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ARTICLE

Uncovering Jakarta Air Pollution Problem Using Classification Analysis of Public Policy

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ABSTRACT
This research aims to obtain formal problems and policy recommendations related to the air pollution phenomenon in Jakarta. Air pollution is a phenomenon of environmental quality degradation caused by several human activities. In the long run, emission load compounds produced by air pollution have been proven to threaten human survival. This issue needs to be addressed by the government by identifying the root causes and exploring alternative solutions to mitigate and prevent the worst impacts of air pollution. This research uses a qualitative research method of literature study by disseminating research results, reports, and news about air pollution in Jakarta. This research led to the formulation of a formal problem regarding the causes of air pollution in Jakarta, which is attributed to a linear increase in population, coinciding with the development of industries and the growing use of motorized vehicles, resulting in high exhaust emissions. The findings of this research indicate that motorized vehicles are the primary factor contributing to air pollution in Jakarta, as they are the main cause of high levels of air pollution in the city. This was identified using a multi-step process of public policy analysis, from classification analysis to the use of the pros and cons method. To overcome these problems, this research proposes policy recommendations that focus on increasing control over the number of vehicles through effective parking management in public spaces.

A. INTRODUCTION

The proliferation of economic activities in Jakarta increases air pollution caused by pollutants emitted due to transportation, industrial, and residential activities (Syuhada et al., 2023). The high mobility of Jakarta residents affirms the evidence of IQAir's data release, with the highest air quality index from October to September 2023, the highest being 163 and the lowest being 109, which is classified as unhealthy, especially for vulnerable and sensitive groups (IQAir, 2023).

Approximately, air pollution in Jakarta has caused significant health issues, estimated to be over 5.5 million illnesses in 2010, including respiratory infections and health diseases (Dinas Lingkungan Hidup DKI Jakarta & Vital Strategies, 2020). Greenpeace estimates air pollution contributed to 11,000 deaths, and 2.8 billion rupiahs in losses by 2023 (Syuhada et al., 2023). Recently, Jakarta ranked highest in air pollution among the world and Southeast Asian cities

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(AlFaruq, 2023). The central government has also intervened in handling air pollution in Jakarta (Menkomarinves, 2023).

The policy alternatives have not discussed the source of the problem, but have only focused on attention in the upstream sector (Samudra et al., 2024). High-emission coal and manufacturing companies are still operating, and the number of motorized vehicles is increasing each year (BPS DKI Jakarta, 2023). The court case won by civil society means that the government should make alternative policies that are more comprehensive and touch the source of pollution problems (Quina, 2021).

Many air pollution-related studies have been conducted in various cities around the world (Bermejo et al., 2023), some of which are health-related and focus on environmental science and medicine (Zhang et al., 2022). Most of these studies focus on particulate compounds and their impact on health (Handhayani, 2023; Syuhada et al., 2023). Similarly, some studies focused on major pollutants (Pramudya et al., 2023; Soemarko et al., 2023). On the other hand, many addressed the sources of pollution and their impact on health (Rendana et al., 2022; Soemarko et al., 2023). Several other studies also focus on air pollution mitigation policies and efforts (Rendana et al., 2022; Samudra et al., 2024) as well as recommend strategies such as increasing public awareness, electric vehicle adoption, and increasing green spaces to support air quality improvement in Jakarta (Sanni et al., 2024). However, there are gaps in the existing literature, especially in the analysis of the root causes of air pollution that are systematically categorized to determine key solutions. In addition, few studies discuss how the policy is debated in the social and political context to offer policy recommendations.

Based on the knowledge gap above, this research contributes to filling the research gap related to air pollution in Jakarta in public policy analysis studies by employing a classification analysis perspective to identify the root causes of problems and using the pros and cons method to provide solutions based on stakeholder perceptions of the policy alternatives offered. Finally, this research seeks to answer, "how to analyze the source of air pollution problems and how best to address them with a high degree of acceptance?" using public policy analysis techniques (Dunn, 2018)This study identifies problems, evaluates alternatives, and recommends data-driven strategies to help policymakers effectively reduce air pollution in DKI Jakarta.

This research contributes to three key areas: 1) analyzing pollution sources through classification methods, 2) providing policy recommendations using a pro-and-con approach, and 3) examining factors such as urbanization, industry, geography, and population dynamics that affect Jakarta's air quality. It provides relevant policy recommendations for DKI Jakarta's unique context.

B. LITERATURE REVIEW

Air Pollution Phenomenon

Air pollution is the pollution of the atmosphere by harmful substances, including gases (e.g., sulfur dioxide, nitrogen dioxide), particulates (e.g., PM10, PM2.5), and biological materials. These pollutants come from various sources, such as industrial activities, vehicle emissions, and natural events, such as forest fires (Chaurasia et al., 2023). The adverse effects of air pollution are far-reaching, impacting human health, ecosystems, and the climate. Health issues include respiratory and cardiovascular diseases, while environmental impacts include acid rain, ozone layer depletion, and climate change (Gkatzios et al., 2024). Many air pollution mitigation efforts have been implemented through various approaches. One of them is in terms of policy and governance, creating comprehensive policies that deal with air pollution, as well as climate change, and public health (Rendana et al., 2022).

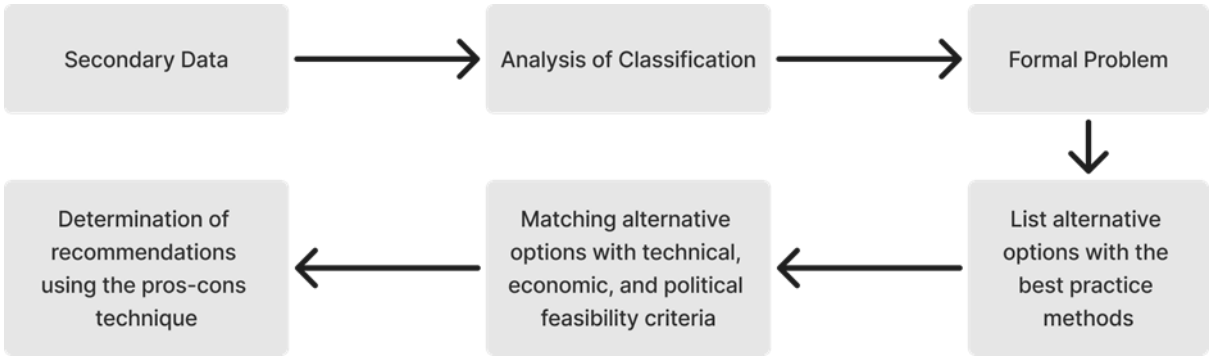
Air Pollution Control Policy

Air pollution control policies are crucial in mitigating the adverse impacts on public health and the environment. Strategies include integrating air pollution control with climate change mitigation (Feng et al., 2025) and implementing strict regulatory frameworks (Abrams et al., 2019). Technological innovations, such as industrial scrubbers and advanced modeling tools (Samudra et al., 2024), play an important role. Local initiatives, such as vehicle use restrictions (Wu et al., 2018), also contribute. Effective control requires policy synergies, considering climate change interactions, and public participation (Ogwu et al., 2024). Continued research and innovation are required to address emerging challenges and improve air quality.

C. METHOD

This research uses a qualitative method with a literature study approach (Johnston & Johnston, 2017). The data sources were eight documents on air pollution in Jakarta and 30 online news articles sourced from 18 verified online news sources. Then, researchers used the Creswell model data analysis technique (2009) through the following stages: (1) organizing and preparing data, (2) reading through all data, (3) categorizing the data (causes of air pollution) and grouping them in several segments, (4) connecting themes that have been grouped to get a deeper understanding of the phenomenon of air pollution, and (5) interpreting the understanding obtained from segments and segment relationships in the previous stage to answer research questions. Furthermore, data validity testing is carried out using source triangulation techniques by comparing information through sources obtained from different agencies and online sources.

After obtaining conclusions from the research data analysis, the researcher then integrated them into the classification analysis technique to identify the causes of air pollution. Then, the determination of policy alternatives was carried out by looking at existing best practices obtained from think tank documents or previous research. This is adjusted to the criteria of technical feasibility, economic possibility, and political feasibility (Bardach, 2012; Dunn, 2018). After that, the most feasible recommendations are selected using a pro-con analysis, with policy alternatives being popularly chosen among stakeholders (Dunn, 2018).



(Source: data processed by researchers)

Figure 1. Research Stages

D. RESULT AND DISCUSSION

Jakarta Province air quality monitoring study report (2023) determines that the primary sources of air pollution include the energy generation sector, the manufacturing industry sector, and the motor vehicle sector. In addition, climate and weather changes have contributed to worsening air pollution (Handhayani, 2023). These causes were determined as logical divisions in the classification analysis.

Coal-Fired Power Plant (CFPP)

The Ministry of Energy and Mineral Resources mentioned that until now, there have been six coal-fired power plants operating in Jakarta. However, this number includes only 16 other coal-fired power plants located not far from Jakarta (Myllyvirta et al., 2020). According to the DKI Jakarta Environmental Office (2020), transboundary pollution through coal combustion contributes at least 9 – 10% to pollution and contributes to SO2 (64%) and CO (45%) emissions. Researchers identified that several factors cause the high use of coal through CFPP, including:

First, increased electrical power consumption that is linear with population growth. Based on data released by the Central Bureau of Statistics, the population density in DKI Jakarta is equivalent to 103 times the population density of Indonesia (Javier, 2021). This is supported by the results of the 2020 census, which showed that the population of DKI Jakarta reached 10.56 million people, an increase of 954 thousand people from the last census in 2010. The increasing population is considered in line with the increasing consumption of electric power from the community.

Second, Ineffective use of renewable energy. Based on data released by the Ministry of Energy and Mineral Resources, the achievement of the portion of renewable energy in the national energy mix until 2022 was recorded to have only reached 12.3% and is still far from the 2025 target of 23% (Humas EBTKE, 2023). In addition, another factor that causes the ineffectiveness of EBT is that the electricity price is more expensive compared to the price of electricity from coal-fired power plants (Meilanova, 2020).

Third, Heavy reliance on coal. In 2019, Indonesia plans to add 31,200 MV coal-fired power plants, 20% of which are located within a 100 km radius of Jakarta. The policy is estimated to have an impact on air quality equivalent to adding 10 million cars to Jakarta (Myllyvirta et al., 2020). Another study found that the planned coal-fired power plant will cause 2,600 deaths each year (Koplitz et al., 2017).

Fourth, Weak supervision system of emission quality limit regulation. Based on Regulation of the Minister of Environment and Forestry No. 15 of 2019, the emission quality limits for coal-fired power plants are more lenient compared to those in other countries. For example, SO2 and NOx are 200 mg/Nm³ and PM is 50 mg/Nm³, respectively. Meanwhile, the quality standards for coal-fired power plants' emissions in China are strict, such as SO2 of 50 mg / Nm3, NOx 35 mg/ Nm3, and PM 10 (Susanto, 2019). Findings by the Center for Research on Energy and Clean Air (CREA) state that there are indications that the activities of the Suralaya coal-fired power plant in the Jabodetabek area exceed the quality standards set by the government. CREA found that three pollutants exceed the quality standards, namely NOx, SO2, and PM 2.5 dust particles. In addition, it also has an impact on the economic and health aspects of the community around the coal-fired power plants complex (Sinaga, 2023).

Ground Transportation

Data from the DKI Jakarta Environment Agency (2023) showed that transportation exhaust emissions are one of the main contributors to air pollution. In relation to this, out of all transportation means, land transportation through fossil-fueled motor vehicles can contribute at least 32-57% of carbon exhaust emissions (Dinas Lingkungan Hidup DKI Jakarta & Vital Strategies, 2020). By focusing on the land transportation sector, researchers parse and classify several contributing factors, from motor vehicles to air pollution in DKI Jakarta, some of which are as follows:

Economic growth and population growth. DKI Jakarta's economy grew an average of 4.59% annually in 2021-2023, slightly below the national average of 4.69% (BPS DKI Jakarta, 2024b). This means that with a relatively good economy, the population is increasingly able to buy things, including a private vehicle. Based on data collected from BPS DKI Jakarta from

2016 to 2023, it shows that the growth in the number of vehicles in Jakarta increased by approximately 720,000 vehicles per year. In addition, the most significant portion of vehicle types is motorcycles at 79.58% (BPS DKI Jakarta, 2024b).

The location of residence and driving distance are linearly related to fuel consumption. Most workers in DKI Jakarta are predominantly from a few satellite towns and buffer cities. This has an impact on the high average driving distance of these workers. BPS DKI Jakarta (2020) estimates that people who live in several satellite cities and work in DKI Jakarta, on average, travel 40 km per day, spending an average fuel consumption of 43.9 km/liter for two-wheeled vehicles and 10.2 km/liter for four-wheeled vehicles.

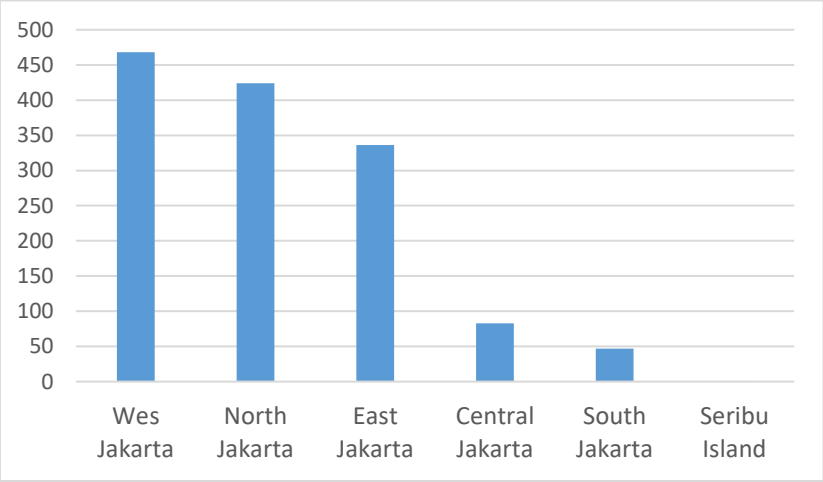
Fuel type and quality. The Ministry of Energy and Mineral Resources noted that in 2021, Pertalite consumption amounted to 23 million kiloliters. Pertalite is the most consumed gasoline-type fuel by the public, accounting for almost 80% of other gasoline fuels (Direktorat Jenderal Minyak dan Gas Bumi KESDM, 2022).

Additionally, according to data from PT Pertamina Regional West Java, it was observed that fuel consumption increased in several cities in the Jakarta area at the beginning of 2021. In South Jakarta City, the consumption of pertalite type fuel increased by around 39%, in the West Jakarta City area, it also increased by around 38%, and in East Jakarta City, there was an increase of around 34% (Avisena, 2021). This increase is linear, corresponding to the increasing volume of vehicles in DKI Jakarta.

Manufacturing Industries

DKI Jakarta has a few industries engaged in manufacturing. This certainly has a significant influence, especially on the economy. Based on data from BPS DKI Jakarta (2024a) in 2024, the manufacturing industry sector contributed 1,359 business units/companies, with the largest distribution in West Jakarta, North Jakarta, and East Jakarta.

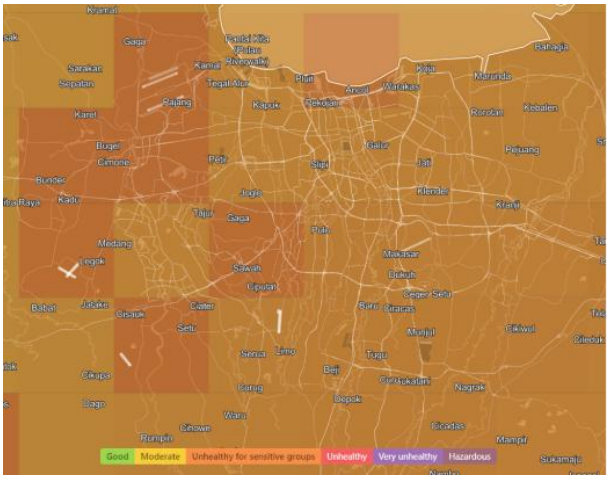
Increase in the number of fossil-based manufacturing industries. The manufacturing industry sectors are spread throughout DKI Jakarta province with West Jakarta having the most industries, which is 34.44% of the total industries, see Figure 5 (BPS DKI Jakarta, 2024a).



(Source: BPS DKI Jakarta, 2023)

Figure 2. Distribution of Manufacturing Industries in DKI Jakarta Based on Location

Most of these factories rely on gasoline and diesel for electricity generation, heating, and hot water. By 2023, the industrial sector in Jakarta will be the dominant source of emissions (Dinas Lingkungan Hidup DKI Jakarta, 2023). When referring to the data, most manufacturing industries are in the West Jakarta area, making the region the area with the highest level of air pollution in DKI Jakarta.



(Source: IQAir, 2023b)

Figure 3. IQAir Satellite Image Viewing as of September 2023

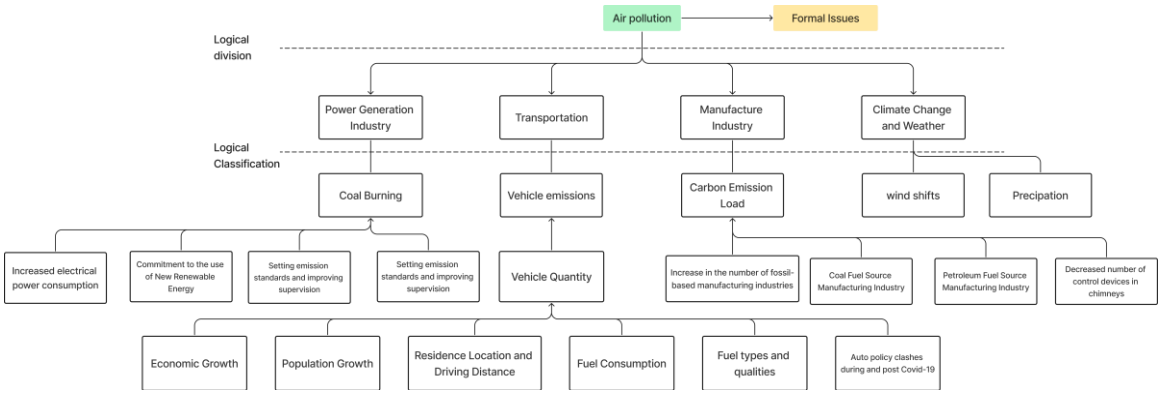
Figure 6 shows that the West Jakarta area is solid red, indicating unhealthy air conditions. It affirms that the decline in air quality is caused by, among other things, an increase in urban population and industrial energy consumption (Dinas Lingkungan Hidup DKI Jakarta & Vital Strategies, 2022). Concerns arise because the region has a high population density, second only to Central Jakarta (BPS DKI Jakarta, 2024a).

Contribution of Fossil Sources to the Manufacturing Industry. The manufacturing industry uses 52% natural gas, 44% petroleum, and only 4% coal (Amri et al., 2020). However, the use of fossil energy as industrial fuel has a significant impact on the emission loads such as SO_2 CO NO_2 NOx NO PM2.5, PM10, THC, PM1, and O_3 (Dinas Lingkungan Hidup DKI Jakarta, 2023).

A decrease in the number of control devices in chimneys. According to the DKI Jakarta air inventory report (2020), out of 933 registered emission sources, 423 emission sources used control devices in 2018 and 416 units in 2019. As a result of emission sources no longer operating, the value of using control devices through chimneys has decreased. This is since the value was previously higher.

Climate Change Contribution

Under a high emissions scenario, risks from extreme temperatures and precipitation are projected to occur in almost all cities, impacting freshwater availability, regional food security, human health, and industrial output. In addition, Jakarta's climate is strongly influenced by the recent El Nino and La Nina weather cycles, which further leads to a delayed onset of rainfall in Jakarta (Ilhamsyah, 2019; UNESCO, 2023). Therefore, both dry and wet seasons can influence pollutants, such as from vehicle exhaust fumes in the wet season (42-57 %) and dry season (32-41 %), coal combustion producing more in the dry season (14 %), and open burning (Dinas Lingkungan Hidup DKI Jakarta & Vital Strategies, 2022).



(Source: data processed by researchers)

Figure 4. Classification Analysis of DKI Jakarta Air Pollution

The study shows that high mobility areas trigger more pollution. Economic activities drive industrial growth, resulting in increased emissions from both industry and transportation. In Jakarta, Pollution is primarily caused by population growth, industrialization, and the increasing number of motor vehicles, which is further worsened by the effects of climate change on weather and wind patterns.

Discussions

Identification of the Root Causes of Air Pollution in Jakarta

Based on the classification analysis and formal problem mapping, researchers identified several root causes of air pollution in Jakarta, including coal power plant activity, land transportation, the manufacturing industry, and weather and climate change. The most significant factor in air pollution is the transportation problem, which is supported by population mobility and changes in economic structure, especially in industrial areas and urban businesses (Amri et al., 2020). In addition, the external factors of climate change and erratic weather make the level of air pollution due to fuel combustion in vehicles more widespread and exacerbate damage to air quality.

However, understanding the context of this problem requires determining alternative solutions in multiple steps with a scientific data of evidence-based approach. Therefore, this research examines various policy alternatives to mitigate air pollution from the transportation sector, which is identified as the primary contributor based on academic studies. Then, the options are screened based on the evaluation of economic and political criteria and involve participation in public opinion.

Determination of Alternative Solutions to Vehicle- Driven Air Pollution and Matching with Political and Technical Criteria

Before determining recommendations, the next step is to identify several policy alternatives from think tanks or previous studies and then evaluate them against predetermined criteria. The selection of these criteria is based on the researcher's preferences and alignment with the issues raised. Namely, vehicles are a significant cause of air pollution in Jakarta (Dunn, 2018). Some alternative policies offered are (Option 1) development of NMT (Non-Motorized Transport) facilities, such as pedestrian sidewalks and cycling infrastructure (ITDP Indonesia, 2017), (Option 2) integrating modes of transportation is also a vision of realizing a sustainable transportation system (ITDP Indonesia, 2017), (Option 3) use of clean/renewable energy to tackle pollution (Shafiei & Salim, 2014), (Option 4) improvement of vehicle fuel quality to achieve low-emission transportation (Mara & Nuarsa, 2022), (Option 5) traffic engineering

management (Putra, 2023), (Option 6) controlling the number of vehicles through parking management (ITDP Indonesia, 2017).

Each alternative offer's fulfillment is analyzed based on political, technical, or economic criteria as a stage to identify the feasibility of implementation. The three criteria were chosen based on the consideration that air pollution control policies must be acceptable to stakeholders, have regulatory suitability, and not cause resistance in the community. In addition, it has a real technical impact in reducing air pollution, provides optimal benefits at a rational cost, and does not burden the government or society.

Table 1 below presents the analysis of the feasibility criteria for the six alternative policy options identified.

Table 1. Analysis of eligibility criteria in public policy analysis

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Technical feasibility						
Effectiveness	Sidewalk improvements focused on road segments around mass transit stations (Irafany et al., 2023)	There is integration between Transjakarta, MRT, and LRT (Yuantisya, 2022)	-			Limiting the number of parking spaces and setting a maximum number of parking spaces on parcels/buildings, especially in TOD areas (Wantara, 2017)
Adequacy	Pedestrians and cyclists are the leading actors of public space in urban cities (Karanikola et al., 2018)	The Government of Jakarta has seen that MRT, LRT, and Transjakarta are a unified mass transit service (Yuantisya, 2022)	-			Parking policy with the application of minimum parking requirement (Simatupang et al., 2022)
Political viability						
Acceptability	-	The government discussed this policy, which was supported by the legislature and the community (Santoso et al., 2018)	The policy of using electric/EBT vehicles still has pros and cons among political actors and the public (Annur, 2023)	Still a matter of debate between political actors and the public because of the potential for inflation (Ali et al., 2023)	Already implemented in Jakarta, these include odd-even, low-emission zones, and Car-Free Day.	-
Appropriateness	Generally appropriate in the context of Jakarta to solve air pollution problems with vehicle management					
Responsiveness	-	Policies that support the needs of the community (Yuantisya, 2022)	The policy of using renewable energy vehicles can encourage the quality of people's fuel needs. But there are still limitations in price and infrastructure (Nurbaiti, 2022)	Tends to make it difficult for people to get their needs followed by rising prices (Ali et al., 2023)	Loss for some groups, as it blocks road access.	-
Legal	-	Regulation of the Governor of DKI Jakarta No. 68 of 2021	Minister of Transportation	-	Regulation of the Governor of DKI Jakarta No. 88 of 2019, No. 66 of	-

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
			Regulation No. 45 of 2020		2020, and No. 151 of 2017	
Equity	-	Promoting equity and justice for society (Julio et al., 2020)	There is a potential for uneven distribution of people acquiring electric vehicles, so subsidies are encouraged (Nurbaiti, 2022)	Encourage ease of access for the community in obtaining better quality fuel.	-	-
Economic possibility						
Economic Efficiency	-	The integration between mass transportation modes makes it easier for passengers to reach their destination (Yuantisya, 2022)	Indonesia again has sufficient resources to use electric vehicles (Sihombing, 2022)	-	-	-
Profitability	-	The number of passengers is increasing every year (Antara, 2022A)	The number of electric motors used in Indonesia increased 13-fold from 2020 to 2022 (Annur, 2023)	-	-	-
Cost Effectiveness	-	The cost required is relatively large (Antara, 2022A)	This policy is costly (Nurbaiti, 2022)	-	-	-

Finally, based on the analysis of policy options and existing criteria. There are policy options considered to meet the requirements, either politically, economically, or technically. These options include Option 2, which meets all requirements; Option 3, which meets both political viability and economic feasibility; Option 1, which meets technical feasibility criteria; and Option 6, which also meets technical feasibility criteria.

Analysis of the Determination of Transportation

After determining feasible alternative policy options based on the previous criteria, the next step is to determine policy recommendations through the pro-contra method. This method not only identifies opinions that support or reject each policy alternative but also tests the feasibility of policies in social and political reality. The consideration of using this method is that the air pollution policy issue caused by motorized vehicle activities is a cross-sectoral problem, and this method can measure the level of acceptance by each actor. Apart from the actors, the pro-contra method can be used to analyze aspects of policy acceptance more systematically, providing more comprehensive recommendations than simply choosing policies based on technical or economic effectiveness alone.

The following is an analysis of recommendations using the pros and cons method of the four policy options that are feasible in terms of the criteria.

Integration between Mass Transportation Modes

Public transportation in Jakarta struggles with a stigma, requiring improved service standards as per Ministerial Regulation Number 10 of 2012, which emphasizes safety, comfort, affordability, equality, and reliability. Here are the positive and negative sentiments of this issue.

Table 2. Stakeholder Sentiment Mapping of mass transportation intermodal integration policies

No.	Stakeholder	Actor	Statement/Response	Sentiment
1.	Government	Anies Baswedan	Enhance transport integration to cut air pollution (Gewati, 2023)	Pros
		Head of DKI Jakarta Transportation Office	Promote mass transport to ease congestion (Pribady, 2023)	Pros
		Jabodetabek Transportation Management Authority	Integration benefits the community (Badan Pengelola Transportasi Jabodetabek, 2021)	Pros
		President Director of PT JakLingko Indonesia	Transport integration cuts private vehicle use (Hastuti, 2021)	Pros
		DKI Jakarta Legislative Council	Public transport integration falls short (Majni, 2019)	Cons
		Jakarta Transportation Council	Transport connectivity in Jakarta faces obstacles (Kartika & Maharani, 2019)	Cons
2.	Observer	Agus Pambagio	Transport integration system lacks principle (Hapsari & Sari, 2021)	Cons
		Djoko Setijowarno		
		Yayat Supriatna	Transport integration tariffs are costly (Purnama, 2023)	Cons
3.	NGO/Community	ITDP	Public transport integration in Jabodetabek (ITDP Indonesia, 2017)	Pros
4.	Public	Media	Transport integration tariffs are too high (Laksono, 2023)	Cons

No.	Stakeholder	Actor	Statement/Response	Sentiment
		Media	Limited public transport in Jabodetabek (Wisanggeni et al., 2022)	Cons

Source: Data processed by researchers

Use of Clean/New Renewable Energy

Transportation in DKI Jakarta, which relies heavily on fossil fuels, contributes significantly to pollution. The government addresses this issue by promoting electric vehicles through Presidential Regulation No. 55 of 2019, aiming to boost energy security and protect the environment. Here are the positive and negative sentiments of this issue.

Table 3. Stakeholder Sentiment Mapping on the Use of Clean / New Renewable Energy

No.	Stakeholder	Actor	Statement/Response	Sentiment
1.	NGO/Community	Koaksi Indonesia	Policy gaps: biofuel, EV standards (Syahni, 2021)	Cons
		Indonesian Renewable Energy Society	Indonesia's fossil fuel reliance hinders EBT effectiveness (Fitriani, 2021)	Cons
2.	Public	Media	Most reject EV subsidies as biased (CNN Indonesia, 2023)	Cons

Source: Data processed by researchers

Construction of NMT (Non-Motorized Transport) Facilities

Non-motorized transport (NMT) facilities aim to promote short-distance mobility through safe and accessible infrastructure for walking or cycling. Here are the positive and negative sentiments of this issue.

Table 4. Sentiment Mapping of NMT Facility Development Stakeholders

No.	Stakeholder	Actor	Statement/Response	Sentiment
1.	Government	DKI Jakarta Bina Marga Office	Sidewalks designed for all users benefit everyone (Antara, 2022b)	Pros
		Anies Baswedan	Creating a third space for community (Antara, 2022b)	Pros
		DKI Jakarta Transportation Office	Built a bicycle lane network (Prayoga, 2022)	Pros
		Anies Baswedan	DKI Jakarta focuses on building cycling paths (Antara, 2022b)	Pros
		Anies Baswedan	DKI Jakarta prioritizes sidewalk development, aligning with global city trends (Wiguna, 2022)	Pros
		Head of the DKI Jakarta Transportation Office	Bicycle lanes are a priority for Governor Anies Baswedan (Prayoga, 2022)	Pros
2.	Observer	Yayat Supriatna	Bicycle paths reduce pollution, promote culture (Prayoga, 2022)	Pro
		Yayat Supriatna	Street vendors persist; bike lanes misused by motorcycles (Prayoga, 2022)	Cons
3.	NGO/Community	Nirwono Joga (City Planning Observer)	Focus on penalties over education (Prayoga, 2022)	Cons
		Nirwono	Lack of studies leads to misuse (Prayoga, 2022)	Cons

No.	Stakeholder	Actor	Statement/Response	Sentiment
		Indonesian Landscape Architects Association	The next government must continue pedestrian revitalization (Agustian & Ihsanuddin, 2022a)	Pros
		Jakarta Bike2Work Indonesia	The community must prioritize cyclists, pedestrians, and transit (Prisie, 2023)	Pros
4.	Public	Media	Regret misuse of cycling lanes (Prayoga, 2022)	Cons

Source: Researcher processed data

Controlling the Number of Vehicles through Parking Management

Effective parking management optimizes space, improves service quality, enhances safety, reduces congestion and pollution, and supports non-motorist mobility. Here are the positive and negative sentiments of this issue.

Table 5. Stakeholder Sentiment Mapping Controlling the Number of Vehicles through Parking Management

No.	Stakeholder	Actor	Statement/Response	Sentiment
1.	Government	Head of the DKI Jakarta Transportation Office	High-priced parking for vehicles failing emissions (Huda, 2023)	Pros
		DKI Jakarta Air Pollution Control Task Force	Expanding disincentive parking to boost emission tests (Huda, 2023)	Pros
		Head of the Parking Management Unit of the DKI Jakarta Transportation Office	JakParkir app launched to manage parking, ease payments (Setyadhi, 2023)	Pros
		DKI Jakarta Legislative Council	Reducing roadside parking, setting maximums in IMB, and enforcing via regional regulations (Sa'diyah & Ucu, 2013)	Pros
		Jakarta City Transportation Council	Jakarta's sidewalk development aligns with global trends. (Wiguna, 2022)	Pros
		Head of the DKI Jakarta Transportation Office	High parking fees boost public transit use (Tim detik.com, 2020)	Pros
2.	Observer	Azaz Tigor Nainggolan	Audit illegal parking causing congestion (Prayoga & Sujatmiko, 2022)	Pros
		Nirwono	Communal parking lots build resident awareness (Elisabeth, 2021)	Pros
3.	NGO/C Successful policy reduces private car use	ITDP Indonesia	Parking restrictions reduce vehicle congestion (ITDP Indonesia, 2017)	Pros
		CORE Indonesia	Successful policy reduces private car use (Elisabeth, 2021)	Pros
		Forum Warga Jakarta Kota	Towing alone won't solve illegal parking issues (Agustian & Ihsanuddin, 2022b)	Pros

Source: Researcher processed data

The mapping results indicate that parking management to control vehicle numbers is the most widely supported policy, with no counter-sentiment, making it a recommended solution for addressing air pollution in DKI Jakarta. The government can take the following steps to implement this policy:

To address air pollution in DKI Jakarta through controlling the number of vehicles, the government can implement several parking management strategies: 1) Parking Restriction and Pricing Policy: Establish zones with restricted parking or high prices to reduce vehicle use in the city center, encourage the use of public transportation, and non-motorized modes (Comi & Elnour, 2024). Raise parking fees in congested areas to reduce the number of vehicles and congestion (Tsai et al., 2021). 2) Optimizing Parking Space Utilization includes implementing a smart parking system using technology to manage parking more efficiently, reducing time spent searching for parking and vehicle emissions (Balasubramanian et al., 2024). In addition, a reservation system can be implemented to reduce cruising time and improve traffic flow (Pan et al., 2024). 3) Environmental Traffic Restrictions with the Low Emission Zones (LEZs) system, which restricts access for high-emission vehicles. This means applying strict emission standards for vehicles in certain parking areas (Song et al., 2021). 4) Improving Parking Design and Layout. In other words, using parking designs that increase efficiency and reduce emissions (Anugrah et al., 2019). Such as underground and multi-storey parking, these parking facilities can reduce the need for on-street parking and congestion (AlKheder & AlRukaibi, 2020).

E. CONCLUSION

This research has identified that air pollution in Jakarta is a complex environmental problem that impacts public health and economic activity. Based on the classification analysis, it was found that the primary sources of air pollution in DKI Jakarta are three sectors: coal-fired power plants, motorized vehicles, and manufacturing industries, as well as climate change and weather conditions. However, the most significant contributor to air pollution emissions comes from motorized vehicles.

To address this, an exploration of various policy alternatives based on previous studies. Some of the proposed alternatives include the development of non-motorized transport (NMT) facilities, integrating mass transportation modes, utilizing clean energy in transportation, enhancing fuel quality standards, implementing traffic engineering management, and controlling vehicle numbers through effective parking management. Each option is evaluated for its feasibility in terms of political, economic, or technical criteria to ensure that its implementation is realistic and effective.

Following the feasibility process, the pros and cons method was used to enable a systematic analysis of the level of public acceptance of the policy. The results of the analysis indicate that controlling the number of vehicles through parking management is the most feasible option for implementation in the short to medium term. This policy has a high level of public acceptance with low resistance. However, this research has limitations, as it relies solely on secondary data in its analysis. Therefore, future research is directed at developing a conceptual model based on primary data to provide a more comprehensive picture of policy effectiveness in the long term.

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