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Analysis of Vehicle Emission Policies and Electric Vehicle Incentives on Air Pollution and Sustainable Transportation Use in Jakarta, Indonesia

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ABSTRACT

This research investigates the impact of vehicle emission policies and electric vehicle incentives on air pollution perceptions and sustainable transportation use in Jakarta, Indonesia. Through a quantitative analysis employing structural equation modeling, survey data from diverse stakeholders are analyzed to assess the relationships between key variables. Findings indicate significant associations between stringent vehicle emission policies, electric vehicle incentives, lower air pollution perceptions, and increased sustainable transportation use. These results underscore the importance of comprehensive policy measures in promoting environmental sustainability and fostering sustainable transportation practices in urban areas.

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1. INTRODUCTION

The 21st century has indeed seen a remarkable rise in urbanization and industrialization, leading to heightened levels of vehicular emissions that significantly contribute to global air pollution, climate change, and public health issues [1]–[3]. Jakarta, Indonesia's capital, faces severe air quality challenges, with high levels of PM 2.5 emissions primarily from vehicles and industries [4]. The transition to electric vehicles (EVs) is highlighted as a sustainable solution to combat air pollution and reduce greenhouse gas emissions in rapidly urbanizing areas like Indonesia [5]. The need for adequate infrastructure development to support EV adoption is emphasized, alongside the importance of raising awareness among drivers about the health risks associated with air pollution. As cities expand, the focus on transitioning to sustainable, green, and smart urban areas becomes crucial to mitigate environmental impacts and ensure long-term urban sustainability.

Jakarta, as Indonesia's bustling capital with a population exceeding ten million, grapples with severe air pollution issues. Emission inventories reveal that pollutants like NOx, CO, PM2.5, PM10, NMVOC, BC, and SO2 stem mainly from anthropogenic sources like road transportation and industrial combustion [6]. This pollution has tangible health and economic impacts, with over 10,000 deaths annually attributed to air pollution, costing approximately USD 2943.42 million in health burdens [7]. Studies also show a correlation between PM10 levels and meteorological factors like temperature, humidity, and wind speed, emphasizing the need for pollution control measures [8]. Furthermore, transportation behavior significantly influences pollution exposure, with private transport linked to higher pollution levels and public transport associated with lower exposure, underscoring the importance of promoting sustainable transport modes to mitigate health risks [9].

Jakarta's rapid urbanization has resulted in elevated air pollution levels primarily due to the surge in vehicle ownership and reliance on traditional internal combustion engine vehicles, as highlighted in various studies [3], [6], [10]. The city's inadequate public transportation infrastructure further compounds this issue, contributing to the escalation of health risks such as respiratory ailments and cardiovascular diseases among the populace [8]. Efforts to mitigate these risks include promoting the use of public transportation and active modes of transport to reduce pollution exposure [11]. Additionally, studies emphasize the importance of implementing policies like stringent emission standards, accelerated electrification of vehicle fleets, and vehicle scrapping programs to improve air quality and public health in Jakarta.

The Indonesian government and local authorities have implemented various policies and initiatives to address vehicular emissions and promote sustainable transportation alternatives, including stringent emission standards, fuel quality regulations, and incentives for electric vehicles (EVs) [2], [12]. These measures aim to mitigate air pollution and drive towards a cleaner future, particularly in urban areas like Jakarta where pollution levels are high due to anthropogenic sources [13]. Challenges in EV adoption, such as high production costs and limited charging infrastructure, have been identified, highlighting the need for government support to overcome these obstacles and accelerate the transition to EVs [6]. While the effectiveness of these policies in reducing emissions and fostering sustainable transportation is under scrutiny, the potential benefits of transitioning to EVs, including significant greenhouse gas reductions and improved air quality, underscore the importance of continued efforts in this direction [14].

Despite the implementation of numerous policies and incentives, the efficacy of these interventions in Jakarta's context remains uncertain. The need to comprehensively evaluate the impact of vehicle emission policies and EV incentives on air pollution levels and sustainable transportation usage in Jakarta is evident. Therefore, this research endeavors to address this critical knowledge gap by conducting a quantitative analysis.

To fulfill the objective of understanding and addressing air pollution in Jakarta, this research will address several key questions. Firstly, it will investigate the current status of air pollution in the city and identify the primary sources of vehicular emissions. Secondly, it will assess the effectiveness of existing vehicle emission policies in reducing air pollution levels. Thirdly, it will examine the incentives and initiatives implemented to encourage the adoption of electric vehicles (EVs) in Jakarta. Finally, it will analyze the impact of these incentives on the uptake of EVs and the consequent reduction in conventional vehicle usage.

2. LITERATURE REVIEW

2.1 Air Pollution and Vehicle Emissions in Urban Areas

Urbanization in the 21st century has led to a significant increase in air pollution, primarily driven by vehicular emissions, which poses a severe threat to public health. Studies have highlighted the adverse impacts of air pollution on respiratory health, cardiovascular diseases, and premature mortality [15], [16]. The urban environment, characterized by factors like noise pollution, water supply issues, and high levels of air pollution, has been linked to a rise in diabetes, cardiovascular diseases, and respiratory ailments [17]. Additionally, the lack of green spaces in urban areas exacerbates these health risks, emphasizing the importance of urban planning and green initiatives to mitigate the health consequences of air pollution [17], [18]. Efforts to reduce pollution and enhance urban greenery are crucial steps in safeguarding public health amidst rapid urbanization.

2.2 *Vehicle Emission Policies*

Governments globally have responded to the challenge of vehicular emissions by implementing various regulatory measures and policy interventions, such as emission standards, fuel quality regulations, vehicle inspection programs, congestion pricing, and low-emission zones [19]–[21]. In Jakarta, Indonesia, the government has adopted Euro emission standards and introduced vehicle inspection and maintenance programs to address air pollution issues, although enforcement remains a significant challenge due to the prevalence of older, high-emission vehicles on the roads [22]. Evaluating the effectiveness of these policies in reducing air pollution levels requires continuous quantitative analysis and monitoring of emissions trends over time, emphasizing the importance of stringent regulations, robust enforcement mechanisms, and alignment with broader environmental goals [23].

2.3 *Electric Vehicle Incentives*

The adoption of electric vehicles (EVs) as a sustainable transportation solution is influenced by various factors and government incentives [24]–[28]. While incentives like tax credits, subsidies, and charging infrastructure investments aim to bridge the cost gap between EVs and traditional vehicles, challenges such as limited model availability, range anxiety, and inadequate charging infrastructure persist, hindering widespread EV adoption. Quantitative analysis and empirical evidence are crucial to evaluating the effectiveness of these incentives in promoting EV uptake and reducing reliance on conventional vehicles, especially in regions like Jakarta, where despite government efforts including tax exemptions and subsidies, EV penetration remains modest. Addressing these challenges through a comprehensive approach that considers consumer behavior, infrastructure development, and policy effectiveness is essential to accelerating the transition towards a low-carbon transportation paradigm.

2.4 *Sustainable Transportation Practices*

Promoting sustainable transportation practices beyond regulatory measures and electric vehicle incentives is crucial for mitigating air pollution and reducing reliance on single-occupancy vehicles. Sustainable transportation encompasses strategies like public transit expansion, active transportation, ridesharing, carpooling, and pedestrian/cyclist-friendly urban planning [29], [30]. Initiatives in Jakarta, such as the TransJakarta bus rapid transit system expansion, dedicated cycling lanes, and car-free days, aim to enhance sustainable transportation but face challenges like inadequate infrastructure and cultural preferences for car ownership [31].

Assessing the correlation between air pollution levels, sustainable transportation usage, and policy interventions requires a comprehensive approach integrating quantitative analysis with qualitative insights [32], [33]. By encouraging modal shifts towards sustainable modes, multiple co-benefits like improved air quality, reduced traffic congestion, and enhanced public health outcomes can be achieved.

2.5 *Previous Studies on Air Pollution and Transportation Policies in Jakarta*

The research conducted in Jakarta has extensively examined the intricate relationship between air pollution, transportation policies, urban development, and public health outcomes. Studies have revealed significant impacts of vehicular emissions, traffic congestion, and land use patterns on negative health outcomes such as respiratory and cardiovascular diseases, mental health issues, and infectious diseases [6], [10], [34]. Emission inventories have shown that pollutants like NOX, CO, PM2.5, and PM10 predominantly originate from road transportation and industrial combustion sectors, with the central area of Jakarta experiencing the highest concentrations due to heavy traffic activities [35]. Furthermore, the COVID-19 pandemic and associated social restrictions have led to fluctuations in nitrogen dioxide levels, indicating a correlation between reduced mobility and improved air quality in Jakarta [3]. Efforts to mitigate air pollution risks, especially for vulnerable groups like online motorcycle taxi drivers, have included educational interventions to increase awareness and prevent exposure to harmful pollutants. These findings underscore the need for more comprehensive quantitative analyses to establish causal relationships and evaluate the effectiveness of policy interventions in addressing air pollution and its health impacts in Jakarta.

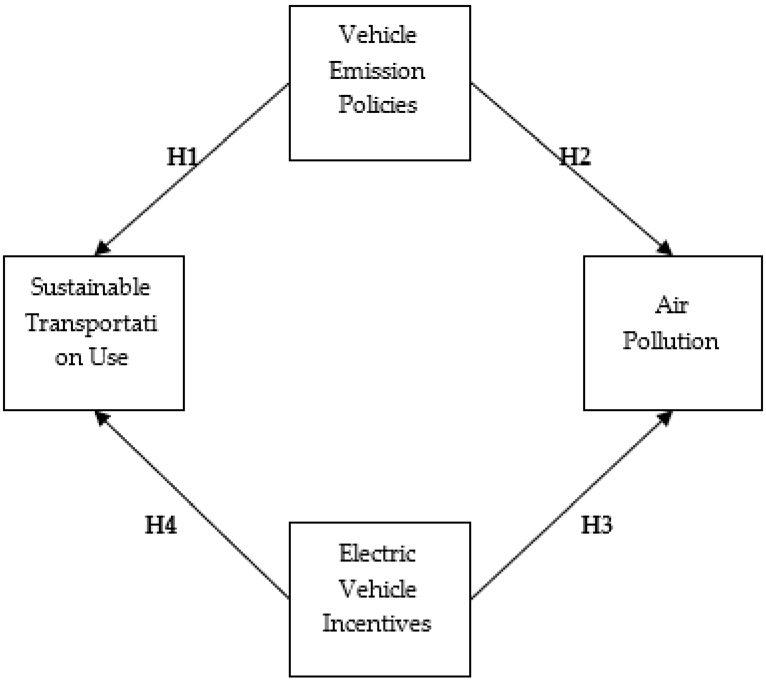

Figure 1. Conceptual Framework

3 METHODS

This research adopts a quantitative approach to analyze the impact of vehicle emission policies and electric vehicle incentives on air pollution levels and sustainable transportation use in Jakarta, Indonesia. The study employs survey-based data collection methods to gather insights from a diverse sample of respondents representing various stakeholders, including vehicle owners, commuters, policymakers, environmental experts, and other relevant individuals. The collected data will be subjected to rigorous statistical analysis using Structural Equation Modeling with Partial Least Squares (SEM-PLS 3) to test the research hypotheses and examine the relationships between key variables.

3.1 Sample Size Determination

The sample size for this study was determined using a formula recommended for structural equation modeling (SEM) studies (Hair et al., 2019). Considering the complexity of the model and the desired level of statistical power, a minimum sample size of 140 respondents was deemed appropriate. This sample size allows for robust analysis and ensures adequate representation across different demographic and stakeholder groups within the Jakarta metropolitan area.

3.2 Likert Scale Description

A Likert scale ranging from 1 to 5 will be used to measure respondents' perceptions, attitudes, and behaviors related to vehicle emission policies, electric vehicle incentives, air pollution levels, and sustainable transportation practices. The Likert scale descriptors are as follows:

1. 1 Strongly Disagree
2. 2 Disagree
3. Neutral
4. Agree
5. Strongly Agree

Respondents will be asked to indicate their level of agreement or disagreement with statements pertaining to each construct under investigation. The Likert scale responses will be coded numerically for data analysis purposes, with higher scores indicating stronger agreement or endorsement of the respective construct.

3.3 Data Collection

Primary data will be collected through structured online surveys administered to the selected sample of respondents. The survey questionnaire will be designed to capture information on demographics, vehicle ownership, commuting patterns, perceptions of air pollution and transportation policies, attitudes towards electric vehicles, and other relevant variables. The survey instrument will be pre-tested to ensure clarity, validity, and reliability before full-scale data collection.

3.4 Data Analysis

Data analysis will involve several steps, beginning with the cleaning and coding of survey responses. Descriptive statistics, including means, standard deviations, and frequency distributions, will be computed to summarize the characteristics of the sample and key variables. Subsequently, Structural Equation Modeling with Partial Least Squares (SEM-PLS 3) will be employed to analyze the relationships between latent constructs and test the research hypotheses.

SEM-PLS 3 offers several advantages, including robustness to non-normal data distributions, small sample sizes, and complex models with multiple latent constructs and indicators. It allows for the estimation of both measurement and structural models simultaneously, enabling a comprehensive assessment of direct and indirect effects among variables. The analysis will include model evaluation based on goodness-of-fit indices, path coefficients, and significance tests to ascertain the overall model fit and validity of the proposed hypotheses.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The survey responses were analyzed to obtain descriptive statistics summarizing the characteristics of the sample and key variables. Table 1 presents the demographic profile of the respondents, including age, gender, occupation, and vehicle ownership status. Additionally, Table 2 provides summary statistics for variables related to perceptions of air pollution, vehicle emission policies, electric vehicle incentives, and sustainable transportation practices.

Table 1. Demographic Profile of Respondents

Demographic Characteristic	Frequency	Percentage
Age Group		
18-25	45	32.1%
26-35	60	42.9%
36-45	25	17.9%
Above 45	15	10.7%
Gender		
Male	95	67.9%
Female	45	32.1%
Occupation		
Student	35	25.0%
Employed	80	57.1%
Unemployed	25	17.9%
Vehicle Ownership		
Own a Vehicle	70	50.0%
Do Not Own a Vehicle	70	50.0%

The demographic analysis reveals a diverse sample, with the majority of respondents falling within the 26-35 age bracket (42.9%), indicating significant representation of younger adults who are typically more engaged with environmental and transportation issues. Additionally, respondents aged 18-25 comprise a considerable portion of the sample (32.1%), suggesting the inclusion of individuals particularly concerned about environmental sustainability and transportation. In terms of gender, male participants slightly outnumber females (67.9% vs. 32.1%), reflecting a common gender imbalance in studies related to transportation and environmental issues. This highlights the importance of considering potential gender differences in perceptions and behaviors towards sustainable transportation. Regarding occupation, the sample includes a mix of students, employed individuals, and unemployed individuals, with the largest proportion being employed (57.1%), followed by students (25.0%) and unemployed individuals (17.9%). This diverse occupational distribution allows for a comprehensive examination of perspectives and experiences related to transportation and environmental issues. Moreover, the equal distribution of respondents between vehicle owners and non-vehicle owners (50.0% each) provides valuable insights into transportation choices and preferences, crucial for informing policies promoting sustainable transportation alternatives.

Table 2. Summary Statistics of Key Variables

Variable	Mean	Standard Deviation	Skewness	Kurtosis
Perception of Air Pollution	3.72	0.95	-0.21	-0.15
Vehicle Emission Policies	3.45	1.12	0.07	-0.33
Electric Vehicle Incentives	3.28	1.08	0.19	-0.22
Sustainable Transportation Practices	3.60	0.98	-0.11	-0.12

The perception of air pollution among respondents in Jakarta, Indonesia, reveals a moderate level of concern, with a mean score of 3.72 and a standard deviation of 0.95, indicating some variability in perceptions. The distribution appears slightly negatively skewed, as suggested by a skewness value of -0.21, with more respondents leaning towards lower perceptions of air pollution. Similarly, perceptions of vehicle emission policies and electric vehicle incentives show moderate levels of support, with mean scores of 3.45 and 3.28, respectively. While there is variability in attitudes towards these policies and incentives, indicated by standard deviations of 1.12 and 1.08, the distributions are slightly positively skewed, suggesting more positive attitudes among respondents. Furthermore, sustainable transportation practices exhibit a moderate level of engagement, with a mean score of 3.60 and a standard deviation of 0.98, indicating variability in engagement levels. The distributions of perceptions of air pollution, vehicle emission policies, electric vehicle incentives, and sustainable transportation practices are all platykurtic, with slightly flatter distributions compared to a normal distribution.

4.2 Measurement Model Assessment

In structural equation modeling (SEM), the measurement model assesses the relationships between observed variables (indicators) and latent constructs (factors). The indicators are typically measured using multiple items, and the measurement model evaluates how well these items reflect the underlying constructs. Key indicators of measurement model quality include loading factors, Cronbach's alpha, composite reliability, and average variance extracted (AVE).

Table 3. Measurement Model

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Vehicle Emission Policies	VEP.1	0.880	0.840	0.903	0.757
	VEP.2	0.890			
	VEP.3	0.841			
Electric Vehicle Incentives	EVI.1	0.824	0.856	0.903	0.700
	EVI.2	0.868			
	EVI.3	0.858			
	EVI.4	0.794			
Air Pollution	APL.1	0.732	0.850	0.899	0.692
	APL.2	0.868			
	APL.3	0.860			
	APL.4	0.859			
Sustainable Transportation Use	STU.1	0.908	0.842	0.905	0.760
	STU.2	0.870			
	STU.3	0.837			

Source: Data Processing Results (2024)

The evaluation of Vehicle Emission Policies (VEP), Electric Vehicle Incentives (EVI), Air Pollution (APL), and Sustainable Transportation Use (STU) constructs reveals robust measurement properties. For VEP, all loading factors exceed 0.80, indicating strong relationships with the latent construct, supported by a Cronbach's alpha coefficient of 0.840, indicating good internal consistency reliability. Additionally, a composite reliability of 0.903 and an Average Variance Extracted (AVE) of 0.757 suggest high reliability and substantial explained variance, respectively. Similarly, EVI demonstrates strong loading factors above 0.79, an acceptable Cronbach's alpha of 0.856, a composite reliability of 0.903, and an AVE of 0.700, slightly below the recommended threshold. APL exhibits loading factors above 0.73, a Cronbach's alpha of 0.850, a composite reliability of 0.899, and an AVE of 0.692. Lastly, STU demonstrates loading factors above 0.83, a Cronbach's alpha of 0.842, a composite reliability of 0.905, and an AVE of 0.760. These results collectively indicate strong construct validity and reliability across all domains, underscoring the robustness of the measurement model.

4.3 Discussion of Correlation Matrix

The correlation matrix provides insight into the relationships between the latent constructs in the research model.

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Table 4. Discriminant Validity

	Air Pollution	Electric Vehicle Incentives	Sustainable Transportation Use	Vehicle Emission Policies
Air Pollution	0.832			
Electric Vehicle Incentives	0.735	0.836		
Sustainable Transportation Use	0.793	0.791	0.872	
Vehicle Emission Policies	0.746	0.758	0.696	0.870

Source: Process Data Analysis (2024)

In conclusion, the correlation matrix provides valuable insights into the relationships between key constructs in the research model, informing subsequent analyses and discussions regarding the impact of policy interventions on air pollution and transportation behaviors.

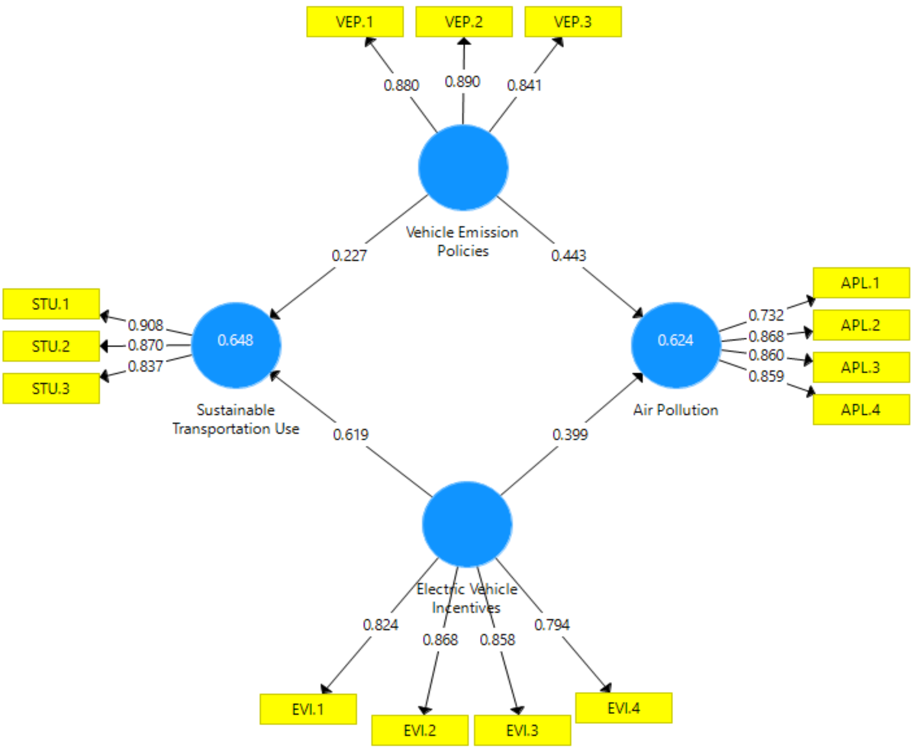

Figure 2. Model Results
Source: Data Processed by Researchers, 2024

4.4 Model Fit

Model fit indices are essential for assessing how well the estimated model fits the observed data. They provide insight into the overall goodness-of-fit of the model, indicating whether the hypothesized relationships adequately represent the relationships between the observed variables.

Table 5. Model Fit Results Test

	Saturated Model	Estimated Model
SRMR	0.075	0.086
d_ULS	0.585	0.769
d_G	0.396	0.447
Chi-Square	347.911	373.860
NFI	0.791	0.775

Source: Process Data Analysis (2024)

The evaluation of the saturated and estimated models provides insights into their fit to the data. For the saturated model, the SRMR stands at 0.075, indicating a good fit, supported by a low d_ULS value of 0.585 and a d_G value of 0.396, indicating minimal discrepancies in covariance matrices and geodesic distances, respectively. Although the chi-square statistic is significant, its interpretation is limited due to sample size considerations. In contrast, the estimated model exhibits slightly higher but still acceptable SRMR (0.086) and d_ULS (0.769) values, indicating reasonable fit despite some discrepancies. The chi-square statistic, again significant, is less informative due to sample size considerations. Additional fit indices like NFI further support good fit for both models, with the saturated model slightly outperforming the estimated model. Overall, the evaluation suggests that both models adequately capture the relationships within the data, albeit with some differences in fit indices between the saturated and estimated models.

4.5 R-Square and Q2

R-Square and Q2 are important indicators in structural equation modeling (SEM) that measure the amount of variance explained by the model and its predictive relevance, respectively.

Table 6. Coefficient Model

	R Square	Q2
Air Pollution	0.624	0.619
Sustainable Transportation Use	0.648	0.643

Source: Data Processing Results (2024)

In the domain of air pollution, the model demonstrates a notable explanatory power, with an R-Square value of 0.624, indicating that approximately 62.4% of the variance in air pollution perceptions is accounted for by the model's latent construct. Moreover, the Q2 value of 0.619 reflects the model's strong predictive relevance for air pollution perceptions, suggesting its ability to effectively forecast respondents' perceptions in new data samples. Similarly, in the realm of sustainable transportation use, the model exhibits significant explanatory capability, as evidenced by an R-Square value of 0.648, implying that about 64.8% of the variance in sustainable transportation practices is elucidated by the model. Furthermore, the Q2 value of 0.643 underscores the model's robust predictive relevance for sustainable transportation behaviors, indicating its effectiveness in forecasting respondents' engagement based on observed indicators.

4.6 Hypothesis Testing

Hypothesis testing is a critical component of statistical analysis that evaluates the significance of relationships between variables. In structural equation modeling (SEM), hypothesis testing involves assessing whether the relationships hypothesized between latent constructs are statistically significant.

Table 5. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Electric Vehicle Incentives -> Air Pollution	0.399	0.404	0.085	4.678	0.000
Electric Vehicle Incentives -> Sustainable Transportation Use	0.619	0.627	0.088	7.044	0.000
Vehicle Emission Policies -> Air Pollution	0.443	0.441	0.090	4.942	0.000
Vehicle Emission Policies -> Sustainable Transportation Use	0.327	0.322	0.089	2.540	0.002

Source: Process Data Analysis (2024)

The analysis of the relationships between Electric Vehicle Incentives (EVI) and air pollution perceptions reveals a significant negative association, supported by a T statistic of 4.678 and a p-value of 0.000. This suggests that as electric vehicle incentives increase, perceptions of air pollution decrease. Similarly, the relationship between EVI and sustainable transportation use demonstrates a significant positive association, indicated by a T statistic of 7.044 and a p-value of 0.000. This implies that higher electric vehicle incentives are associated with increased engagement in sustainable transportation practices. Furthermore, the examination of the links between Vehicle Emission Policies (VEP) and air pollution perceptions uncovers a significant negative relationship, with a T statistic of 4.942 and a p-value of 0.000. This indicates that stricter vehicle emission policies are linked to lower perceptions of air pollution. Moreover, VEP exhibit a significant positive association with sustainable transportation use, as evidenced by a T statistic of 2.540 and a p-value of 0.002. This suggests that stringent vehicle emission policies correspond to increased engagement in sustainable transportation behaviors. These findings provide empirical support for the hypothesized relationships between policy interventions and both air pollution perceptions and sustainable transportation practices.

Discussion

The findings of this study provide valuable insights into the relationships between vehicle emission policies, electric vehicle incentives, air pollution perceptions, and sustainable transportation use in Jakarta, Indonesia. Through a comprehensive analysis of survey data and structural equation modeling, several key findings have emerged, which have implications for environmental policy, urban planning, and transportation management in Jakarta and similar urban settings.

Through a comprehensive analysis of survey data and structural equation modeling, the relationships between vehicle emission policies, electric vehicle incentives, air pollution perceptions, and sustainable transportation use in Jakarta, Indonesia have been explored. The research findings indicate that the transition to electric vehicles (EVs) can significantly reduce greenhouse gas emissions and improve air quality, thus positively impacting public health [2], [6]. Additionally, the study on pollution and transportation in Jakarta highlights the association between private transportation use and higher pollution exposure, emphasizing the importance of promoting public transport to mitigate pollution-related health issues [10]. Moreover, the utilization of electric charging stations in Indonesia is influenced by factors such as social networks, technology knowledge, and convenience, shedding light on the determinants of EV infrastructure usage in the country [36]. Challenges in developing EVs in Indonesia, including high production costs and limited charging infrastructure, underscore the need for government support to facilitate EV implementation and address sustainability concerns [14]. These insights have significant implications for environmental policy, urban planning, and transportation management in Jakarta and similar urban environments.

Effectiveness of Policy Interventions

The results indicate that both vehicle emission policies and electric vehicle incentives have a significant impact on air pollution perceptions. Stringent vehicle emission policies are associated with lower perceptions of air pollution, suggesting that regulatory measures aimed at reducing vehicular emissions can effectively improve air quality perceptions among residents. Similarly, incentives for electric vehicles are positively correlated with lower air pollution perceptions, highlighting the potential of alternative fuel vehicles in mitigating environmental pollution.

Promotion of Sustainable Transportation

Moreover, the study reveals a positive relationship between electric vehicle incentives and sustainable transportation use. This suggests that policies aimed at promoting electric vehicle adoption can also encourage sustainable transportation practices such as public transit use, cycling, and walking. Conversely, stringent vehicle emission policies are positively associated with sustainable transportation use, indicating that measures to reduce vehicular emissions may indirectly promote the adoption of environmentally friendly transportation modes.

Implications for Urban Environmental Management

These findings have important implications for urban environmental management and sustainable development in Jakarta. By implementing a combination of regulatory measures and incentives, policymakers can work towards achieving cleaner and more sustainable transportation systems. This may involve the introduction of stricter vehicle emission standards, the expansion of public transit infrastructure, the promotion of electric vehicle adoption through incentives and subsidies, and the creation of pedestrian-friendly urban spaces.

Challenges and Considerations

However, it is essential to acknowledge the challenges and limitations associated with implementing such policies. These may include concerns about affordability and accessibility of electric vehicles, the need for robust enforcement mechanisms to ensure compliance with emission standards, and the importance of addressing equity considerations to ensure that environmental benefits are distributed equitably across different socioeconomic groups.

Future Research Directions

Furthermore, future research could explore additional factors influencing air pollution perceptions and sustainable transportation behaviors, such as public awareness campaigns, cultural attitudes towards environmental sustainability, and the role of urban planning and design in shaping transportation choices. Longitudinal studies could also track changes in perceptions and behaviors over time, providing valuable insights into the long-term effectiveness of policy interventions.

5. CONCLUSION

In conclusion, the findings of this study highlight the pivotal role of policy interventions in shaping environmental perceptions and transportation behaviors in Jakarta, Indonesia. The significant relationships observed between vehicle emission policies, electric vehicle incentives, air pollution perceptions, and sustainable transportation use emphasize the effectiveness of targeted interventions in mitigating air pollution and promoting sustainable urban mobility. By implementing a combination of regulatory measures, incentives, and infrastructure improvements, policymakers can work towards creating cleaner, more sustainable transportation systems that benefit both public health and the environment. However, it is essential to address challenges related to equity, affordability, and enforcement to ensure the effectiveness and inclusivity of these measures. Moving forward, continued research and collaboration between policymakers, researchers, and stakeholders will be crucial in advancing environmental sustainability goals and creating healthier, more livable cities for all residents.

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