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# AIR POLLUTION MANAGEMENT DUE TO COAL LOADING AND UNLOADING ACTIVITIES AT THE MAHAKAM COAL TERMINAL JETTY

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***Abstract*** *Coal loading and unloading operations at the Mahakam Coal Terminal Jetty in Embalut Village, East Kalimantan, have contributed significantly to local air pollution. Fine coal dust particles are released into the surrounding environment, negatively impacting the health of workers and nearby communities. This study aims to examine the causes of air pollution at the jetty and identify suitable mitigation strategies. A descriptive qualitative approach was applied, with data collected through direct observation, interviews with stakeholders (including operational staff, HSE personnel, and the village head), and documentation of jetty activities and environmental conditions. Data credibility was ensured using triangulation. Results reveal that the main contributor to air pollution is the absence of effective dust control systems, particularly during the loading and unloading processes. Additional factors, such as high wind speeds, intense operational activity, and the lack of buffer vegetation, worsen the pollution levels. Health complaints reported by residents include respiratory issues, eye irritation, and skin problems. While some mitigation efforts such as water spraying systems, dust nets, equipment cleaning, and periodic air quality checks have been introduced, their implementation remains inconsistent. To address this, the study recommends the systematic adoption of Standard Operating Procedures (SOP) and the development of green infrastructure to minimize long-term environmental impacts.*

***Keywords:*** *air pollution, coal, dust control, loading and unloading*

Abstrak. Kegiatan bongkar muat batubara di Jetty Mahakam Coal Terminal yang terletak di Desa Embalut, Kalimantan Timur, telah memberikan kontribusi signifikan terhadap polusi udara di wilayah sekitar. Partikel debu batubara halus terlepas ke lingkungan sekitar, sehingga berdampak negatif terhadap kesehatan para pekerja dan masyarakat setempat. Penelitian ini bertujuan untuk mengkaji penyebab polusi udara di jetty serta mengidentifikasi strategi mitigasi yang sesuai. Pendekatan deskriptif kualitatif digunakan dengan pengumpulan data melalui observasi langsung, wawancara dengan para pemangku kepentingan (termasuk staf operasional, personel K3, dan kepala desa), serta dokumentasi aktivitas jetty dan kondisi lingkungan. Kredibilitas data dijamin melalui triangulasi. Hasil penelitian menunjukkan bahwa penyebab utama polusi udara adalah tidak adanya sistem pengendalian debu yang efektif, terutama pada saat proses bongkar muat berlangsung. Faktor tambahan seperti kecepatan angin yang tinggi, intensitas aktivitas operasional, dan tidak adanya vegetasi penyangga turut memperburuk tingkat polusi. Keluhan kesehatan yang dilaporkan warga meliputi gangguan pernapasan, iritasi mata, dan masalah kulit. Meskipun beberapa upaya mitigasi seperti sistempenyemprotan air, pemasangan jaring debu, pembersihan peralatan, serta pemeriksaan kualitas udara secara berkala telah diterapkan, pelaksanaannya masih belum konsisten. Untuk mengatasi hal ini, penelitian merekomendasikan penerapan Prosedur Operasi Standar (SOP) secara sistematis dan pengembangan infrastruktur hijau untuk meminimalkan dampak lingkungan dalam jangka panjang.

**Kata Kunci::** *polusi udara, batubara, pengendalian debu, bongkar muat.*

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## 1. INTRODUCTION

According to Gunara, coal remains one of the most vital energy sources, especially for electricity generation. Nearly half of Indonesia's domestic coal consumption is used as fuel for power plants. Coal also plays a key role in supporting various industrial sectors (Pahlevi et al., 2024). In the logistics context, Dirk Koleangan, as cited in Rusmiyanto and Dessixson (2022), explains that loading and unloading involve the transfer of goods from land-based transport, requiring proper infrastructure and efficient procedures.

Coal loading and unloading operations contribute significantly to regional economic growth but often face environmental challenges, particularly air pollution caused by coal dust. This dust can disrupt local communities and hinder operational continuity at jetty areas, as seen at the Mahakam Coal Terminal Jetty in Embalut Village, East Kalimantan. Operated by PT. Mahakam Coal Terminal, this facility handles coal transfers between barges and stockpiles.

Air pollution occurs when the natural composition of the atmosphere is disrupted by foreign substances or particles, originating from industrial, residential, and transportation activities (Minhatul Maula, 2024). Coal terminals often experience air quality issues due to dust released during loading, storage, and transport. According to the WHO, over 90% of the global population lives in areas where air quality fails to meet safe standards, posing serious health risks (Umah & Gusmira, 2024). In 2016, an estimated 6.5 million deaths were linked to exposure to polluted air (Kornelis et al., 2024). Research has confirmed the long-term impacts of pollution on lung function and cardiovascular health (Hidajat, 2023). Even anchored ships can emit significantly higher emissions than regular port operations, contributing further to air pollution (Muhammad & Kabul, 2023).

Residents of Embalut Village have reported that coal handling activities generate dense dust that affects breathing, contaminates rainwater, and damages plants. Increased cases of respiratory illness and eye irritation have prompted community protests and demands for immediate mitigation measures. This situation highlights that air pollution from coal operations is not only a technical or operational issue but also a social and public health concern. Addressing air pollution from coal loading and unloading requires emission control technologies, responsible operational practices, and compliance with

environmental regulations. Preventive measures are essential to protect air quality around the Mahakam Coal Terminal Jetty and safeguard community health and environmental sustainability.

Indonesia, rich in coal reserves, is among the world's top coal producers and exporters. According to the Ministry of Energy and Mineral Resources, at the current production rate, national coal reserves are projected to last about 83 more years (Afin A.P & Kiono B.F.T, 2021). Major mines, particularly in East Kalimantan, produce tens of millions of tons of coal annually, much of which is exported. Samarinda, located along the Mahakam River, is a key hub for high-quality coal production and export.

The rapid development of Indonesia's transportation sector, especially in Kalimantan, is driven by growing demand for goods and trade. Improving the quality and efficiency of coal ports in East Kalimantan is vital for supporting smooth logistics operations. The Samarinda coal port plays a crucial role in transferring coal from barges to export vessels and in local distribution, supported by dedicated infrastructure such as conveyor belts and specialized docks designed for efficient large-scale operations

## 2. THEORETICAL DESCRIPTION

The theoretical review serves as the conceptual foundation to analyze the research problems. In this study, the theories used relate to management, air pollution, coal loading and unloading activities, and jetty operations.

a. Management (Handling) According to the *Big Indonesian Dictionary* (KBBI), management or "handling" refers to a process, action, or method to address and solve a problem properly. Effective handling emphasizes preventive actions, control measures, improvements, and evaluation to achieve the desired outcome (Kartini & Yayandi, 2021).
b. Air pollution is a condition where the air quality deteriorates due to the presence of harmful substances that endanger the health of living beings (Mazayaniq, 2024). Pollutants can be dust, gas, vehicle emissions, industrial emissions, or mining activities. Major air pollutants include particulate matter (PM10 and PM2.5), carbon monoxide (CO), sulfur dioxide ($SO_2$), and nitrogen dioxide ($NO_2$), which can negatively affect human health, causing respiratory disorders, irritation, and other serious illnesses (Anandari et al., 2024).

c. Coal Loading and Unloading Activities Coal loading and unloading activities involve transferring bulk cargo from or to ships, barges, trucks, or stockpiles. This process carries a high risk of dust pollution due to the physical properties of coal, which easily breaks down into fine particles (Gunara, 2024). Therefore, special equipment such as grab cranes, conveyor belts, stackers, and dust suppression systems are required to minimize air pollution.

d. Jetty as a Loading and Unloading Facility A jetty is a port structure that extends into the sea or river and serves as a berth for ships to dock for loading and unloading operations (Arisanto, 2023). Jetties play an essential role in supporting cargo flow and logistics, especially in mining areas that do not yet have large dock facilities.

e. Sources of Air Pollution at Coal Loading Jetties. Air pollution at coal terminal jetties generally arises from several factors. Dust emissions are released during the transfer of coal from barges to stockpiles. In many cases, loading equipment lacks proper dust enclosures, allowing particles to escape into the air. Strong winds can carry fine coal dust into nearby residential areas, worsening the impact. Additionally, inadequate standard operating procedures (SOPs) for dust control and the absence of sufficient buffer vegetation further contribute to the problem

f. Air Pollution Mitigation Efforts. To control air pollution at coal loading jetties, several measures can be implemented. Installing water spraying systems can help suppress dust emissions during coal transfer. The use of dust barrier nets can further prevent particles from spreading to surrounding areas. Providing personal protective equipment (PPE) for workers is essential to minimize health risks. Planting buffer vegetation around the terminal can also help capture airborne dust. In addition, routine maintenance of loading equipment and the implementation of environmentally friendly standard operating procedures (SOPs) for coal handling are necessary to ensure effective pollution control.

## 3. METHODS

This study employs a descriptive qualitative approach conducted at PT Ancara Logistics Indonesia and PT Mahakam Coal Terminal, Samarinda Branch, over a 12-month period, starting from July 22, 2023, to July 27, 2024. According to Sahir (2021), the descriptive method in research aims to describe a phenomenon by presenting data systematically and accurately. This method describes, analyzes, and compares research data or objects based on actual conditions and offers solutions to problems (Rengkuan et al., 2023). The data sources in this study come from both primary and secondary data. Primary data are obtained directly from research subjects using measuring instruments or data collection tools that directly access the subjects as the source of the required information (Pratama et al., 2024). The primary data were collected through direct observation and interviews with the Head of Operations Unit of PT Mahakam Coal Terminal, the Human Safety Environment (HSE) division, and the Head of Embalut Village. Meanwhile, according to Sari et al. (2023), secondary data are obtained from second-hand or secondary sources relevant to the required data, collected indirectly, such as through reports or documents from previous researchers. The secondary data were gathered through documents and reports relevant to the research object.

Data collection techniques are procedures used by researchers to obtain information needed to answer the research problem statements (Abubakar, 2021). In practice, this study uses several data collection methods: observation, interviews, documentation, and literature study. Data collection is conducted to ensure a systematic process of gathering and recording information relevant to specific research objectives (Romdona et al., 2025). In the context of qualitative research, the researcher functions as the main instrument directing the research process. After the data are collected, the next step is to analyze the data through a data analysis process.

According to Sugiyono (2022:131), data analysis is the stage of organizing and systematically arranging the information obtained from interviews, direct observations, and documentation. The data analysis method used in this research includes the process of data reduction, data presentation, and drawing conclusions. Furthermore, this study also examines data validity to ensure the reliability of the presented results. In qualitative studies, data validity is a crucial component that must be considered by researchers so that the results obtained can be scientifically accountable (Sa'adah et al., 2022:54). Data validity in this study is verified using the triangulation method. Triangulation is a

technique used to check the validity of data by comparing information obtained from various sources, times, or different approaches (Mekarisce, 2020:150).

## 4. RESULT AND DISCUSSION

Based on direct observation and interviews with field officers as well as local residents, it was found that coal loading and unloading activities at the Mahakam Coal Terminal Jetty have had a significant impact on the decline in air quality in the surrounding area. The dominant type of air pollution originates from coal dust that becomes airborne during the transfer of coal from barges to the conveyor belt, as well as when the material is stockpiled at storage locations. The majority of workers and nearby residents reported experiencing mild respiratory complaints, such as coughing, shortness of breath, and irritation of the eyes and skin. These complaints typically increase during the dry season, when low air humidity allows dust to be more easily lifted and dispersed into the air.

Air quality standards have been regulated under several national laws and regulations, one of which is Law Number 32 of 2009 concerning Environmental Protection and Management. This regulation requires every business entity to implement preventive, control, and recovery measures against environmental pollution, including air pollution. Articles 20 and 21 of the law specifically state that any activity with the potential to cause significant environmental impacts, such as coal loading and unloading operations, must possess an Environmental Impact Assessment (AMDAL) or Environmental Management and Monitoring Efforts (UKL-UPL) document.

Site investigations revealed that air pollution levels around the jetty are considerably high, particularly due to coal dust particles released during the loading and unloading processes. These findings indicate that air pollution remains likely to occur from industrial activities that are not equipped with optimal emission control systems. The absence of effective dust filtering devices suggests a weak implementation of the clean production principle, which should be an integral part of coal port operations. These adverse effects have impacted the health of nearby residents, consistent with the study by Fitria (2016), which concluded that exposure to dust can trigger respiratory tract

disorders. Based on these findings, several critical points can be identified as the main sources of air pollution:

1. The Coal Unloading Process from Barge to Conveyor

   The unloading phase of coal from barges to the conveyor system represents one of the most vulnerable stages in terms of dust release into the air. This activity is typically carried out using heavy equipment such as grab cranes or ship unloaders, which function to extract coal from the barge and transfer it into Hoppers or directly onto the conveyor system.

**Figure 1.** Coal Loading and Unloading Activities at the MCT Jetty
Source : Research Documentation

2. Stockpile Activity (Coal Piling)

   The coal stockpiling activity that is not equipped with adequate protective covers or enclosures has the potential to allow coal dust to be carried by the wind, subsequently causing air pollution and posing adverse effects on human health and the surrounding environment. Fine coal particles of microscopic size, such as PM10 and PM2.5, can enter the human respiratory system through inhalation, thereby increasing the risk of disorders such as coughing, throat irritation, and even acute respiratory infections (ARI). In addition to being hazardous to health, dispersed coal dust may also contaminate other environmental elements such as soil, water, and vegetation around the stockpile area, which in turn can disrupt the balance of the local ecosystem.

**Figure 2.** Loading and Unloading Area of Mahakam Coal Terminal
Source : Research Documentation

3. Internal Transportation within the Terminal Area

   Coal transport vehicles operating without covers contribute to the increase of dust emissions in the surrounding environment. Research findings indicate that uncovered vehicles have a significantly higher potential to generate particulate emissions compared to those equipped with protective covers. Dust released during this transportation process can pollute the air, seep into the soil, and contaminate water sources around the terminal area, ultimately having a negative impact on environmental quality and lowering the living standards of nearby communities.

**Figure 3.** Uncovered Dump Truck
Source : Research Documentation

4. Loading and Unloading Equipment

   The loading and unloading equipment used in field operations is rarely subjected to routine cleaning and maintenance. This neglect contributes to environmental pollution around the work area. The accumulation of coal dust on the surface of the equipment causes these particles to be released back into the air during loading and unloading activities. This condition is exacerbated by the absence of adequate filtration systems and emission control mechanisms on operational machines, which contributes to the increased concentration of air pollutants. If not addressed through appropriate measures, this situation can have serious consequences not only for the health of workers who are continuously exposed to polluted air but also for the surrounding environment, including residential areas near the operational site.

Based on the data collection results through interviews, direct observations, and documentation, the researcher successfully obtained several key findings during the research process. These findings are presented in the following section, aligned with the

data collection methods previously described.

1. Causes of air pollution at the Mahakam Coal Terminal Jetty

   Air pollution at the Mahakam Coal Terminal Jetty is a serious issue that poses health risks to workers and nearby communities. To effectively control this problem, it is important to understand the main causes of pollution from coal loading and unloading activities. Several studies have shown that port operations, especially coal handling, are significant sources of airborne dust. These findings provide valuable insights for identifying pollution factors and developing targeted control measures to protect health and safety around the terminal.
2. The high levels of air pollution in this area are mostly caused by coal loading and unloading processes that are not equipped with adequate dust control systems. Coal is often moved in open conditions without proper measures like water spraying or dust suppression technology, allowing fine coal particles to become airborne especially in dry and windy weather. Without effective emission controls and environmentally responsible practices, this dust pollution can seriously degrade local air quality, harm public health, and damage the surrounding coastal ecosystem.
3. Efforts undertaken in response to air pollution caused by loading and unloading activities at the Mahakam Coal Terminal Jetty
   a. Water Spraying System (Dust Suppression**)**. One of the main measures to reduce air pollution from coal loading and unloading at the Mahakam Coal Terminal Jetty is the use of a water spraying system, or dust suppression system. This system sprays water either automatically or manually at key points such as conveyor belts, hoppers, coal transfer points, and loading or unloading areas. The sprayed water moistens the coal surface, preventing dust particles from becoming airborne and spreading with the wind. This method is especially effective during the coal transfer phase from barge to conveyor, which is the stage most prone to dust dispersion. Proper implementation of this system helps ensure compliance with environmental regulations and protects the health of workers and nearby communities. Terminal operators play an essential role in ensuring the system runs effectively by following set schedules, monitoring performance, conducting inspections, and coordinating with operational teams.

b. In response to community complaints about air pollution from coal loading and unloading, the Mahakam Coal Terminal Jetty management has taken several mitigation measures. These include strengthening communication with residents through outreach programs, providing complaint channels, and holding regular dialogues with community leaders and local authorities. This aims to increase transparency and build trust with the local community. As part of their social responsibility, the company also supports affected residents by offering healthcare services, distributing free masks, and providing regular medical check-ups. By combining technical solutions with community engagement, the company hopes to reduce air pollution and maintain good relations with the surrounding community.

## 5. CONCLUSIONS

Air pollution at the Mahakam Coal Terminal Jetty is a significant environmental concern, primarily caused by coal loading and unloading activities that are not supported by adequate dust control measures, such as water spraying and dust suppression systems. Without these controls, dust particles are more likely to disperse into the air, posing health risks to workers and nearby communities and polluting the surrounding environment. As part of its mitigation efforts, the company has installed water spraying systems in key areas and strengthened its communication and social responsibility initiatives with affected residents. This combination of technical measures and community engagement demonstrates the company's commitment to minimizing dust emissions. A clear understanding of the underlying causes and the consistent implementation of sustainable preventive strategies are essential to ensure a healthier and safer working and living environment for all stakeholders.

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