

Empirical Evidence on the Mediating Role of Attitude Between Environmental Concern and Perceived Usefulness toward Electric Motorcycles Adoption Intentions Among Female Gen Z

Ni Komang Prema Narayani, Ali Hanafiah

Universitas Mercu Buana, Indonesia

Email: narayaniema17@gmail.com, ali.hanafiah@mercubuana.ac.id

Abstract

The global reliance on fossil fuels has intensified the energy crisis and worsened urban air pollution, creating an urgent need for sustainable transportation solutions. Electric motorcycles offer a promising alternative, especially in Indonesia where motorcycle use is widespread. This study investigates the influence of environmental concern and perceived usefulness on the intention of female Gen Z consumers to adopt SELIS electric motorcycles, with attitude toward electric motorcycles as a mediating variable. The total of 210 sample was collected through a structured online questionnaire using purposive sampling and analyzed with Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS. The findings reveal that both environmental concern and perceived usefulness significantly enhance intention to use, while also shaping favorable attitudes toward electric motorcycles. Attitude itself exerts a strong positive influence on intention and mediates the relationships between the independent variables and intention. These results highlight that adoption decisions are driven not only by ecological awareness but also by functional value, with attitude reinforcing this effect. The study concludes that strategies integrating sustainability messages with practical benefits are essential to encourage wider adoption of electric motorcycles among female Gen Z consumers.

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INTRODUCTION

The global reliance on fossil fuels has created an urgent energy crisis, driving both environmental degradation and rising economic costs. Fossil fuels not only remain the primary source of greenhouse gas emissions but also accelerate global warming, air pollution, and public health risks (Achuo & Ojong, 2023; Kay Lup et al., 2023). In Southeast Asia, Indonesia faces some of the most

severe consequences, with recent reports showing air pollution levels surpassing global health standards and threatening urban populations (Regan, 2024). This challenge underscores the need for sustainable energy solutions aligned with the United Nations' 2030 Agenda, particularly Sustainable Development Goal (SDG) 7 on affordable and clean energy.

Within this context, electric vehicles (EVs) are increasingly viewed as a transformative technology for sustainable transportation. They significantly reduce carbon emissions, enhance energy efficiency, and support climate change mitigation efforts (Pandita et al., 2024; Tyagi & Vishwakarma, 2022). In Indonesia, the adoption of electric motorcycles has risen sharply in recent years, supported by growing consumer awareness and government initiatives. However, adoption remains limited compared to the overall potential, with challenges such as weak charging infrastructure, high upfront costs, and brand-specific performance barriers still restricting growth (Naqiya & Rahadian, 2023).

A particularly important segment in this transition is Generation Z, who represent the largest demographic group in Indonesia and are highly engaged with sustainability issues (Dihni, 2022). Surveys reveal that young Indonesians exhibit strong interest in environmental concerns, with a majority expressing willingness to support eco-friendly businesses and brands (Dihni, 2021). Within this group, female consumers are emerging as a critical demographic in shaping the future of EV adoption. Over the last decade, women's participation in motorcycle ownership and usage has grown steadily, now accounting for nearly one-third of all riders (Lukita et al., 2020). Female riders tend to prioritize practicality, safety, and design, factors that align closely with the unique value proposition of electric motorcycles such as SELIS (Novanto, 2024). Their role as decision-makers in household mobility choices further strengthens their influence on adoption trends.

Despite this potential, the determinants of female Gen Z's intention to adopt EVs remain underexplored in the Indonesian context. Prior studies have highlighted the importance of environmental concern, knowledge, and perceived usefulness in shaping attitudes and behavioral intentions toward EVs (Dash, 2021; Jaiswal et al., 2022; Thakur et al., 2023). However, limited research has focused specifically on young female consumers, who may be influenced not only by ecological values and functional benefits but also by social norms and external factors such as family and peer influence. Addressing this gap is crucial to advancing both theory and practice in sustainable consumer behavior.

This study investigates the impact of environmental concern and perceived usefulness on the intention of female Gen Z consumers in Indonesia to adopt SELIS electric motorcycles, with attitudes toward EVs serving as a mediating variable. By focusing on this demographic group, the research

contributes novel insights into gendered adoption behavior in the EV market, an area that has received limited scholarly attention. The findings are expected to offer both theoretical contributions, by advancing understanding of consumer behavior in sustainable transportation, and practical implications for manufacturers and policymakers seeking to accelerate EV adoption in emerging markets like Indonesia.

Triple Bottom Line Theory

The Triple Bottom Line, introduced by Elkington (1994), broadens organizational performance metrics beyond profits to include social progress and environmental responsibility, summarized as “People, Planet, and Profits.” A successful business model is one that balances these three pillars (Abraham, 2024).

Stimulus-Organism-Response Theory

The Stimulus-Organism-Response (SOR) model explains how external environmental stimuli (S) influence internal cognitive and emotional states (O), which then shape behavioral responses (R) (Mehrabian & Russell, 1974). The theory highlights the mediating role of emotional and cognitive processes in translating external cues into actions. Its adaptability makes it a useful framework for studying consumer behavior, especially in contexts where external influences trigger attitudinal and behavioral changes (Duong, 2023).

Generation Z Consumers

Generation Z is an influential consumer segment in Indonesia due to their digital-native culture, strong purchasing power, and high environmental awareness. Despite their relatively young age, many members of Generation Z already exercise considerable purchasing power and decision-making autonomy, particularly in urban areas (Dihni, 2021). Their strong environmental awareness is coupled with a willingness to align lifestyle choices with sustainability values, making them early adopters of eco-friendly innovations such as electric vehicles. Several studies have also explored the behaviors of Gen Z in Indonesia, highlighting key factors that shape their consumer choices (Fortunata & Hanafiah, 2024; Hanafiah et al., 2023; Hanafiah & Djabbar, 2024).

Environmental Concern

Environmental concern reflects individuals' awareness of environmental degradation and their willingness to act in protecting the environment (Hackett, 1993; Tiwari et al., 2024). It captures personal evaluations of environmental issues and readiness to contribute through pro-environmental behaviors.

Perceived Usefulness

Perceived usefulness, from the Technology Acceptance Model (Davis, 1989), refers to the belief that using a technology enhances performance. It consistently predicts adoption across contexts, as technologies perceived as valuable and beneficial increase intention to use.

Attitude

Attitude is defined as an individual's positive or negative evaluation of performing a behavior (Ajzen, 1991; Ajzen & Fishbein, 2000). Favorable attitudes strengthen intention by shaping how individuals assess outcomes and desirability of engaging in the behavior.

Intention to Use

Intention to use, rooted in the Theory of Reasoned Action (Fishbein & Ajzen, 1975), reflects motivational readiness to perform a behavior. Stronger intentions signal higher likelihood of adoption, shaped by attitudes, perceived benefits, and external social influences.

Hypotheses Development and Research Framework

Environmental concern has been widely linked to pro-environmental behaviors. Studies confirm that individuals with higher concern for the environment demonstrate stronger purchase intentions toward sustainable products, including EVs and green goods (Antunes et al., 2023; Klabi & Binzafrah, 2023; Yanyan et al., 2023). Based on the findings of previous studies, the following hypothesis can be formulated:

H1: Environmental Concern positively influences the Intention to Use electric motorcycles among Female Gen Z.

Perceived usefulness, a core construct of the Technology Acceptance Model, consistently predicts adoption across technologies. Research shows its positive effect on behavioral intention, ranging from EV adoption to digital payments (Jaiswal et al., 2022; Kumar et al., 2024). Based on the findings of previous studies, the following hypothesis can be formulated:

H2: Perceived Usefulness positively influences the Intention to Use electric motorcycles among Female Gen Z.

Environmental concern also shapes attitudes toward sustainable choices. Prior studies demonstrate its significant impact on attitudes toward green products (Kwistianus et al., 2020; Suhartanto et al., 2023). Based on the findings of previous studies, the following hypothesis can be formulated:

H3: Environmental Concern positively influences Attitude toward electric motorcycles among Female Gen Z.

Similarly, perceived usefulness enhances positive attitudes toward innovations, as confirmed in contexts such as Halal products and digital banking (Kumari & Devi, 2023; Rizkitysha & Hananto, 2022). Based on the findings of previous studies, the following hypothesis can be formulated:

H4: Perceived Usefulness positively influences Attitude toward electric motorcycles among Female Gen Z.

Attitude itself is a strong determinant of intention. Studies confirm that favorable attitudes increase adoption in areas such as financial services and household technologies (Himel et al., 2021; Kumar et al., 2024). Based on the findings of previous studies, the following hypothesis can be formulated:

H5: Attitude toward electric motorcycles positively influences Intention to Use among Female Gen Z.

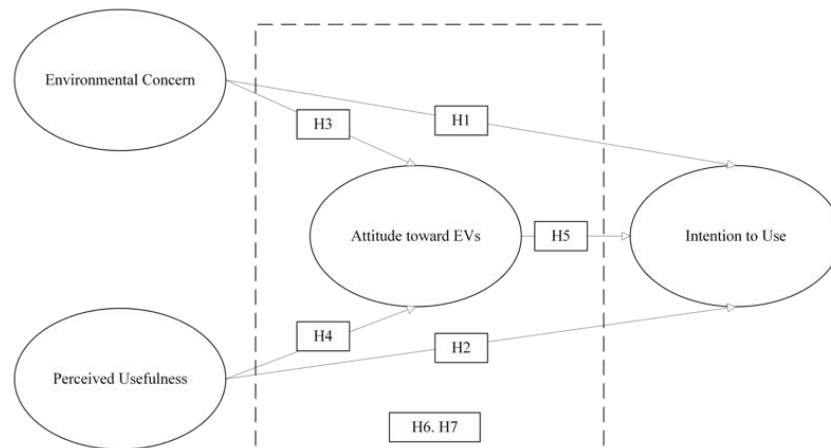
Attitude also plays a mediating role. Evidence shows that attitudes significantly mediate the effects of environmental concern and perceived usefulness on intention, particularly in green product and EV adoption contexts (Khor et al., 2023; Khurana et al., 2019; Lau & Hashim, 2020). Based on the findings of previous studies, the following hypotheses can be formulated:

H6: Attitude mediates the relationship between Environmental Concern and Intention to Use.

H7: Attitude mediates the relationship between Perceived Usefulness and Intention to Use.

From the literature review the researcher formulated the research framework can be shown as below:

Figure 1. Research Framework



METHODS

Method

This study employed a quantitative, causal research design to examine the relationships between environmental concern, perceived usefulness, attitude, and intention to use electric motorcycles among female Generation Z in Jakarta. Drawing from the theoretical foundation in the research framework, the variables are measured and adapted from previous research (Jaiswal et al. 2022; Huang et al., 2021; Ngoc et al., 2023)

Table 1. Operationalization of Variables

Variables	Indicators	References
Environmental Concern	EC1. I am concerned about current environmental pollution. EC2. I am worried about the worsening air quality. EC3. I believe that vehicle exhaust emissions are one of the main causes of air pollution. EC4. I feel that I am not doing enough to help protect the environment from air pollution. EC5. I believe that everyone has the responsibility to adopt low-carbon emission modes of transportation.	(Jaiswal et al. 2022)
Perceived Usefulness	PU1. I believe that SELIS electric motorcycles can help reduce household transportation expenses. PU2. I believe that SELIS electric motorcycles can reduce carbon emissions and help alleviate energy shortages. PU3. I believe that SELIS electric motorcycles can improve travel efficiency and quality of life. PU4. I believe that SELIS electric motorcycles can reduce physical and mental fatigue and benefit health.	(Huang et al., 2021)

Attitude	ATT1. I am interested in using SELIS electric motorcycles. ATT2. I support the use of SELIS electric motorcycles. ATT3. I think using SELIS electric motorcycles is a good idea. ATT4. I think using SELIS electric motorcycles is a wise decision.	(Ngoc et al., 2023)
Intention to Use	ITU1. I am willing to adopt SELIS electric motorcycles when choosing a vehicle in the near future. ITU2. I plan to adopt SELIS electric motorcycles when choosing a vehicle in the near future. ITU3. I intend to adopt SELIS electric motorcycles when choosing a vehicle in the near future. ITU4. I would like to recommend others to adopt SELIS electric motorcycles when they plan to choose a vehicle.	(Jaiswal et al., 2022)

Population and Sampling

The target population consisted of female Generation Z (born 1997–2012) residing in Jakarta who had never purchased or used a SELIS electric motorcycle. A purposive sampling method was applied, as respondents were selected based on these criteria. Following Hair et al. (2018), the sample size was determined by multiplying the number of indicators (17) by a factor of 10, resulting in a minimum of 170 respondents. In total, 210 valid responses were collected.

Instrument and Measurement

Data were collected through an online structured questionnaire distributed via Google Forms. The questionnaire used a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”) to measure the constructs. Indicators for environmental concern, perceived usefulness, attitude, and intention to use were adapted from prior validated studies.

Data Analysis

Descriptive analysis was conducted to summarize demographic characteristics. The main analytical tool was Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS. The outer model was assessed through indicator reliability, convergent validity ($AVE \geq 0.50$), internal consistency (Cronbach’s alpha and composite reliability ≥ 0.70), and discriminant validity ($HTMT \leq 0.90$; Fornell-Larcker criterion). Model fit was evaluated using SRMR (<0.08). The inner model was examined through the coefficient of determination (R^2), effect size (f^2), and hypothesis testing via bootstrapping to determine path significance.

RESULTS

Descriptive Statistics

The study collected 210 valid responses from female Generation Z aged 18-28. Most

respondents were students (78.6%), followed by private employees (15.2%), entrepreneurs (8%), and government employees (2.4%). Geographically, they were distributed across Jakarta, with the highest concentration in Jakarta Selatan (29.5%) and Jakarta Timur (26.7%). In terms of monthly expenses, 53.8% reported less than Rp 3,000,000, 27.1% between Rp 3,000,001–Rp 5,000,000, and smaller proportions above Rp 5,000,000.

Table 2. Respondents' Demographic

Demographic Profile		Frequency	Percentage (%)
Gender	Female	210	100.0
	Male	0	0.0
Age	18-28	210	100.0
	29-35	0	0.0
Occupation	Private Employee	32	15.2
	Entrepreneur	8	3.8
	Student	165	78.6
	Government Employee	5	2.4
Place of Residents	North Jakarta	18	8.6
	West Jakarta	38	18.1
	East Jakarta	56	26.7
	Central Jakarta	36	17.1
	South Jakarta	62	29.5
Monthly Expenses	<Rp 3.000.000	113	53.8
	Rp 3.000.001 - Rp 5.000.000	57	27.1
	Rp 5.000.001 - Rp 7.000.000	23	11.0
	Rp 7.000.001 - Rp 10.000.000	11	5.2
	>Rp 10.000.000	6	2.9

Outer Model Evaluation

The assessment of the measurement model confirmed that all indicators loaded strongly on their respective constructs, with values ranging from 0.763 to 0.908 for Attitude, 0.723 to 0.847 for Environmental Concern, 0.790 to 0.897 for Intention to Use, and 0.803 to 0.926 for Perceived

Usefulness. These results indicate that the items are good representations of the latent variables. Internal consistency was supported by Cronbach's Alpha and Composite Reliability values, which exceeded 0.70 across all constructs, including Attitude ($\alpha = 0.864$; CR = 0.908), Environmental Concern ($\alpha = 0.856$; CR = 0.896), Intention to Use ($\alpha = 0.884$; CR = 0.921), and Perceived Usefulness ($\alpha = 0.903$; CR = 0.933). Convergent validity was also established, with AVE values above 0.50 for all constructs (0.634–0.777).

Table 3. Outer Model

Construct	Items	Outer Loadings	Cronbach's Alpha	Composite Reliability	AVE
ATT	ATT 1	0.908	0.864	0.908	0.713
	ATT 2	0.843			
	ATT 3	0.856			
	ATT 4	0.763			
EC	EC 1	0.723	0.856	0.896	0.634
	EC 2	0.726			
	EC 3	0.847			
	EC 4	0.845			
	EC 5	0.830			
ITU	ITU 1	0.876	0.884	0.921	0.744
	ITU 2	0.790			
	ITU 3	0.897			
	ITU 4	0.883			
PU	PU 1	0.926	0.903	0.933	0.777
	PU 2	0.905			
	PU 3	0.886			
	PU 4	0.803			

Reflective indicators can be evaluated using cross loading between the indicators and their corresponding constructs. An indicator is considered valid if it has the highest loading factor on its target construct compared to its loading factors on other constructs. Based on the output, all indicators have the highest loading factor on their respective target constructs compared to other constructs and thus can be declared valid.

Table 4. Cross Loading

Construct	Attitude (Z)	Environmental Concern (X1)	Intention to Use (Y)	Perceived Usefulness (X2)
ATT 1	0.908	0.416	0.590	0.305
ATT 2	0.843	0.345	0.486	0.229
ATT 3	0.856	0.400	0.486	0.230
ATT 4	0.763	0.342	0.448	0.208
EC 1	0.265	0.723	0.384	0.128
EC 2	0.331	0.726	0.588	0.274
EC 3	0.322	0.847	0.565	0.224
EC 4	0.452	0.845	0.701	0.305
EC 5	0.367	0.830	0.643	0.193

ITU 1	0.576	0.589	0.876	0.435
ITU 2	0.494	0.642	0.790	0.314
ITU 3	0.506	0.672	0.897	0.412
ITU 4	0.489	0.659	0.883	0.348
PU 1	0.231	0.236	0.392	0.926
PU 2	0.300	0.285	0.412	0.905
PU 3	0.223	0.284	0.384	0.886
PU 4	0.267	0.222	0.354	0.803

Discriminant validity was established through the HTMT ratio, Fornell-Larcker criterion, and cross-loading analysis. The HTMT values across all construct pairs ranged from 0.320 to 0.832, remaining well below the 0.90 threshold, indicating that the constructs are empirically distinct. Similarly, the Fornell-Larcker results showed that the square root of the AVE for each construct (ranging from 0.796 to 0.881) was greater than its correlations with other constructs. Together, these results confirm that discriminant validity is achieved for all constructs in the model.

Table 5. Fornell-Larker Criterion

Construct	ATT	EC	ITU	PU
ATT	0.844			
EC	0.447	0.796		
ITU	0.599	0.743	0.862	
PU	0.291	0.292	0.438	0.881

Table 6. Heterotrait-Monotrait (HTMT)

Construct	ATT	EC	ITU	PU
ATT				
EC	0.506			
ITU	0.682	0.832		
PU	0.325	0.320	0.489	

Inner Model Evaluation

The inner model was evaluated using R^2 , effect size (f^2), and model fit indices. The coefficient of determination shows that environmental concern and perceived usefulness explain 22.8% of the variance in Attitude, while Attitude, Environmental Concern, and Perceived Usefulness collectively explain 67.3% of the variance in Intention to Use, indicating a strong explanatory power for the latter. Effect size analysis reveals that Environmental Concern has a strong impact on Intention to Use ($f^2 = 0.729$) and a moderate effect on Attitude ($f^2 = 0.185$), while Attitude exerts a moderate effect on Intention to Use ($f^2 = 0.206$). In contrast, Perceived Usefulness demonstrates weak effects on both

Attitude ($f^2 = 0.036$) and Intention to Use ($f^2 = 0.098$). Model fit results further confirm adequacy, with an SRMR value of 0.069, which falls below the 0.08 threshold, indicating that the overall model exhibits a good fit.

Table 7. R-square

	R-square	R-square adjusted
Attitude (Z)	0.228	0.220
Intention to Use (Y)	0.673	0.669

Table 8. F-square

	f-square
ATT-> ITU	0.202
EC -> ATT	0.184
EC -> ITU	0.743
PU -> ATT	0.036
PU -> ITU	0.094

Table 9. Model Fit

	Saturated model	Estimated model
SRMR	0.069	0.069
d_{ULS}	0.718	0.718
d_G	0.425	0.425
Chi-square	490.624	490.624
NFI	0.809	0.809

Hypotheses Testing (Bootstrapping)

The hypothesis testing results indicate that all proposed relationships are supported. Environmental Concern significantly influences both Intention to Use ($t = 10.730$, $p < 0.001$) and Attitude ($t = 5.936$, $p < 0.001$). Similarly, Perceived Usefulness has a significant effect on Intention to Use ($t = 4.270$, $p < 0.001$) and Attitude ($t = 2.569$, $p = 0.010$). Attitude itself exerts a strong positive influence on Intention to Use ($t = 5.284$, $p < 0.001$). Furthermore, mediation analysis confirms that Attitude mediates the relationship between Environmental Concern and Intention to Use ($t = 3.509$, $p < 0.001$), as well as between Perceived Usefulness and Intention to Use ($t = 2.147$, $p = 0.032$).

Table 10. Hypotheses Testing

Hypotheses	Relationship	STDEV	T Statistics	P Values	Results
H1	EC -> ITU	0.052	10.730	0.000	Supported
H2	PU -> ITU	0.045	4.270	0.000	Supported
H3	EC -> ATT	0.067	5.936	0.000	Supported
H4	PU -> ATT	0.068	2.569	0.010	Supported
H5	ATT -> ITU	0.056	5.284	0.000	Supported
H6	EC -> ATT -> ITU	0.033	3.509	0.000	Supported
H7	PU -> ATT -> ITU	0.024	2.147	0.032	Supported

DISCUSSIONS

The findings confirm that environmental concern has a strong positive effect on both attitude and intention, consistent with prior studies showing that environmental concern predicts sustainable consumption behavior, such as electric vehicle adoption (Sukma et al., 2023; García de Blanes Sebastián et al., 2023) and green product purchases (Yanyan et al., 2023). This suggests that eco-consciousness remains a powerful driver of behavioral intention in sustainability contexts.

Perceived usefulness also showed a significant effect on intention and attitude, though with smaller magnitude. This aligns with research demonstrating that usefulness influences technology adoption, including electric vehicles (Hussain & Qureshi, 2024; Ngoc et al., 2023). While practicality and cost-efficiency encourage adoption, the findings indicate that usefulness plays a complementary role to environmental concern, especially among young consumers who value both utility and eco-friendliness.

Attitude emerged as a central determinant of intention, confirming the Theory of Planned Behavior's predictions and aligning with studies in Indonesia, Vietnam, and Brazil that link favorable attitudes to higher EV adoption (Gunawan et al., 2022; Ngoc et al., 2023; Buranelli de Oliveira et al., 2022). Moreover, attitude mediated the effects of both environmental concern and perceived usefulness on intention, consistent with Lau & Hashim (2020) and Himel et al. (2021), who found that positive attitudes reinforce the path from beliefs to behavioral intentions.

CONCLUSION AND IMPLICATION FOR FUTURE RESEARCH

This study set out to examine the effects of environmental concern and perceived usefulness on female Gen Z's intention to adopt SELIS electric motorcycles, with attitude as a mediating variable. The findings advance current knowledge on sustainable consumer behavior in several ways. First, they demonstrate that environmental concern is not only a direct driver of behavioral intention but also an important antecedent of favorable attitudes, highlighting the central role of environmental values in shaping adoption decisions. Second, perceived usefulness, although less influential than environmental concern, emerged as a significant factor, confirming that rational assessments of practicality and efficiency complement value-driven motivations. Together, these findings underscore that both ecological awareness and functional benefits must be addressed simultaneously to strengthen consumer adoption of

electric motorcycles. Attitude functions as the psychological bridge that translates environmental concern and perceived usefulness into concrete behavioral intentions. This contributes to the literature on electric vehicle adoption by clarifying how attitudinal processes shape the decision-making of young, sustainability-conscious consumers, a segment often overlooked in mobility research.

The implications extend to practice as well. For manufacturers such as SELIS, the results suggest that marketing and product strategies should integrate environmental messaging with clear demonstrations of functional advantages. Campaigns that connect ecological impact with tangible lifestyle benefits are likely to build stronger positive attitudes and, in turn, increase adoption. On a broader level, the findings support policy initiatives aimed at promoting sustainable transport through awareness campaigns and infrastructure development targeted at young urban populations.

Future research should expand the scope beyond female Gen Z in Jakarta to explore whether these relationships hold across different demographic groups, cultural contexts, and geographic regions. Incorporating moderating factors such as charging infrastructure, range anxiety, and policy incentives would provide a more comprehensive understanding of adoption barriers. Mixed-method approaches, including interviews and behavioral tracking, could enrich insights into how stated intentions translate into real-world use. Such extensions would deepen the theoretical and practical contributions of this line of research and help accelerate the transition toward sustainable urban mobility.

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