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Air Quality Monitoring in Briquette Industrial Environments through Air Particle Detection Systems

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ABSTRACT

Air is the most basic need for the survival of living things, especially humans. Briquetting plants are one of the industries that produce airborne particles harmful to human health and the surrounding environment. These particles can cause respiratory problems and serious illnesses if not properly detected and controlled. Therefore, an air particle detection system is indispensable for monitoring air quality in the factory environment. PT Arkelindo Bara Sejahtera, as a company engaged in the manufacture of briquettes, has a negative impact on the environment, especially air pollution due to the carbonization process that produces smoke and dust. The implementation of this community service activity aims to improve air quality in the briquette industry environment through the implementation of an air particle detection system. This activity includes socialization about the dangers of air particles, training on the use of detection devices, and filling out questionnaires to evaluate participants' understanding. The results of this activity show that the air quality in the factory environment is still poor with high Air Quality Index (AQI) values, mainly caused by the carbonization process. However, this activity succeeded in raising the awareness of the factory staff on the importance of air quality monitoring and providing concrete recommendations to reduce particle emissions, including the use of cleaner fuels and improving the efficiency of the carbonization process. Thus, it is hoped that this activity can help prevent more severe air pollution in the future and protect the health of the surrounding community.

Keywords: *air quality, air particle detection, environmental pollution, briquette factory, emission control*

1. INTRODUCTION

Indonesia has experienced rapid growth in tandem with advancements in science and technology. The expansion of industries in Indonesia, while beneficial for society, also has the potential to create environmental issues. The industrial development in Indonesia has seen a swift increase, keeping pace with scientific and technological progress. However, this industrial growth, despite its advantages for the population, can also lead to environmental challenges. Air is the most fundamental requirement for the survival of all living beings, particularly humans. Air pollution causes numerous health problems, especially respiratory diseases, and breathing clean air is a basic right for all individuals **(Danian et al., 2015) (Taştan, 2022)**. According to the World Health Organization (WHO), there are hazardous substances

originating from buildings, construction materials, indoor equipment, and combustion or heating processes that can trigger health issues. However, we often fail to recognize the causes and dangers of poor indoor air quality; rooms may contain invisible dirt, dust, or certain gases **(Gita et al., 2022).** The abundance of odorless and invisible hazardous gases contributes to the low public awareness regarding the dangers of air pollution **(Rosa et al., 2020).**

Air pollution can be categorized into two sources: natural and anthropogenic. Natural sources encompass forest fires, volcanic eruptions, soil erosion by wind, natural radioactivity, and the decomposition of organic matter by bacteria. Anthropogenic sources, on the other hand, are highly diverse. These include motor vehicles, industries, thermal power plants, and agricultural activities. Fossil fuels (coal, oil, natural gas) are combusted in industries, thermal power plants, and vehicles. As a result, carbon monoxide (CO), carbon dioxide (CO2), sulfur dioxide (SO2), sulfur trioxide (SO3), and nitrogen oxides are released. Various hydrocarbons (methane, butane, ethylene, benzene) and suspended particles (dust, lead, cadmium, chromium, arsenic salts, etc.) are also emitted **(Moise et al., 2020) (El-Gammal et al., 2016) (Yun et al., 2023)**. Air pollution is a persistent global challenge faced by societies worldwide, primarily caused by various activities such as transportation and industry. Air pollution, particularly PM2.5 - airborne particles with a diameter of less than 2.5 micrometers - has been responsible for numerous respiratory disorders and other health issues affecting populations globally. Currently, air pollution is increasingly presenting a situation that demands attention. This condition stems from all sources of air pollution resulting from various activities. One significant contributor is industrial factory operations. Activities from industrial factories constitute a substantial source of freely released air pollutants **(Azzahro et al., 2019)**.

Briquette factories are among the industries that produce air pollutants in the form of dust. This dust can cause air pollution and negatively impact public health. Therefore, an air particle detection system is necessary in the briquette factory environment to monitor air quality and prevent pollution **(Zaenuri, 2011) (Raza et al., 2021)**. The briquette factory environment often produces air particles that are harmful to human health and the surrounding environment. These particles can cause respiratory problems and serious diseases if not properly detected and controlled. Consequently, an air particle detection system is needed to monitor air quality in the factory environment

The production process of briquettes, especially involving the combustion of raw materials, significantly contributes to air pollution. The resulting emissions, particularly fine invisible particles, can spread widely and adversely affect the surrounding air quality. These particles are highly dangerous as they can be easily inhaled and penetrate deep into the human respiratory tract, causing various health problems ranging from mild irritation to serious lung diseases **(Bousiotis et al., 2023)**. Ultrafine particles with aerodynamic diameters less than 2.5 micrometers (PM2.5) and 10 micrometers (PM10) pose a serious threat to human health. When inhaled, these particles can penetrate deep into the respiratory tract, even reaching the lung alveoli. Long-term exposure to these particles can cause various serious health issues, from eye and throat irritation, respiratory disorders such as asthma and chronic bronchitis, to heart disease, stroke, and even lung cancer **(Budianto et al., 2024)**. Therefore, real-time air quality monitoring in briquette industrial environments is crucial.

The revolution in sensor technology and the Internet of Things (IoT) has paved the way for more sophisticated and cost-effective air quality monitoring systems compared to conventional

methods. Optical-based particle sensors, such as the PMS5003, have demonstrated highly satisfactory performance in measuring concentrations of very fine (PM2.5) and fine (PM10) airborne particulate matter. With their high accuracy, these sensors can provide real-time data on air quality at various locations, enabling us to monitor and analyze changes in air quality more effectively **(Hery, 2023) (Vélez et al., 2023)**

PT. Arkelindo Bara Sejahtera is a company specializing in briquette manufacturing, from raw material procurement to production processes, enabling them to produce high-quality briquette products. The PT Arkbase factory, located on Jl. Raya Cihaurbeuti-Panumbangan in Ciamis, West Java, has negative impacts on the environment. The briquette factory causes adverse effects, particularly air pollution, which impacts environmental health due to briquette combustion.

The significant adverse effects caused by air pollution necessitate special attention in its control from various parties, including both the government and society. One form of control is easy access to air quality information, which must be provided by the government through the Air Pollution Standard Index (ISPU) monitored via Air Quality Monitoring Stations (AQMS) **(Hasanuddin, 2023) (Akbar, 2022) (Ertiana, 2024)**. To mitigate the negative impact of briquette factories, a dust detection device and ventilation system functioning as an air purifier in the room are required. This equipment can serve as an indicator and warning of air pollution levels for the surrounding community and can reduce air pollution levels in the briquette factory environment.

This community service activity aims to help improve air quality in the PT Arkelindo Bara Sejahtera briquette factory environment by implementing an air particle detection system. This is very important because the factory produces harmful particles that have the potential to cause health problems, such as respiratory disorders. To achieve this goal, the program included socialization on the dangers of airborne particles, training on the use of detection devices, as well as the completion of questionnaires by participants to evaluate the extent of their understanding on the importance of maintaining air quality.The results of this activity showed that the air quality in the factory was still poor, characterized by high Air Quality Index (AQI) values.

The impact of this activity was not only seen in the participants' increased awareness of the dangers of air pollution, but also in their ability to independently use air particle detectors to monitor air quality in the workplace. Our partners also experienced an increased understanding of various air pollution control measures, along with a commitment to implement the recommendations, such as improving the carbonization process and switching to more environmentally friendly fuels. In addition, the implementation of air particle detectors provided tangible benefits to partners in the form of real-time air quality information, allowing them to take early preventive measures. Thus, it is hoped that this activity can prevent more severe air pollution in the future, protect the health of workers, and have a positive impact on the community around the factory.

2. METHOD

The methods used in this community service activity involve several stages. Coordination with PT. Arkelindo was conducted to discuss the technical implementation and ensure support from the factory, which also included discussions on the importance of air quality monitoring and how this community service activity could help the surrounding community.Socialization about

the use of air particle detection devices was carried out to enhance partners' understanding of the importance of air quality monitoring. This socialization also included explanations on how these devices can help the community in maintaining their health.The implementation of the 9-in-1 Air Quality Monitor Detector was done to ensure the device functions properly in the briquette factory environment. These stages collectively aimed to improve air quality in the briquette factory environment and raise public awareness about the importance of air quality monitoring.

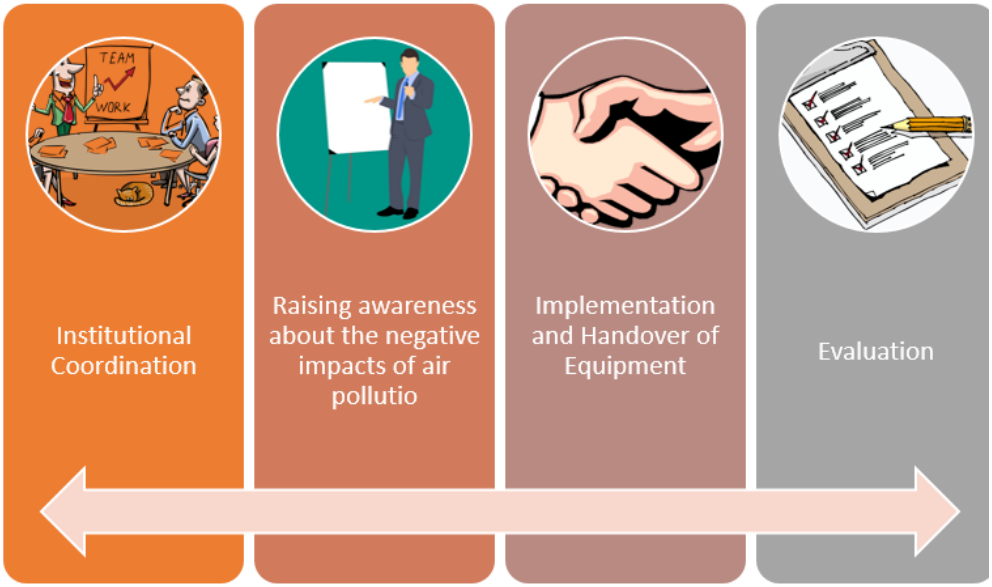

Figure 1. Implementation Method

Figure 1 show Implementation Method in the community service activity aimed at improving air quality in the briquette industry environment has been successfully completed. The coordination phase with partners went smoothly, resulting in agreements on implementation timing and necessary support. The socialization of air particle detection equipment usage was also effective, enhancing partners' understanding of the importance of air quality monitoring. After the equipment was installed and operated, air quality data was successfully collected. Based on the evaluation results, increases in particle concentration were found at certain hours, or decreases in concentration after equipment implementation. These findings will serve as the basis for developing recommendations to improve air quality in the factory area.

3. RESULTS AND DISCUSSION

3.1 Coordination with PT. Arkelindo

Coordination between the Community Service Team and PT. Arkelindo took place in early August. This activity was conducted to discuss the overall technical implementation of the Community Service Program (PKM). It also aimed to secure support from the factory for the smooth execution of the planned activities.

Figure 2. Coordination with PT.Arkelindo

Figure 2 show the coordination with PT. Arkelindo. This activity was carried out to assess the existing conditions in the briquette factory environment and to understand the factory's needs in order to comprehend the importance of maintaining air quality in the briquette factory environment. The discussion concluded that the need for air detection equipment was a significant issue in this briquette factory.

3.2 Socialization of Air Particle Detection Device

In this community service activity, the product used is the 9-in-1 Air Quality Monitor Detector. This product has several advantages that make it suitable for use in air particle detection systems in briquette factory environments, namely:

- It can detect various types of air pollutants, including air particles.
- It can work well in dusty and brightly lit environments.

Figure 3. 9-in-1 Air Quality Monitor Detector

Figure 3 show the 9 in 1 Ari quality Monitor Detector. Here is a more detailed explanation of this product's advantages:

1. Ability to detect various types of air pollutants : The 9-in-1 Air Quality Monitor Detector has sensors that can detect various types of air pollutants, including air particles. This is important because air pollutants can have negative impacts on public health.
2. Capability to work well in dusty and brightly lit environments : The 9-in-1 Air Quality Monitor Detector can function effectively in dusty and brightly lit environments. This is crucial because briquette factories typically operate in such conditions.

Overall, the 9-in-1 Air Quality Monitor Detector is a suitable product for use in air particle detection systems within briquette factory environments. This product offers advantages that can assist in monitoring air quality and preventing air pollution

3.3 Tool Implementation

Figure 4. Tool Implementation Activities

This activity is conducted to determine the extent to which this tool works effectively for application in the briquette factory, as well as to familiarize employees at the Briquette factory with the use of this tool as seen in figure 4. This activity is carried out to ensure the tool functions properly, with testing performed using appropriate test methods. After the tool is tested, it can be used to collect data. The collected data can be used to evaluate the tool's performance and to obtain user feedback.

3.4 Air Detection Device Measurement Results

Table 1. Measurement Results

Room	Result
Flour Room (Front)	Temperature: 30 C
	Humidity: 68 %RH
	HCHO : 0,007
	TVOC :0,12
	PM 2,5 : 52
	PM 10 : 68
	CO :1
	CO2 :417
	AQI :71

Room	Result
Flour Room (Middle)	Temperature: 30 C
	Humidity: 63 %RH
	HCHO : 0,004
	TVOC :0,005
	PM 2,5 : 29
	PM 10 : 38
	CO :2
	CO2 :412
	AQI :40
Flour Room (Rear)	Temperature: 30 C
	Humidity: 63 %RH
	HCHO : 0,006
	TVOC :0,011
	PM 2,5 : 24
	PM 10 : 31
	CO :1
	CO2 :440
	AQI :33
Room	
Production Area (Front)	Temperature: 31 C
	Humidity: 62 %RH
	HCHO : 0,04
	TVOC :0,022
	PM 2,5 : 94
	PM 10 : 123
	CO :1
	CO2 :412
	AQI :123
Production Area (Midlle)	Temperature: 31 C
	Humidity: 72 %RH
	HCHO : 0,012
	TVOC :0,024
	PM 2,5 : 104
	PM 10 : 136
	CO :1
	CO2 :412
	AQI :136
Production Area (Rear)	Temperature: 30 C
	Humidity: 68 %RH
	HCHO : 0,008
	TVOC :0,013
	PM 2,5 : 147
	PM 10 : 192
	CO :1
	CO2 :406
	AQI :195

Based on the table 1, it can be concluded that the air quality in the briquette factory environment is poor. This is indicated by high AQI values in all rooms. The high AQI values show that the concentration of air particles in the briquette factory environment exceeds safe limits. The main cause of poor air quality in the briquette factory environment is the carbonization process. The carbonization process produces smoke and dust containing various

types of air particles, such as PM 2.5, PM 10, and CO. These air particles can cause various health problems, ranging from eye and respiratory tract irritation to cancer.

Here are some key points from this conclusion:

- The air quality in the briquette factory environment is poor.
- The main cause of poor air quality is the carbonization process.
- Efforts to address air quality issues include using cleaner fuels, improving the efficiency of the carbonization process, and adding air filtration devices.

The results of this community service activity indicate that the air quality in the briquette factory environment remains poor, with high AQI values in all rooms, primarily due to the carbonization process which produces smoke and dust containing various types of air particles such as PM2.5, PM10, and CO. Despite this, the activity successfully increased public awareness about the importance of air quality monitoring and provided concrete recommendations to reduce air particle emissions, including the use of cleaner fuels, improving the efficiency of the carbonization process, and adding air filtration devices. Feedback from partners showed that the activity helped them understand the importance of air quality monitoring and how to implement air particle detection devices.

3.5 Community Awareness and Feedback Post-Activity

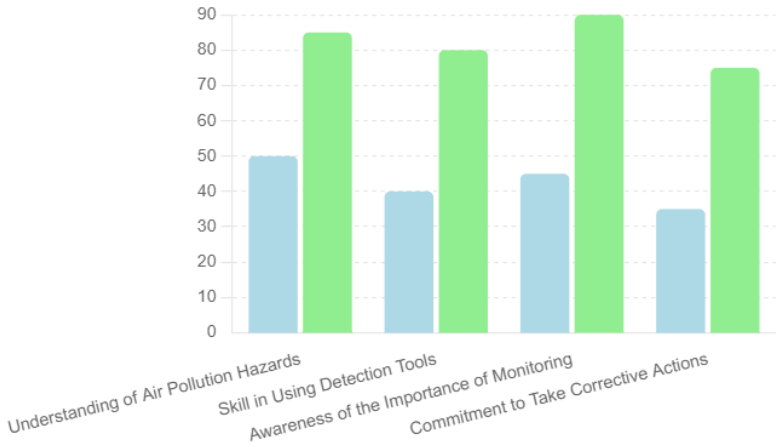

Figure 5. Survey Result

Figure 5 shows a graph of the questionnaire responses, indicating a substantial enhancement in participants' comprehension and awareness following the community service activity. Prior to the exercise, participants' comprehension of the hazards associated with air pollution was at 50%, proficiency in utilizing air particle detection systems was 40%, awareness of the significance of air quality monitoring stood at 45%, and dedication to implementing remedial measures was only 35%. Subsequently, following the activity, there was a significant enhancement, with comprehension of the hazards of air pollution increasing to 85%, proficiency in utilizing detecting equipment rising to 80%, awareness of the necessity of monitoring reaching 90%, and dedication to remedial action escalating to 75%. The socializing and training program effectively enhanced participants' knowledge, abilities, and motivation to adopt improved methods for maintaining air quality in the workplace.

This community service initiative effectively enhanced public knowledge of the significance of air quality monitoring inside the briquette production setting. Participants were provided with comprehensive information regarding the health hazards posed by airborne particles, particularly those produced during the carbonization process. The training on the air particle detecting device facilitated a comprehensive grasp of its functionality and its application in real-time air quality monitoring. Following the implementation of the program, feedback from partners indicated a marked enhancement in their comprehension of the significance of preserving air quality. Partners indicated they felt more prepared to undertake specific measures to diminish particle emissions, including adopting recommendations for cleaner fuels and enhancing the efficiency of the carbonization process. Furthermore, people became increasingly cognizant of the health concerns associated with air pollution, thereby motivating them to engage more actively in environmental protection.

4. CONCLUSIONS

This community service activity was carried out with the main objective of helping to improve air quality in the PT Arkelindo Bara Sejahtera briquette factory environment through the implementation of an accurate and reliable air particle detection system. After testing, the system was proven to function well even in heavy industrial environmental conditions. In addition to the technical implementation, this activity also included socialization to the participants on the importance of air quality monitoring as well as training on the use of detection equipment. From the results obtained, there was a significant improvement in the participants' understanding and skills related to air quality monitoring. The partners in this activity also experienced clear benefits, including the ability to monitor air quality in real-time and their commitment to implement corrective measures, such as the use of more environmentally friendly fuels and improved efficiency of the carbonization process. Thus, this activity succeeded in achieving its objectives not only in technical aspects, but also in building a deeper awareness of the importance of maintaining air quality, which will ultimately have a positive impact on the health of workers and communities around the factory.

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