingness to Buy and Electric Vehicle Adoption were adapted from prior consumer behavior and electric vehicle adoption research.

The following table presents the operationalization of variables in Table 1.

Table 1. Operationalization of variables

Variables	Indicator	Description	Source
Perceived Ease of Use (PEOU)	PEOU1	Ease of learning electric motorcycle operation	(Rachmawati & Rahardi, 2023; Woody et al., 2024; Zabivullah, 2025)
	PEOU2	Ease of operating electric motorcycles	(Rachmawati & Rahardi, 2023; Woody et al., 2024; Zabivullah, 2025)
	PEOU3	Ease of understanding the charging system	(Rachmawati & Rahardi, 2023; Woody et al., 2024; Zabivullah, 2025)
Perceived Usefulness (PU)	PU1	Improves mobility efficiency	(Mukesh & Narwal, 2023; Ashutosh, 2024; Farooq & Cora, 2024)
	PU2	Supports daily activities	(Mukesh & Narwal, 2023; Ashutosh, 2024; Farooq & Cora, 2024)
	PU3	Enhances travel effectiveness	(Mukesh & Narwal, 2023; Ashutosh, 2024; Farooq & Cora, 2024)
Relative Advantage (RA)	RA1	Superior to conventional motorcycles	(Chen et al., 2021; Huber et al., 2021; Arpaci et al., 2025)
	RA2	Offers more advanced technology	(Chen et al., 2021; Huber et al., 2021; Arpaci et al., 2025)
	RA3	Provides a more modern riding experience	(Chen et al., 2021; Huber et al., 2021; Arpaci et al., 2025)
Compatibility (COM)	COM1	Compatibility with daily routines	(Lashari et al., 2021; Wongsunopparat & Cherian, 2023; Konstantinou et al., 2025)
	COM2	Does not change existing mobility patterns	(Lashari et al., 2021; Wongsunopparat & Cherian, 2023; Konstantinou et al., 2025)

Variables	Indicator	Description	Source
Compatibility (COM)	COM3	Compatibility with travel habits	(Lashari et al., 2021; Wongsunopparat & Cherian, 2023; Konstantinou et al., 2025)
Vehicle Performance (VP)	VP1	Driving range capability	(Hamza et al., 2021; Wongsunopparat & Cherian, 2023; Olayode et al., 2024)
	VP2	Battery charging time	(Hamza et al., 2021; Wongsunopparat & Cherian, 2023; Olayode et al., 2024)
	VP3	Motor/engine performance	(Hamza et al., 2021; Wongsunopparat & Cherian, 2023; Olayode et al., 2024)
	VP4	Overall operational reliability	(Hamza et al., 2021; Wongsunopparat & Cherian, 2023; Olayode et al., 2024)
Total Cost Ownership (TCO)	TCO1	Initial purchase cost	(Kumar & Chakrabarty, 2020; Andor et al., 2020; Febransyah, 2021; Sankaran & S, 2022; Ruiz-Real et al., 2024)
	TCO2	Maintenance and operational costs	(Kumar & Chakrabarty, 2020; Andor et al., 2020; Febransyah, 2021; Sankaran & S, 2022; Ruiz-Real et al., 2024)
	TCO3	Government incentives/subsidies toward ownership costs	(Kumar & Chakrabarty, 2020; Andor et al., 2020; Febransyah, 2021; Sankaran & S, 2022; Ruiz-Real et al., 2024)
Willingness to Buy (WTB)	WTB1	Intention to purchase an electric motorcycle	(Javid et al., 2022; Jou et al., 2023; Kaur Hansaram et al., 2024; Suvittawat, 2024; Wang et al., 2023)
	WTB2	Interest in owning an electric motorcycle	(Javid et al., 2022; Jou et al., 2023; Kaur Hansaram et al., 2024; Suvittawat, 2024; Wang et al., 2023)
	WTB3	Willingness to choose an electric motorcycle in the future	(Javid et al., 2022; Jou et al., 2023; Kaur Hansaram et al., 2024; Suvittawat, 2024; Wang et al., 2023)
	WTB4	Readiness to purchase an electric motorcycle	(Javid et al., 2022; Jou et al., 2023; Kaur Hansaram et al., 2024; Suvittawat, 2024; Wang et al., 2023)
	WTB5	Likelihood of purchasing an electric motorcycle	(Javid et al., 2022; Jou et al., 2023; Kaur Hansaram et al., 2024; Suvittawat, 2024; Wang et al., 2023)
Electric Vehicle Adoption (AEM)	AEM1	Actual use of an electric motorcycle	(Mbutura et al., 2025; Shetty & Rizwana, 2024; Suwignjo et al., 2023; Toraman et al., 2024).
	AEM2	Frequency of electric motorcycle usage	(Mbutura et al., 2025; Shetty & Rizwana, 2024; Suwignjo et al., 2023; Toraman et al., 2024).
	AEM3	Integration into daily mobility activities	(Mbutura et al., 2025; Shetty & Rizwana, 2024; Suwignjo et al., 2023; Toraman et al., 2024).
	AEM4	Continuance intention to use electric motorcycles	(Mbutura et al., 2025; Shetty & Rizwana, 2024; Suwignjo et al., 2023; Toraman et al., 2024).

Variables	Indicator	Description	Source
Electric Vehicle Adoption (AEM)	AEM5	Commitment to using electric motorcycles	(Mbutura et al., 2025; Shetty & Rizwana, 2024; Suwignjo et al., 2023; Toraman et al., 2024).

Construct operationalization was developed from well-established scales reported in previous studies. All latent constructs, Perceived Ease of Use, Perceived Usefulness, Relative Advantage, Compatibility, Vehicle Performance, Total Cost of Ownership, Willingness to Buy, and Electric Vehicle Adoption were operationalized using reflective indicators adapted to the context of electric motorcycles. All measurement items were assessed consistently using a seven-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"), ensuring consistency across constructs and facilitating reliable comparisons within the PLS-SEM analysis. The measurement instrument was subsequently evaluated through tests of reliability and validity before the structural relationships were analyzed.

3.4 Statistical Technique

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. PLS-SEM was selected because it is suitable for predictive research, complex models involving multiple constructs, and studies that aim to examine both direct and indirect relationships among variables. In addition, PLS-SEM does not require strict assumptions regarding data normality and is appropriate for exploratory and theory extension research. The analysis followed a two-stage approach according by Hair, Hult, Ringle, and Sarstedt (2022). First, the measurement model (outer model) was assessed to evaluate indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Indicator reliability was assessed using outer loadings, while internal consistency reliability was evaluated through Cronbach Alpha and Composite Reliability (CR). Convergent validity was assessed using Average Variance Extracted (AVE), whereas discriminant validity was examined using the Heterotrait-Monotrait Ratio (HTMT). Second, the structural model (inner model) was evaluated by examining collinearity, path coefficients, coefficient of determination (R^2), effect size (f^2), and hypothesis testing. The significance of the structural relationships was assessed through the bootstrapping procedure with 5,000 resamples. Path coefficients were considered significant when the p-value was below 0.05. In addition, mediation analysis was conducted to examine the mediating role of willingness to buy in the relationships between perceived ease of use, perceived usefulness, relative advantage, compatibility, vehicle performance, total cost ownership, and electric vehicle adoption.

4. Results and Discussions

4.1 Results

The demographic characteristics of the respondents are presented in Table 2 to provide an overview of the study sample:

Table 2. Respondent characteristics

Characteristic	Category	Frequency	Percentage (%)	Characteristic	Category	Frequency	Percentage (%)
Age	17–29 years	145	36	Education	Senior High School	101	25
	30–45 years	250	63	Education	Diploma (D3)	31	8
	>45 years	5	1	Education	Bachelor Degree (S1)	224	56
Gender	Female	262	66	Education	Master Degree (S2)	43	11
	Male	138	34	Education	Doctoral Degree (S3)	1	0
Occupation	Student	97	24	Top Electric Motorcycle Brands	Volta	51	13
	Private Employee	89	22	Top Electric Motorcycle Brands	Polytron	42	11

Characteristic	Category	Frequency	Percentage (%)	Characteristic	Category	Frequency	Percentage (%)
Occupation	Entrepreneur	101	25	Top Electric Motorcycle Brands	Viar	37	9
	State-Owned Enterprise Employee	69	17	Top Electric Motorcycle Brands	Alva	36	9
	Civil Servant/Military/Police	44	11	Top Electric Motorcycle Brands	U-Winfly	32	8
Duration of Ownership	< 1 year	82	21	Top Electric Motorcycle Brands	Selis	34	9
	1–2 years	222	56	Top Electric Motorcycle Brands	Gesits	30	8
	> 2 years	96	24	Top Electric Motorcycle Brands	United e-Motor	30	8
	> 2 years	96	24	Top Electric Motorcycle Brands	Others	108	27

Based on Table 2, the sample was dominated by respondents aged 30-45 years (63%), females (66%), and individuals holding a bachelor's degree (56%). Most respondents had owned an electric motorcycle for 1-2 years (56%), indicating sufficient experience to evaluate the technology. The diversity of electric motorcycle brands further suggests that the sample adequately represents users from different market segments.

The measurement model was evaluated using Partial Least Squares Structural Equation Modeling (SEM-PLS) to assess indicator reliability through outer loading values. The results show that most indicators meet the recommended loading threshold (>0.70), indicating adequate convergent validity. The detailed outer loading values for each indicator are presented in the Table 3:

Table 3. Outer loadings of measurement items

Variables	Indicator	Outer Loading
Perceived Ease of Use (PEOU)	PEOU1	0.812
	PEOU2	0.786
	PEOU3	0.804
Perceived Usefulness (PU)	PU1	0.798
	PU2	0.798
	PU3	0.779
Relative Advantage (RA)	RA1	0.812
	RA2	0.824
	RA3	0.788
Compatibility (COM)	COM1	0.821
	COM2	0.769
	COM3	0.787
Vehicle Performance (VP)	VP1	0.776
	VP2	0.770
	VP3	0.728
	VP4	0.758
Total Cost Ownership (TCO)	TCO1	0.786
	TCO2	0.788
	TCO3	0.798

Variables	Indicator	Outer Loading
Willingness to Buy (WTB)	WTB1	0.763
	WTB2	0.724
	WTB3	0.718
	WTB4	0.787
	WTB5	0.701
Electric Vehicle Adoption (AEM)	AEM1	0.799
	AEM2	0.774
	AEM3	0.768
	AEM4	0.771
	AEM5	0.762

The measurement model assessment demonstrates in Table 3, all measurement indicators achieved outer loading values above the recommended threshold of 0.70 (0.701–0.824), confirming satisfactory indicator reliability and convergent validity. Therefore, all indicators were retained for subsequent analyses.

The measurement model was assessed to ensure that all constructs met the requirements of reliability and convergent validity before proceeding to structural model evaluation. Reliability was examined using Cronbach Alpha and Composite Reliability (CR), while convergent validity was assessed through the Average Variance Extracted (AVE). According to Hair, Hult, Ringle, and Sarstedt (2022), constructs are considered reliable when Cronbach Alpha and CR values exceed 0.70, and convergent validity is established when AVE values are greater than 0.50. The results of the assessment are presented in Table 4.

Table 4. Construct reliability and validity

Construct	Cronbach Alpha	Composite Reliability (ρc)	AVE	Interpretation
Perceived Ease of Use (PEOU)	0.720	0.843	0.641	Reliable and Valid
Perceived Usefulness (PU)	0.703	0.835	0.627	Reliable and Valid
Relative Advantage (RA)	0.735	0.850	0.653	Reliable and Valid
Compatibility (COM)	0.704	0.835	0.628	Reliable and Valid
Vehicle Performance (VP)	0.754	0.844	0.575	Reliable and Valid
Total Cost Ownership (TCO)	0.700	0.833	0.625	Reliable and Valid
Willingness to Buy (WTB)	0.792	0.857	0.546	Reliable and Valid
Electric Vehicle Adoption (AEM)	0.834	0.883	0.601	Reliable and Valid

All constructs demonstrated satisfactory internal consistency and convergent validity, with Cronbach Alpha and Composite Reliability values exceeding 0.70 and AVE values above 0.50. These results confirm that the measurement model is reliable and suitable for structural model evaluation. Therefore, all constructs were deemed reliable and valid for subsequent structural model analysis (Hair et al., 2022).

Following the assessment of reliability and convergent validity, discriminant validity was evaluated to determine whether each construct is empirically distinct from the other constructs in the model. This study employed the Heterotrait-Monotrait Ratio (HTMT) criterion, which is considered a more rigorous approach for assessing discriminant validity in PLS-SEM. According to Hair et al. (2022), discriminant validity is established when HTMT values are below the threshold of 0.90, indicating that each construct measures a concept that is sufficiently different from the others. The results of the HTMT analysis are presented in Table 5.

Table 5. Heterotrait-Monotrait Ratio (HTMT)

Construct	PEOU	PU	RA	COM	VP	TCO	WTB	AEM
PEOU	-							
PU	0.850	-						
RA	0.741	0.772	-					
COM	0.729	0.838	0.825	-				
VP	0.716	0.731	0.826	0.897	-			
TCO	0.817	0.752	0.754	0.789	0.836	-		
WTB	0.769	0.776	0.762	0.839	0.768	0.839	-	
AEM	0.629	0.663	0.712	0.845	0.760	0.792	0.830	-

The HTMT results presented in Table 5 indicate that all construct pairs satisfy the recommended discriminant validity criterion, as all HTMT values are below the threshold of 0.90 (Hair et al., 2022). All HTMT values were below the recommended threshold of 0.90, indicating adequate discriminant validity. The findings confirm that each construct represents a distinct concept and measures different aspects of electric motorcycle adoption.

Before evaluating the structural relationships and testing the research hypotheses, it is important to assess the presence of multicollinearity among the predictor constructs. Collinearity was examined using the Variance Inflation Factor (VIF), which measures the extent to which a predictor variable is linearly related to other predictor variables in the model. According to Hair et al. (2022), VIF values below 5.0 indicate the absence of critical multicollinearity issues and suggest that the predictor constructs can be reliably used for structural model estimation. The results of the inner model collinearity assessment are presented in Table 6.

Table 6. Inner model collinearity statistics (VIF)

Relationship	VIF
PEOU → WTB	1.946
PU → WTB	1.991
RA → WTB	1.995
COM → WTB	2.190
VP → WTB	2.266
TCO → WTB	1.966
PEOU → AEM	1.993
PU → AEM	2.026
RA → AEM	2.029
COM → AEM	2.297
VP → AEM	2.287
TCO → AEM	2.091
WTB → AEM	2.289

The VIF values ranged from 1.946 to 2.297, well below the recommended threshold of 5.0. This indicates that multicollinearity is not a concern and that the estimated structural relationships can be interpreted with confidence (Hair et al., 2022).

Table 7. Direct effects hypothesis testing

Hypotheses	Relationship	Coefficient (β)	T-Statistic	P-Value	Result
H_1	PEOU → WTB	0.142	1.801	0.072	Not Supported
H_2	PU → WTB	0.122	1.794	0.073	Not Supported
H_3	RA → WTB	0.123	2.254	0.024	Supported
H_4	COM → WTB	0.217	3.030	0.002	Supported
H_5	VP → WTB	0.095	1.232	0.218	Not Supported
H_6	TCO → WTB	0.233	2.872	0.004	Supported

Hypotheses	Relationship	Coefficient (β)	T-Statistic	P-Value	Result
H_7	PEOU → AEM	-0.026	0.401	0.688	Not Supported
H_8	PU → AEM	0.000	0.005	0.996	Not Supported
H_9	RA → AEM	0.076	1.355	0.175	Not Supported
H_{10}	COM → AEM	0.244	3.288	0.001	Supported
H_{11}	VP → AEM	0.117	1.661	0.097	Not Supported
H_{12}	TCO → AEM	0.178	2.453	0.014	Supported
H_{13}	WTB → AEM	0.313	3.846	0.000	Supported

Table 7 shows after confirming the reliability, convergent validity, discriminant validity, and absence of multicollinearity, the structural model was evaluated to examine the proposed relationships among the constructs. Hypothesis testing was conducted using the bootstrapping procedure in SmartPLS 4. The significance of each path was assessed based on the path coefficient (β), t-statistic, and p-value. the hypothesis is supported when the t-statistic exceeds 1.96 and the p-value is less than 0.05 at a 95% confidence level. The results of the direct effect hypothesis testing are presented in Table 7.

The structural model supports six of the thirteen direct hypotheses. Compatibility and total cost of ownership significantly influence both willingness to buy and electric vehicle adoption, while Relative Advantage significantly affects willingness to buy only. In addition, willingness to buy exerts a significant positive effect on electric vehicle adoption. In contrast, Perceived Ease of Use (PEU), Perceived Usefulness (PU), and Vehicle Performance (VP) do not exhibit significant direct effects, suggesting that consumers place greater emphasis on lifestyle compatibility and economic considerations than on technological attributes.

To further examine the mediating role of Willingness to Buy (WTB) in the relationship between the antecedent variables and Electric Vehicle Adoption (AEM), an indirect effect analysis was conducted using the bootstrapping procedure in SmartPLS 4. The significance of the mediation effect was assessed based on the indirect path coefficient (β), t-statistic, and p-value. Following Hair et al. (2022), an indirect effect is considered significant when the t-statistic exceeds 1.96 and the p-value is less than 0.05. The results of the mediation analysis are presented in Table 8.

Table 8. Indirect effects hypothesis testing

Hypotheses	Indirect Relationship	Coefficient Value (β)	T-Statistic	P-Value	Result
H_{14}	PEOU → WTB → AEM	0.045	1.600	0.110	Not Supported
H_{15}	PU → WTB → AEM	0.038	1.516	0.130	Not Supported
H_{16}	RA → WTB → AEM	0.038	1.884	0.060	Not Supported
H_{17}	COM → WTB → AEM	0.068	2.436	0.015	Supported
H_{18}	VP → WTB → AEM	0.030	1.212	0.226	Not Supported
H_{19}	TCO → WTB → AEM	0.073	2.057	0.040	Supported

The mediation analysis reveals that willingness to buy significantly mediates the effects of Compatibility and Total Cost of Ownership on electric vehicle adoption. No significant mediation effects are observed for Perceived Ease of Use, Perceived Usefulness, Relative Advantage, or Vehicle Performance. These findings highlight willingness to buy as an important mechanism through which compatibility and economic considerations are translated into actual adoption behavior.

After evaluating the direct and indirect relationships among the constructs, the coefficient of determination (R^2) was assessed to determine the explanatory power of the structural model. The R^2 value represents the proportion of variance in an endogenous construct that can be explained by its predictor variables. According to Hair et al. (2022), R^2 values of 0.75, 0.50, and 0.25 can be interpreted as substantial, moderate, and weak explanatory power, respectively. The results of the R^2 assessment are presented in Table 9.

Table 9. Coefficient of determination (R^2)

Endogenous Variable	R^2
Willingness to Buy (WTB)	0.563
Electric Vehicle Adoption (AEM)	0.579

The model demonstrates moderate explanatory power, accounting for 56.3% of the variance in willingness to buy and 57.9% of the variance in electric vehicle adoption. These results indicate that the proposed framework explains a substantial proportion of consumer adoption behavior while suggesting that additional factors beyond the current model may also contribute.

In addition to evaluating the significance of the structural relationships, this study assessed the effect size (f^2) to determine the contribution of each exogenous construct to the endogenous variables. The f^2 statistic measures the change in the coefficient of determination (R^2) when a specific predictor is removed from the model. According to Hair et al. (2022), f^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large effect sizes, respectively. The results of the effect size assessment are presented in Table 10.

Table 10. Effect Size (f^2) assessment

Relationship	f^2	Effect Size
PEOU → WTB	0.024	Small
PU → WTB	0.017	Negligible
RA → WTB	0.017	Negligible
COM → WTB	0.049	Small
VP → WTB	0.009	Negligible
TCO → WTB	0.063	Small
PEOU → AEM	0.001	Negligible
PU → AEM	0.000	Negligible
RA → AEM	0.007	Negligible
COM → AEM	0.062	Small
VP → AEM	0.014	Negligible
TCO → AEM	0.036	Small
WTB → AEM	0.102	Small

Most relationships exhibit small or negligible effect sizes. Among the predictors, Willingness to Buy has the strongest contribution to electric vehicle adoption, whereas Total Cost of Ownership and Compatibility provide the largest contributions to willingness to buy. Although the individual effects are modest, these variables represent the most influential determinants within the proposed model.

4.2 Discussion

This study provides empirical evidence that electric motorcycle adoption is primarily influenced by compatibility, total cost ownership, and willingness to buy, while perceived ease of use, perceived usefulness, and vehicle performance do not significantly influence adoption behavior. These findings reinforce the argument of Innovation Diffusion Theory (IDT), which emphasizes that the compatibility of an innovation with users' existing lifestyles, habits, and needs is a critical determinant of adoption. The significant effect of compatibility on both willingness to buy and electric vehicle adoption is consistent with previous studies showing that consumers are more likely to adopt electric vehicles when the technology aligns with their mobility patterns and daily routines (Lashari, Ko, & Jang, 2021; Wongsunopparat, & Cherian, 2023). The finding also extends the work of Tjokrosaputro and Indrawan (2025), who reported high interest in electric motorcycles among digital natives but were unable to explain how such interest translates into actual adoption. The present study demonstrates that compatibility serves as one of the mechanisms that bridge purchase intention and adoption behavior.

The significant role of total cost ownership further highlights the importance of economic considerations in consumers' adoption decisions. This result supports previous studies indicating that consumers evaluate electric vehicles based on long-term ownership costs, including purchase price, maintenance expenses, operational costs, and government incentives (Kumar, & Chakrabarty, 2020; Mukesh, & Narwal, 2023; Shankar, Kumar, Yadav, Misra, & Pani, 2024).

Consistent with Anastasiadou and Gavanas (2022), high acquisition costs remain a major barrier to adoption, whereas favorable ownership economics increase consumers' willingness to purchase electric vehicles. The finding also aligns with studies by Lewicki, Drozdz, Wroblewski, and Zarna (2021) and Dutta and Hwang (2021), which emphasize that economic and technical considerations strengthen consumers' perceived ability to adopt electric vehicles. Therefore, beyond environmental benefits, consumers appear to rely heavily on financial evaluations when deciding whether to adopt electric motorcycles.

Another important finding is the significant influence of relative advantage on willingness to buy, although its direct effect on adoption was not supported. This suggests that consumers recognize the superiority of electric motorcycles compared to conventional vehicles in terms of innovation, efficiency, and environmental performance, which increases purchase intentions. This finding supports the Innovation Diffusion Theory perspective and is consistent with studies indicating that perceived technological superiority encourages favorable attitudes toward electric vehicles (Wongsunopparat and Cherian, 2023; Yang, Tu, & Jiang, 2020). However, the absence of a direct effect on adoption suggests that recognizing the advantages of electric motorcycles alone is insufficient to ensure actual adoption. Consumers may still face practical barriers such as infrastructure limitations, uncertainty regarding battery performance, and financial constraints, which prevent the conversion of favorable perceptions into actual behavior.

Interestingly, perceived ease of use and perceived usefulness did not significantly influence either willingness to buy or electric vehicle adoption. These findings support arguments presented in the literature review that the explanatory power of the Technology Acceptance Model (TAM) may be limited in the context of electric vehicle adoption. Previous studies by Dutta and Hwang (2021) and Karpurapu and Venkata (2024) found that perceived usefulness and perceived ease of use do not always significantly predict electric vehicle adoption when compared with environmental, social, or contextual factors. Likewise, the current findings suggest that consumers no longer view ease of operation or usefulness as primary determinants because electric motorcycle technology has become increasingly familiar and accessible. Instead, consumers appear to prioritize practical concerns such as ownership costs and compatibility with their lifestyle. These results provide empirical support for the criticism that TAM tends to overemphasize utilitarian evaluations while underestimating contextual and behavioral factors that shape adoption decisions.

The insignificant effect of vehicle performance on both willingness to buy and adoption also offers an interesting insight. Previous studies suggested that performance attributes such as driving range, charging speed, and operational reliability are important predictors of electric vehicle adoption (Olayode, Jamei, & Alex, 2024; Wongsunopparat and Cherian, 2023). However, the current findings indicate that vehicle performance is no longer a decisive factor among existing electric motorcycle users. One possible explanation is that current electric motorcycle technologies have reached an acceptable performance level for daily commuting purposes, reducing performance concerns among consumers. As a result, differences in performance characteristics may have become less influential than economic and lifestyle-related considerations.

Furthermore, willingness to buy was found to significantly influence electric vehicle adoption, confirming its role as a crucial behavioral mechanism. This finding supports previous studies suggesting that willingness to buy captures consumers' evaluations of both economic benefits and environmental commitment, making it a key predictor of actual adoption behavior (Purwanto, & Irawan, 2024; Sneha, 2025). The result is also consistent with the Theory of Planned Behavior, which posits that behavioral intentions are the most immediate antecedents of actual behavior. More importantly, willingness to buy significantly mediated the relationships between compatibility and adoption as well as between total cost ownership and adoption. This finding extends previous research by demonstrating that consumers first develop purchase intentions based on their assessment of lifestyle compatibility and economic value before translating these perceptions into actual adoption decisions.

Overall, the findings contribute to the growing body of literature by addressing several research gaps identified in previous studies. Earlier research predominantly focused on electric cars in developed countries and often examined intention rather than actual adoption behavior (Jayasingh, Girija, & Arunkumar, 2021). Moreover, previous studies tended to emphasize either technological, economic, or environmental factors separately, without adequately explaining how consumers convert favorable perceptions into actual adoption decisions. The present study addresses these limitations by focusing on electric motorcycles in Indonesia and by demonstrating that willingness to buy functions as an important mechanism linking compatibility and ownership cost perceptions to actual adoption. Consequently, this study provides a more nuanced understanding of electric vehicle adoption in emerging markets and highlights the importance of contextual and economic factors beyond traditional technology acceptance considerations.

5. Conclusions

5.1 Conclusion

This study demonstrates that electric motorcycle adoption is driven primarily by consumers' perceptions of compatibility with their lifestyle and the economic value associated with total cost of ownership. Willingness to buy also plays a pivotal role by translating these favorable evaluations into actual adoption behavior. In contrast, technology-related perceptions, including perceived ease of use, perceived usefulness, and vehicle performance, are less influential in explaining adoption decisions. These findings extend the electric vehicle adoption literature by providing an integrated framework that combines technology acceptance, innovation characteristics, and ownership cost considerations to explain actual adoption behavior. From a practical perspective, the results suggest that policymakers and manufacturers should prioritize improving lifestyle compatibility and reducing ownership costs to accelerate the adoption of electric motorcycles, particularly in emerging markets such as Indonesia.

This study provides several important implications. From a theoretical perspective, it extends the electric vehicle adoption literature by integrating the Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), vehicle performance, and total cost of ownership into a unified framework, while demonstrating that compatibility and total cost of ownership are more influential than technology-related perceptions in explaining actual electric motorcycle adoption through the mediating role of willingness to buy. From a managerial perspective, the findings suggest that manufacturers and marketers should prioritize improving product compatibility with consumers' daily mobility needs and emphasize the long-term economic benefits of ownership through appropriate product design, communication strategies, financing schemes, and after-sales services. From a policy perspective, the results indicate that efforts to accelerate electric motorcycle adoption should extend beyond financial incentives by strengthening charging and battery-swapping infrastructure, expanding ownership support programs, and implementing public awareness campaigns that emphasize the practical and economic advantages of electric motorcycles. Together, these implications highlight the importance of aligning technological innovation, market strategies, and public policy to accelerate sustainable transportation adoption, particularly in emerging markets such as Indonesia.

5.2 Research Limitations

Despite these contributions, this study has several limitations. First, the sample was limited to electric motorcycle users in Indonesia, which may restrict the generalizability of the findings to other countries or types of electric vehicles. Second, the cross-sectional research design captures consumer perceptions at a single point in time and therefore does not fully reflect changes in attitudes and adoption behavior over time. Third, although the model explains a substantial proportion of variance in adoption behavior, approximately 42.1% of the variance remains unexplained, suggesting that other relevant factors were not included in the model. Variables such as charging infrastructure availability, environmental concern, government support, social influence, perceived risk, and brand trust may provide additional explanatory power and should be considered in future studies.

5.3 Suggestions and Directions for Future Research

Future research is encouraged to expand the scope of investigation by incorporating additional behavioral, technological, and policy-related variables, as well as by employing longitudinal or comparative research designs to capture dynamic changes in adoption behavior. Researchers may also examine different categories of electric vehicles and compare consumer adoption patterns across regions or countries. From a practical perspective, policymakers and electric motorcycle manufacturers should focus on improving the compatibility of electric motorcycles with consumers' daily mobility needs and enhancing the affordability of ownership through incentives, financing schemes, and operational cost reductions. Such efforts may strengthen consumers' willingness to buy and accelerate the broader adoption of electric vehicles.

Acknowledgement

The authors gratefully acknowledge Prof. Dr. Ratih Hurriyati, M.P., as the principal supervisor, and Prof. Dr. Disman, M.S. and Dr. Heny Hendrayati, M.M., as co-supervisors, for their invaluable supervision, insightful guidance, and constructive comments throughout the doctoral research and the preparation of this manuscript. Their continuous support and academic mentorship have been instrumental in the successful completion of this study. The authors also thank all respondents for their valuable participation and acknowledge the support provided by the Doctoral Program in Management, School of Postgraduate Studies, Universitas Pendidikan Indonesia, throughout the research process.

Author Contributions

LR conceptualized the study, developed the research framework, designed the methodology, collected and analyzed the data, interpreted the results, and prepared the original draft of the manuscript. RH supervised the research, contributed to the conceptual development, validated the research design, critically reviewed the manuscript, and provided substantial revisions. DD contributed to the research methodology, supervised the statistical analysis, interpreted the findings, and critically revised the manuscript for important intellectual content. HH contributed to the interpretation of the results, manuscript revision, language refinement, and overall improvement of the final manuscript. All authors read, reviewed, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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