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Optimizing Strategies For Controlling And Improving Air Quality As An Effort To Minimize The Impact Of Public Health And Climate Change (Case Study : Jakarta City Air Pollution)

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Abstract
Air pollution is a serious problem that can impact human health and climate change. This article is an attempt to provide a comprehensive overview of air pollution control strategies through a literature review. Jakarta is a city with poor air quality. Pollutants in Jakarta are generated by motor vehicles, industry, and power plants. Optimization strategies that can be carried out are the expansion of LEZ, increasing taxes on polluting vehicles, and subsidies for electric vehicles by considering economic and social factors. Sources of pollutants can include forest fires, industry, transportation, construction, and other anthropogenic activities carried out by human. Pollutant sources can be identified through several methods by making a diagram that is classified based on the gas and its source. Prof. Puji explained the basic principles of industrial management in order to control air quality by identifying the type of pollutants by monitoring, determining the level of pollution from emission sources, comparing with emission quality standards, monitoring air pollution control, and planning control strategies.

Keyword: air quality, public health, climate change, air pollution, strategy

Introduction

Air pollution is defined as a phenomenon that endangers the ecological system and the normal conditions of human existence and development when some substances in the atmosphere exceed a certain concentration (Bai et. al., 2018). Air pollution affects the life of a society, even jeopardizing human survival (Manisalidis et. al., 2020). During the Industrial Revolution, there was a dramatic increase in the use of coal by factories and households, and smog caused significant morbidity and mortality, especially when combined with stagnant atmospheric conditions (Bai et. al., 2018).

Jakarta is included in the list of cities in Indonesia that have poor air quality (Hansun et. al., 2021). This fact is supported by the results of Jakarta's air quality monitoring which shows that the air quality is often at 'unhealthy' conditions. The city of Jakarta has experienced massive development and urbanization coupled with motorization leading to increased energy use. In addition, other factors such as rapid population growth, industrial development, and high motorized vehicle use also contribute to the release of large amounts of small particles into the atmosphere (Kusumaningtyas et. al., 2018).

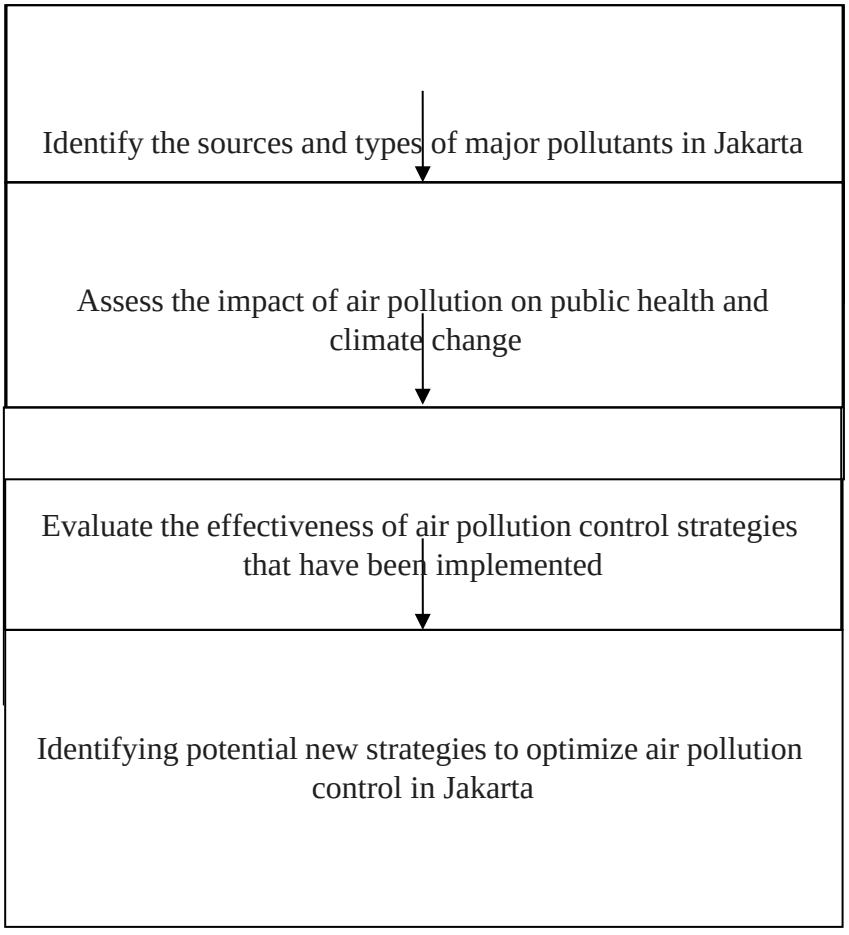
Air pollution in Jakarta has had a negative impact on public health, and also contributes to climate change. Air pollution has various impacts on health. Vulnerable human health can be affected even when air pollution is low. The impact of air pollution on human health is linked to Chronic Obstructive Pulmonary Disease and respiratory diseases (Manisalidis et. al., 2020). Long-term effects due to prolonged exposure are chronic asthma, pulmonary insufficiency, cardiovascular disease, and cardiovascular death (Manisalidis et. al., 2020). Air pollution affects various parts of the human body, namely the lungs, eyes, skin and hair, liver, bones, liver, and brain (Sivarethinamohan et. al., 2020).

Air pollution contributes to climate change. Air pollution increases the concentration of greenhouse gases in the atmosphere, including CO2, CH4, and NOx (Almetwally et. al., 2020). These gases function to retain heat in the atmosphere, which can cause global warming. Air pollution also increases greenhouse gas concentrations through fuel combustion, forest and land fires, and agricultural activities (Munsif et. al., 2021). Climate change due to air pollution has an impact on rising sea levels, changing weather patterns, and species extinction (Rahman, 2018). Therefore, efforts are needed to control and improve air quality in Jakarta City. These efforts must be optimized in order to contribute to public health and climate change. Furthermore, climate change has an impact on disaster threats and the disaster management process needs to pay attention to the communication process because disaster communication plays an important role in the disaster management cycle starting from pre-disaster, emergency response, and post-disaster (Hidayat et. al., 2023).

This article provides a comprehensive overview of the main sources of air pollution in Jakarta and air pollution control strategies by emphasizing the health and climate change impacts of each pollutant; presents optimization strategies for control and reduction of pollutant concentrations and better air quality. With an in-depth discussion of these various aspects, this article is expected to contribute to efforts to control and improve air quality in Jakarta City, as well as in Indonesia in general.

Method

This research was conducted by searching for literature related to the research objectives. The literature study in this research is to utilize existing literature to develop the conceptual framework of the research and develop its theoretical and practical aspects. The literature research carried out includes the selection of library materials in accordance with the research objectives, the search for library materials obtained, the reading of existing library materials, and the presentation of library materials obtained.



Results

Air Quality and Air Pollution

Air quality is the condition of air in an area that includes various physical, chemical, and biological parameters that affect human health, the environment, and the ecosystem as a whole (Mwaanga et. al., 2019). Good air quality is air that has a low pollutant content and does not endanger health and the environment. This can be measured using the air quality index (AQI). AQI is a scale used to classify air quality based on the level of pollutants contained in it (Haq, 2022). Pollution level values are in the range of 0-500 according to the AQI. Good air quality ranges from 0-50 (Sai et. al., 2019). This means that air in this category does not pose a health risk to humans or the environment.

Air pollution is a state in which air quality becomes polluted and mixed with chemicals, gases, or particulate matter (Almetwally et. al., 2020). These pollutants can cause discomfort, illness, or millions of deaths each year. They can also damage plants and other living things such as animals and crops. Haze and acid rain can also be caused by pollutants that lead to respiratory diseases and cancer, and depletion of the ozone layer that contributes to global warming (Almetwally et. al., 2020). The composition of air pollution varies widely, depending on the source, emission rate, and sunlight and wind conditions (Hamanaka et. al., 2018).

The air quality in Jakarta is still generally poor. Based on data from IQAir, the average pollution level in Jakarta in 2023 was 152. This value is included in the "Unhealthy" air quality for the community (Sai et. al., 2019). Air quality in Jakarta is influenced by various factors, including weather, human activities, and government policies. Hot and dry weather can increase the concentration of air pollutants. Human activities are the main source of air pollutants in Jakarta. Combustion activities, such as in motor vehicles and power plants, produce various air pollutants, such as Particulate Matter, ozone, NO2, SO2, and CO (Barus & Rachman, 2019). Industry also produces various air pollutants, such as heavy metals and chemicals. Government policies, such as emission control policies, can affect air quality. In addition, the high population density in urban areas and their consumption patterns also cause various environmental problems such as waste accumulation and vehicle fume emissions and other pollution problems (Hamouri, 2023).

Major Sources and Pollutants in Jakarta

The main sources of air pollution can be categorized into physical, chemical, and biological sources, while the secondary sources are anthropogenic and natural (Solihah et. al., 2021). The main source in urban areas is anthropogenic. Anthropogenic activities are human

activities that generally produce greenhouse gases (Kinon et. al., 2018). Anthropogenic sources of air pollution come from transportation, fuel combustion, various industrial processes, and solid waste disposal. Other sources such as agricultural activities (Shen & Panichakarn, 2023) and boron emissions from highways can be sources derived from human activities that pollute the environment.

Motorized vehicles contribute to high air pollution in Jakarta. The increase in motorized vehicles causes congestion to increase, then the volume of roads is increased by making overpasses, so that pollution increases again (Barus & Rachman, 2019). Motor vehicles contribute emissions as a source of air pollution with a proportion of 60-70% (Tritamtama et. al., 2023). In addition, the cause of pollution in Jakarta comes from industrial activities, households, and construction projects (Barus & Rachman, 2019).

Particulate matter

Particulate matter (PM) is composed of carbon particles with adsorbed organic chemicals and reactive metals (Hamanaka et. al., 2018). Based on particle size, PM is divided into three categories, namely coarse (PM10) with d less than 10 μm, fine (PM2.5) with d less than 2.5 μm, and very fine (PM0.1) with d less than 0.1 μm (Tran et. al., 2020). Particulate matter can be generated naturally or anthropogenically. Naturally, particulate matter is generated from volcanic eruptions, mineral dust, sea salt, and forest fires. Anthropogenic activities that produce particulate matter include fuel combustion, industrial emissions, biomass burning, road dust, and combustion in automobile engines and heating boilers (Almetwally et. al., 2020). PM2.5 and PM10 in Jakarta are mostly generated from the road transportation sector and industrial combustion, with contributions of around 43%-46% for each sector. Heavy vehicles are still the highest contributor to PM2.5 emissions in the transportation sector (Lestari et. al., 2022).

SO2

Sulfur dioxide (SO2) is one of the main pollutants that are mostly geothermal, usually of volcanic origin, or generated by human activities, such as coal and petroleum combustion (Orellano et. al., 2021). SO2 is also produced from fuel combustion in the transportation sector such as ships, trains, and some other means of transportation (Solarin & Tiwari, 2020). Industrial combustion contributes 67% to SO2 emissions (Lestari et. al., 2022). Large concentrations of SO2 in the atmosphere usually lead to the development of other sulfur oxides (SOx), which can react with other compounds in the atmosphere to form small particles (Solarin & Tiwari, 2020).

NO2

Nitrogen dioxide (NO2) is a toxic component that enters the atmosphere as a result of anthropogenic activities and natural processes (lightning and soil processes) (Ogen, 2020). NO2 has the potential to generate secondary pollutants such as peroxyacyl nitrates (PANs), nitric acid, and ozone (O3), which contribute to the formation of smog, acid rain, and the greenhouse effect, respectively (Vîrghileanu et. al., 2020).

O3

Ozone forms in the stratosphere, a layer of the atmosphere located about 20 to 25 kilometers above the Earth's surface (Petrescu et. al., 2018). Ozone in the stratosphere has an important function to block ultraviolet (UV) radiation to Earth. Ozone can also form in the troposphere. Tropospheric ozone is also known as surface ozone. Surface ozone is a major pollutant that can cause various health problems related to breathing, heart, and cancer (Manisalidis et. al., 2021). The main source of surface ozone is motor vehicles (Zawacki et. al., 2018). Motor vehicles produce a variety of gases, including NOx, CO, and hydrocarbons. Other sources of surface ozone are industry, power plants, and fire smoke (Singh & Kavouras, 2022).

CO

Carbon monoxide (CO) is a type of gas that has no color, odor, and taste (Ahmed & Kumar, 2020). The main source of carbon monoxide is the combustion of fossil fuels such as in motor vehicles, industry, and power plants, producing various gases, including CO (Munsif et. al., 2021). The road transportation sector contributes 97% of CO emissions (Lestari et. al., 2022).

Impact of pollutants on human health

Acute respiratory infections (ARI) are infections that occur in the respiratory tract. ARI can be caused by various factors, including viruses, bacteria, and air pollutants (Inderiati et. al., 2023). Air pollutants can cause ARI by irritating the respiratory tract. Air pollution can also worsen respiratory disease conditions. Air pollutants can worsen conditions of respiratory diseases, such as asthma and bronchitis. People with respiratory diseases are more susceptible to respiratory infections (Almetwally et. al., 2020). Harmful gases can cause inflammation in the respiratory tract and worsen respiratory disease conditions.

Chronic obstructive pulmonary disease (COPD) is a heterogeneous disease whose symptoms include persistent breathing and airflow limitation (Annesi-Maesano, 2006). The disease is associated with exposure to large amounts of harmful particles or gases. Smoking,

air pollution, occupational exposure, respiratory infections, and genetic factors such as a1-antitrypsin deficiency are risk factors for COPD, with cigarette smoke being the largest contributor to COPD, followed by air pollutants (Sin et. al., 2023). Short- and long-term exposure to air pollution has a negative effect on the occurrence and progression of COPD (Duan et. al., 2020). Similarly, long-term exposure to indoor air pollution from cigarette smoke and biomass fuels can cause chronic inflammation that contributes to COPD (Sin et. al., 2023).

Air pollution can affect the eyes resulting in complaints of redness, irritation, watering, foreign body sensation, and blurred vision (Yadav, 2019). Continuous exposure of different parts of the eye to polluted air causes burning and redness of the eyes, eye disorders, and several other problems. In addition to these short-term effects, air pollution can also affect vision. (Gautam & Bolia, 2020). When SO2 in the atmosphere increases, there is a decrease in the pH of tears. This can irritate the eyes because there are many corneal afferent nociceptors that are sensitive to tear acidification, and impulses from these neurons will be perceived as pain (Yadav, 2019).

Air pollution can also cause irritation and damage to the scalp. Exposure to air pollution results in scalp irritation, hair damage, root pain, itching, sebum discharge, dandruff, and even hair loss (Ogbodo et. al., 2022). In addition, it also causes damage to the skin by changing the color of the skin, causing wrinkles on the skin, causing skin diseases, disrupting the pH balance of the skin, and causing protein loss in the skin.

Particulate matter is associated with cardiovascular disease and results in heart disease, heart failure, dysrhythmias, and heart attacks (Manisalidis et. al., 2020). Air pollution can cause cardiovascular disease by causing inflammation of the blood vessel walls (Miller, 2020). This inflammation can cause narrowing of blood vessels and increase the risk of cardiovascular disease. Second, by increasing the level of bad cholesterol (LDL) in the blood resulting in narrowing of blood vessels. Thirdly, it increases the risk of stroke, leading to an increase in cardiovascular disease.

Impact of pollutants on climate change

Air pollution and climate change are closely linked. Air pollution is one of the main causes of climate change. Air pollutants, particularly CO2, CH4, and NOx, can absorb heat from the sun and cause the atmosphere to heat up (Singhs & Yadav, 2021). Air pollution gases can absorb heat from the sun and cause the atmosphere to heat up (Al-Ghussain, 2019).

Air pollution can impact climate change in several ways. The first is through increasing the greenhouse effect, which causes the atmosphere to heat up (Mikhaylov et. al., 2020). Air pollution can also disrupt weather systems such as precipitation and temperature patterns (Feng et. al., 2019). Nitrogen oxides, a greenhouse gas that can form from the mixing of N2 and O2 in the air, are released into the atmosphere due to human activities. The phenomenon can cause acid rain. Air pollution can increase the frequency and intensity of extreme weather, such as heat waves, droughts and floods. Methane is released into the atmosphere by various sources, including livestock farming, garbage decomposition and forest burning. Air pollution can increase the frequency and intensity of forest fires, which can release more methane into the atmosphere.

Strategies for controlling and improving air quality in Jakarta

The government has made various efforts to control and improve air quality in Jakarta. Some of the strategies that have been carried out are improving the quality of public transportation so that it is expected to reduce people's dependence on motorized vehicles, so as to reduce air pollution emissions (Ratnawati, 2021). The government has also increased the application of motor vehicle emission tests (Pranoto et. al., 2021). Motor vehicle emission tests are one form of effort to reduce air pollution emissions from motorized vehicles. The DKI Jakarta government has ordered all motorized vehicles to conduct regular emission tests. The implementation of motor vehicle emission tests is expected to catch vehicles that do not comply with emission standards. Vehicles that exceed emission standards may be subject to sanctions, such as fines or ticketing.

Increased supervision of industrial activities and power plants that have the potential to cause air pollution has been carried out. The supervision is carried out to ensure that industrial and power plant activities meet emission standards. Increased supervision of activities in these businesses is expected to reduce air pollution emissions from the industrial sector and power plants. In addition, the government also installed air quality monitoring devices at various points in Jakarta (Gunawan et. al., 2020). These air quality monitors are used to monitor air quality in Jakarta in real-time. The air quality data obtained from the air quality monitors are used to make air pollution control policies. The DKI Jakarta government is trying to increase public awareness in maintaining air quality (Pratomo et. al., 2023). These efforts are carried out through various activities, such as socialization, campaigns, and environmental education.

The effectiveness of air pollution control strategies in Jakarta still needs to be studied further. Air quality in Jakarta is still at the 'unhealthy' level (Toharudin et. al., 2023). There are several factors that cause the low effectiveness of the control strategy. First, the source of air pollution in Jakarta is still dominated by motorized vehicles because the number of motorized vehicles in Jakarta reaches around 18 million units (Edelman & Gunawan, 2020). Second, the air pollution control strategy implemented by the government is still partial (Rendana et. al., 2022). The strategies implemented only focus on one or a few sources of pollution, without looking comprehensively at all sources of air pollution in Jakarta. Third, there is a lack of coordination and cooperation among stakeholders related to air pollution control. This causes air pollution control efforts to be ineffective and inefficient.

Strategies for Optimizing Air Pollution Control in Jakarta

LEZ Expansion

LEZ (Low Emission Zone) is an area that restricts motor vehicles that can enter the area based on their emissions (Ku et. al., 2020). Vehicles that do not meet emission standards are not allowed to enter the LEZ. LEZ expansion can be one of the more effective air pollution control strategies because it can directly reduce the number of motor vehicles that cause air pollution. The DKI Jakarta government has implemented LEZ on several roads in Jakarta, such as Jalan Sudirman and Jalan MH Thamrin. However, LEZ expansion is still needed to cover more roads in Jakarta.

Increased tax on polluting vehicles

Motor vehicle tax is one of the fiscal instruments that can be used to control air pollution. Increasing taxes on polluting vehicles can encourage people to replace their vehicles with more environmentally friendly vehicles. The DKI Jakarta government has implemented a motor vehicle tax based on its emissions. However, the level of tax applied is still relatively low. To increase the effectiveness of this policy, it is necessary to increase the tax rate on polluting vehicles. The tax rate can be adjusted to the emission level of the vehicle.

Subsidies for electric vehicles

Electric vehicles are one of the efforts to reduce air pollution (Sun et. al., 2019). Electric vehicles do not produce emissions, so they can reduce air pollution. The DKI Jakarta

government has subsidized the purchase of electric vehicles. However, the subsidies provided are still limited. To increase the effectiveness of this policy, it is necessary to increase the amount of subsidies for the purchase of electric vehicles. Subsidies can be given directly to consumers or to electric vehicle manufacturers.

These policies need to be implemented in an integrated and sustainable manner to achieve healthy air quality targets in Jakarta. It is necessary to consider the impact of pollution control policies on certain groups of people, especially the vulnerable and low-income. It is also necessary to assess the sustainability of strategies that consider economic factors, such as implementation costs and impacts on employment.

Conclusion

A comprehensive literature review discussed how to optimize control strategies to improve air quality in Jakarta by identifying the sources and types of major pollutants. The main types of pollutants in Jakarta are PM 2.5, PM 10, SO2, NO2, O3, and CO. These pollutants are produced by motor vehicles, industry, and power plants. The government has made control efforts, namely improving the quality of public transportation, motor vehicle emission tests, increasing supervision of industrial and power plant activities, and installing air quality monitoring devices. The control that has been carried out is considered to have low effectiveness. Optimization strategies that can be done are LEZ expansion, increasing polluting vehicle taxes, and subsidies for electric vehicles by considering economic and social factors.

References

Ahmed, S., & Kumar, S. (2020). Carbon monoxide toxicity and its management: A review. *International Journal of Advanced Research in Medicinal Chemistry*, *2*(1), 11-19.

Al-Ghussain, L. (2019). Global warming: review on driving forces and mitigation. *Environmental Progress & Sustainable Energy*, *38*(1), 13-21.

Almetwally, A. A., M. Bin-Jumah, & A. A. Alam. (2020). Ambeint air pollution and its influnce on human health and welfare: an overview. *Env. Sci. and Pollution Research*, *27*, 24815-24830.

Annesi-Maesano, I. J. E. R. M. (2006). Epidemiology of chronic obstructive pulmonary disease. *European Respiratory Monograph*, *38*, 41.

Bai, L., Wang, J., Ma, X., & Lu, H. (2018). Air pollution forecasts: An overview. *International journal of environmental research and public health*, *15*(4), 780.

Barus, L. S., & Rachman, H. O. (2019). Impact of Car-Free Day on air pollution and its multifarious advantages in Sudirman-Thamrin Street, Jakarta. *GEOMATE Journal*, *17*(62), 167-172.

Duan, R. R., Hao, K., & Yang, T. (2020). Air pollution and chronic obstructive pulmonary disease. *Chronic diseases and translational medicine*, *6*(4), 260-269.

Edelman, D. J., & Gunawan, D. S. (2020). Managing the urban environment of Jakarta, Indonesia. *Current Urban Studies*, *8*(01), 57.

Feng, H., Zou, B., Wang, J., & Gu, X. (2019). Dominant variables of global air pollution-climate interaction: Geographic insight. *Ecological indicators*, *99*, 251-260.

Gautam, D., & B. Bolia, N. (2020). Air pollution: impact and interventions. *Air Quality, Atmosphere & Health*, *13*, 209-223.

Gunawan, M., Asyahira, R., & Sidjabat, F. M. (2020). Evaluation of ambient air quality monitoring system in jakarta: A literature review. *Jurnal Serambi Engineering*, *5*(1).

Hamanaka, R. B., & Mutlu, G. M. (2018). Particulate matter air pollution: effects on the cardiovascular system. *Frontiers in endocrinology*, *9*, 680.

Hamouri, B. M. 2023. The impact of qualified industrial zones investment on the environment deterioration in Jordan. *Uncertain Supply Chain Management*, *11*, 769-776.

Hansun, S., Wicaksana, A., & Kristanda, M. B. (2021). Prediction of Jakarta City air quality index: modified double exponential smoothing approaches. *Int J Innov Comput Inf Control*, *17*(4), 1363-71.

Haq, M. A. (2022). SMOTEDNN: A novel model for air pollution forecasting and AQI classification. *Computers, Materials & Continua*, *71*(1).

Hidayat, M., Ikhsano, A., Assegaf, A. H., & Fauzan, R. S. (2023). Community-Based Disaster Mitigation Communication Strategy Through Rainwater Harvesting Movement. *International Journal of Professional Business Review: Int. J. Prof. Bus. Rev.*, *8*(8), 5.

Inderiati, D., Rachmawaty, T., & Anhar, C. A. (2023). Identification of Acute Respiratory Infection Patients Using RP2 Nested Multiplex PCR Test in Jakarta, Indonesia. *Medical Laboratory Technology Journal*, *9*(1).

Ku, D., Bencekri, M., Kim, J., Leec, S., & Leed, S. (2020). Review of European low emission zone policy. *Chem. Eng*, *78*, 241-246.

Kusumaningtyas, S. D. A., Aldrian, E., Wati, T., Atmoko, D., & Sunaryo, S. (2018). The recent state of ambient air quality in Jakarta. *Aerosol and Air Quality Research*, *18*(9), 2343-2354.

Lestari, P., Arrohman, M. K., Damayanti, S., & Z. Klimon. (2022). Emissions and spatial distribution of air pollutants from anthropogenic sources in Jakarta. *Atmospheric Pollution Research*, *13*(9), 101521.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: a review. *Frontiers in public health*, *8*, 14.

Mikhaylov, A., Moiseev, N., Aleshin, K., & Burkhardt, T. (2020). Global climate change and greenhouse effect. *Entrepreneurship and Sustainability Issues*, *7*(4), 2897.

Miller, M. R. (2020). Oxidative stress and the cardiovascular effects of air pollution. *Free Radical Biology and Medicine*, *151*, 69-87.

Munsif, R., Zubair, M., Aziz, A., & Zafar, M. N. (2021). Industrial air emission pollution: potential sources and sustainable mitigation. In *Environmental Emissions*. IntechOpen.

Mwaanga, P., Silondwa, M., Kasali, G., & Banda, P. M. (2019). Preliminary review of mine air pollution in Zambia. *Heliyon*, *5*(9).

Ogbodo, J. O., Arazu, A. V., Iguh, T. C., Onwodi, N. J., & Ezike, T. C. (2022). Volatile organic compounds: A proinflammatory activator in autoimmune diseases. *Frontiers in Immunology*, *13*, 928379.

Ogen, Y. (2020). Assessing nitrogen dioxide (NO2) levels as a contributing factor to coronavirus (COVID-19) fatality. *Science of the Total Environment*, *726*, 138605.

Orellano, P., Reynoso, J., & Quaranta, N. (2021). Short-term exposure to sulphur dioxide (SO2) and all-cause and respiratory mortality: A systematic review and meta-analysis. *Environment international*, *150*, 106434.

Petrescu, R. V., Aversa, R., Apicella, A., & Petrescu, F. I. (2018). NASA sees first in 2018 the direct proof of ozone hole recovery. *Journal of Aircraft and Spacecraft Technology*, *2*(1), 53-64.

Pranoto, H., A. M. Leman, & D. Feriyanto. 2020. Effectiveness of SLIFA device installation for the transportation sector especially on trucks and buses to reduce the environmental impact in the urban area of DKI Jakarta. In *IOP Conference Series: Earth and Environmental Science* (Vol. 485, No. 1, p. 012005). IOP Publishing.

Pratomo, A. B., Mutmainah, H. N., Kristiono, N., & Setyawan, G. C. (2023). Implementation of Internet of Things (IoT) Technology in Air Pollution Monitoring in Jakarta: Quantitative Analysis of the Influence of Air Quality Change and Its Impact on Public Health in Jakarta. *West Science Nature and Technology*, *1*(01), 40-47.

Rahman, H. A. (2018). Climate change scenarios in Malaysia: Engaging the public. *International Journal of Malay-Nusantara Studies*, *1*(2), 55-77.

Ratnawati, E. (2021). MRT as an Alternative Transportation Solution which is environmentally friendly and traffic jam free in Jakarta. In *IOP Conference Series: Earth and Environmental Science* (Vol. 819, No. 1, p. 012040). IOP Publishing.

Rendana, M., W. M. R. Idris, & S. A. Rahim. (2022). Changes in air quality during and after large-scale social restriction periods in Jakarta city, Indonesia. *Acta Geophysica*, *70*(5), 2161-2169.

Sai, K. B. K., Subbareddy, S. R., & Luhach, A. K. (2019). IOT based air quality monitoring system using MQ135 and MQ7 with machine learning analysis. *Scalable Computing: Practice and Experience*, *20*(4), 599-606.

Shen, Y. & Panichakarn, B. 2023. Sustainability of agricultural trade supply chains status, opportunities, and future directions. *Uncertain Supply Chain Management, 11,* 1769-1782.

Sin, D. D., Doiron, D., Agusti, A., Anzueto, A., Barnes, P. J., Celli, B. R., ... & Bourbeau, J. (2023). Air pollution and COPD: GOLD 2023 committee report. *European Respiratory Journal*, *61*(5).

Singh, P., & Yadav, D. (2021). Link between air pollution and global climate change. In *Global Climate Change* (pp. 79-108). Elsevier.

Singh, S., & Kavouras, I. G. (2022). Trends of ground-level ozone in the New York city area during 2007–2017. *Atmosphere*, *13*(1), 114.

Sivarethinamohan, R., Sujatha, S., Priya, S., Gafoor, A., & Rahman, Z. (2021). Impact of air pollution in health and socio-economic aspects: review on future approach. *Materials Today: Proceedings*, *37*, 2725-2729.

Solarin, S. A., & Tiwari, A. (2020). Convergence in sulphur dioxide (SO2) emissions since 1850 in OECD countries: evidence from a new panel unit root test. *Environmental Modeling & Assessment*, *25*(5), 665-675.

Solihah, K. I., Martono, D. N., & Haryanto, B. (2021). Analysis of Spatial Distribution of PM2. 5 and Human Behavior on Air Pollution in Jakarta. In *IOP Conference Series: Earth and Environmental Science*, 940(1), 012018

Sun, X., Li, Z., Wang, X., & Li, C. (2019). Technology development of electric vehicles: A review. *Energies*, *13*(1), 90.

Toharudin, T., R. E. Caraka, I. R. Pratiwi, Y. Kim, P. U. Gio, A. D. Sakti, ... & B. Pardamean. (2023). Boosting Algorithm to handle Unbalanced Classification of PM2. 5 Concentration Levels by Observing Meteorological Parameters in Jakarta-Indonesia using AdaBoost, XGBoost, CatBoost, and LightGBM. *IEEE Access*.

Tran, V. V., Park, D., & Lee, Y. C. (2020). Indoor air pollution, related human diseases, and recent trends in the control and improvement of indoor air quality. *International journal of environmental research and public health*, *17*(8), 2927.

Tritamtomo, K. A., Sembiring, F. E. S., Choirudin, A., & Patria, H. (2023). Analysis of Air Pollution (SO2) at Some Point of Congestion in DKI Jakarta. *Disease Prevention and Public Health Journal*, *17*(1), 82-92.

Vîrghileanu, M., Săvulescu, I., Mihai, B. A., Nistor, C., & Dobre, R. (2020). Nitrogen Dioxide (NO2) Pollution monitoring with Sentinel-5P satellite imagery over Europe during the coronavirus pandemic outbreak. *Remote Sensing*, *12*(21), 3575.

Yadav, V. (2019). Impact of Environmental Factors on Eye Health. *Mediterranean Journal of Basic and Applied Sciences (MJBAS),(Quarterly International Journal)*, *3*(4), 37-46.

Zawacki, M., Baker, K. R., Phillips, S., Davidson, K., & Wolfe, P. (2018). Mobile source contributions to ambient ozone and particulate matter in 2025. *Atmospheric Environment*, *188*, 129-141.