Status of Suspended Particulate Matters Pollution at Traditional Markets in Makassar City

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Abstract. Research on the status of suspended particulate matters pollution in four traditional markets located in Makassar city has been done. The purpose of this research is to know the air quality in the traditional market areas, especially caused by suspended particulate matters. The background of this research is because traders who trade in traditional markets generally peddle their goods along dusty roads and suspended particulate matters in dust can be inhaled when the vehicle passes. These suspended particulate matters pollutant can cause lung diseases. The results showed that the level of suspended particulate matters pollution fluctuates every year depending on the local wind speed, humidity, and temperature. Research results also showed the values were over the standard value according to the governor of South Sulawesi regulation.

1. Introductions

Air is an important material in human life, humans cannot live without air. However, the air around us is not always in a clean state, whereas the human body needs clean air free of pollutants. Dirty air can be caused by the entry of pollutants from transportation, industry, or nature, such as smoke from forest fires, volcanic lava eruptions and etc.

Especially in urban areas, air pollution is mainly caused by industrial activity and transportation. The use of gasoline fuel in transportation, not only produces emissions in the form of gas, but also produces particulate matters that can be suspended in the air. Suspended particulate matters or particulate matters or more commonly referred to as dust in the air can be toxic and interfere respiratory and cardiovascular process. Suspended particulate matters can also be used as an air pollution indicator that shows the level of hazards to both the environment and health and safety [1, 2].

Suspended particulate matters present in the dust are of several sizes, from 0.001 μm to 150 μm. This particle is a gas emission having a size of 1 - 150 μm, bacteria with size 0.3 - 60 μm, wood burning (0.2 - 3), grain dusts (5 - 1000), human sneeze (10 - 100) viruses (0.005 - 0.3) [3, 4]. The size of suspended particulate matters that is often used as an air pollution indicator has a size of 1μm to 100 μm [4], while the health hazard has a size between (0.1 - 10) μm [1, 2, 5, 6]. Sedimentation of suspended particulate matters on the leaf surface can cause leaf photosynthesis capability decreased [7]. Furthermore, the air contaminated by these suspended particulate matters when exposed to the body, can cause various diseases, such as respiratory infections, coughing, irritation of the eyes and throat, cancer, and heart disease [1, 2, 8].

Traditional markets are markets that have no special buildings. Generally, traditional markets arose accidentally, because of the construction of new settlements and the location of modern markets far from these settlements. The market has very simple form of buildings, even in some parts there are no
buildings at all (Figure 1). Merchants hawk their merchandise using only plastic-coated tables, even some traders put their merchandise on the sidewalk. This situation often makes road jams. Vehicles that go through the road become very close to the merchant, which causes the dust to fly. Dust from vehicles that pass near the place of trade, can cause traders at risk for disturbances in the respiratory system due to inhalation of dust particles.

![Figure 1: Traditional market (source: CELEBESONLINE).](image)

To maintain public health within the traditional market environment, local governments should periodically monitor air quality measurements. This is done as a consideration for decision-making whether it is time to relocate the trader or improve market conditions. One of the parameters in air quality is the suspended particulate matters. These parameters are important to be measured and known, because the effects of inhalation of these particles can be seen in a short time.

2. Materials and Methods

The measurement data, which are concentration data of total suspended particles (TSP), were taken directly by using the Air Pollution Collector tool and analysed by gravity meter in laboratory [9]. Samples were taken from five traditional markets: Makassar Central Market, Gowa Central Market, Sungguminasa Market, Daya Market and Maros Central Market (Figure 2).

![Figure 2. Research location](image)

The data of wind speed, humidity, and temperature are carried out at the same day, with measurements twice per day, during high activity to determine the climate conditions of the location of the measurement.
2.1 Results and Discussion

Air quality is strongly influenced by climatic conditions, especially the local climate. High temperatures make the air more dilute, because it corresponds to the physics principle of fluid which says the air viscosity decreases with increasing temperature [10, 11], so the particles are easily dispersed. In addition, wind velocity also affects the distribution of particles in the air, the greater the wind speed, the more distant the particle [12]. The humidity of the air, will make the particles react with moisture, so that the particle size becomes larger [1, 13], similarly, rain will remove the suspended particles in the air by make them falling to the earth.

The air temperature in the five study sites is approximately 30 °C (Table 1). The lowest air temperature is in the Central Market of Gowa which is an average of 30 °C, this market is located in the southern city of Makassar, while the highest temperature is measured in the Central Market of Makassar which is located in the centre of Makassar. The same situation also appears at wind speed. Gowa’s Central Market lies close to the mountainous areas, as well as the Sungguminasa and Maros markets. Instead the Daya Market is located near the bus terminal in the direction of out of town, so the passing vehicles are quite crowded, many buildings, and less plants growing on the roadside, cause the air temperature to be large. Similarly, the Central Market of Makassar is located in the center of the city and surrounded by tall buildings, so the Central Market looks like it is in an enclosed space. That’s why the air temperature in this place to be high and the wind rate is very low.

| Table 1. Microclimate state at the study site. |
|-----------------------------------------------|
| Temperature (°C) | Wind Speed (m/s) | Humidity (%) |
|------------------|------------------|--------------|
| Maros Central Market | 30.5 - 32 | 1.8 – 1.9 | 55 - 75 |
| Gowa Central Market | 29 - 31 | 3.1 – 7 | 55 - 85 |
| Sungguminasa Market | 29 - 32 | 1.5 - 2.7 | 60 - 75 |
| Daya Market | 31 - 32.75 | 1.4 – 3.2 | 50 - 74 |
| Makassar Central Market | 32 - 36 | 0.4 - 0.6 | 60 - 80 |

Suspended particulate matters concentration in each traditional market fluctuates in every market, sometimes increasing and occasionally decreasing each year (Figure 3). This is due to fluctuations of traders who sell in the market. At certain times, as at the approaching feast, the number of merchants increases. Increasing numbers of traders will increase market activity, so traffic and pedestrian traffic friction will increase the concentration of suspended particulate matters in the air. This situation is worsened by road repair activities around the market location, as happened in 2006 in the Maros Central Market, and the Central Market of Makassar in 2010.

In 2009, several tens of meters from the traditional Daya Market began to be built modern market. These development activities lead to increased concentrations of airborne dust. This situation makes the dust concentration to reach more than the air quality standard for dust that is 230 μg/m³ [14].

Although the concentration of suspended particulate matters in the air is largely determined by the existence of development activities or motor vehicle traffic, but human traffic alone can also increase the concentration of suspended particulate matters in the air. Traditional markets that merchants only
use the table or put merchandise on the ground very easily exposed to suspended particulate matters. As it was explained in the background, the size of the dust is vary in shape and size. The particle size ranges from >2 mm to <63 μm with approximately one third of the dust being smaller than 500 μm \[4\]. Atmospheric dust has a diameter of 0.001 – 40 micron \[3\]. Measured suspended particulate matters at the site has a diameter of ≥ 50 μm, which is a particle with a size large enough. Particles with diameter size of this magnitude only takes 4 - 5 seconds in the air from a height of about 2 meters \[15\]. The presence of these particulate matters in the air are shorter when the humidity of the air at the site is high, because the these particulate matters can absorb water that will form a bigger size \[1, 13\].

![Figure 3: Fluctuations particle concentration in five traditional markets in Makassar in period of 2006 - 2012.](image)

However, the particulate matters are not only derived from the land around where merchants are located but also come from motor vehicle emissions, so the particulate matters size reaches 2.5 μm. Particulate matters with this size can enter the alveoli that will cause respiratory problems \[16\]. This has been proved by Nurjazuli \[17\] who found a disturbance in respiratory function in street vendors in the city of Semarang.

This research, only measured the total concentration of suspended particulate matters that have a large enough particle size, while that is very influential on the respiratory system is a particle with a size of 2.5 μm. Therefore, this study cannot be used to infer the cause of respiratory system disorders in traders caused by exposure to suspended particulate matters. However, the results of this research indicate that the quality of suspended particulate matters contamination at the site has exceeded the permitted threshold, so the location is not good for trading. Therefore, local government should consider the relocation of the market or re-arrange the location of the market.

3. Conclusion.
Status of suspended particulate matters contamination in five traditional markets located in Makassar city, namely Daya Market, Maros Central Market, Sungguminasa Market, Gowa Central Market, and Makassar Central Market fluctuate every year. Sometimes it exceeds the threshold, sometimes below the threshold. Nevertheless, the concentration of dust particles often exceeds the threshold limit, which can disrupt the health of traders in those markets. Therefore, the local government should consider the relocation of the market or re-arrange the location of the market so as not to be directly on the side of the road.
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