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STUDY ON CORRELATION BETWEEN MOTOR VEHICLE EMISSION AND PUBLIC HEALTH

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Abstract: All DKI Jakarta area suffers from poor air quality, ±70% caused by traffic externalities or fumes. As what environmentalist considers that even more motor vehicles will take to DKI Jakarta's road, air pollution caused by existing vehicle emission is thought to have already contributed to an increase in asthma and acute respiratory diseases. Environmental Ministry of the Republic of Indonesia responded by setting the air quality standard; particularly the BPLHD – Jakarta helps by assessing pollution at various stages of dispersion in Jakarta. This study approved correlation between motor vehicle emission and its impact on human health throughout DKI Jakarta by Product Moment Pearson Correlation and descriptive analysis is approached by Gordon's theory. The heavy rainfall could more influence some air pollutant (PM_{10}, CO, and NO_x) concentrations, moreover, could influence the correlation patterns between traffic congestion and maximum average of three pollutants have different patterns in rainy season. Meanwhile, few parameters (PM_{10} and CO) in dry season, which have correlation to traffic congestion, show the same patterns. Further observation denotes that either in rainy season or dry season, the average of correlations between air pollutant concentrations and the amount of few respiratory disease cases shows similar patterns.

Key Words: vehicle emission, air pollutant, respiratory diseases

1. INTRODUCTION

Indonesia has a rapid development in urban area either in demography, transportation, or industrial sector. DKI Jakarta is the highest demography metropolitan city, in which it has 12 million populations before 2010. The intensity, quantity, and frequency of either urban or suburban movement are the same factor in increasing transportation problem in Jakarta area; particularly in transportation utility development could not comply with the demand.

Dependency of urban population on transportation systems, particularly the ones using fossil fuels, is quite high. Traffic congestion resulting from transportation changes contributes even greater to deteriorating environment in urban communities. In the last few years, about 70% of ambient-air quality degradation in DKI Jakarta is noted affected by transportation activities.

Based on Central Bureau of Statistics (BPS) Jakarta (2002), the increasing of motor vehicle in Jakarta is ± 11.3% every year. Transportation activities could effect either positive impact like the increasing on DKI Jakarta economic activity, or negative impact like the increasing of street capacity in surrounding downtown area could effect in decreasing ambient air quality and also decreasing on public health quality either pedestrian or local communities. Moreover, these situations are causing the derived effect of environmental quality e.g., the

increase of air pollution, noise, traffic accident, and traffic jam. Based on study from Strategic Urban Road Infrastructure Project (SURIP: 1998) by JICA – SITRAMP (2000), Jakarta traffic jam in 1997 could cause IDR 6.3 billion financial loss daily.

It has long been recognized that poor ambient air quality has an adverse effect on public health. Within the last decade, data and methods have become available which allow for the quantification of adverse health effects associated with exposure to air pollution. It is apparent that such degradation of air quality could affect public health that is still increasing until today.

As acquainted before, which the atmosphere has three main functions in our life as the following: first of all, it is the main source for human's life; secondly, it is the final banishment that it could absorb and recycle the human activity's residue; finally, it could support every life in the earth.

Atmosphere has a certain capacity for giving its functions, which is disturbed by emission, is coming from human activities, particularly traffic fumes are the main pollutant in urban area. In protection and controlling this matter, the last paradigm should be changed for the following reasons:

- The atmosphere capacity in absorbing and recycling pollutant is circumscription;
- Decreasing of atmosphere capacity could effect negative impact in human health, environmental health, economy activity, and urban development;
- The impact cost caused by decreasing ambient air quality is extremely high and could be higher if the air quality is getting worst.

Research problems identified from the background are 1) Are there any correlations between traffic congestion and some parameters of ambient air concentration (CO, NO_x, and PM_{10}), in which most of them come from motor vehicle's emissions, in year 2002 (as an agent)? 2) Are the concentrations of CO, NO_x, and PM_{10} in ambient air at five research locations in DKI Jakarta correlated with the amount of few respiratory illness cases in year 2002 (as a host)? The aims of this research are: 1) To examine the trend correlations between traffic congestion and some parameters of ambient air concentration (CO, NO_x, and PM_{10}) at five research locations in DKI Jakarta in year 2002 (agent). 2) To examine the trend correlation between concentration of CO, NO_x, and PM_{10} in ambient air at five research locations in DKI Jakarta and the increasing amount of few respiratory illness cases in year 2002 (host).

2. MOTOR VEHICLE POLLUTION

Some specialist e.g., Aditama (1999) has been predicted that around 60%–80% of urban population in around the world are living in bad air quality that is some pollutants are almost the same and over to national ambient air quality standard is in Government Regulation of Republic of Indonesia (PP.RI.) No. 41 year 1999 concerning Air Pollution Control. Based on Indonesian Environmental Status Report (2002), most of air pollution (70%) in big cities in Indonesia comes from transportation activities, and the other 30% comes from industrial activity and human settlement. Other research was taken in eight areas in DKI Jakarta stated that there is correlation between increasing the amount of motor vehicle, transportation system, where traffic is not sufficient, and emission standard is weakness as well as lacking in motor vehicle treatment could affect in air pollution. Moreover, air pollution controlling is still not sufficient. BAPEDAL (1992) *in* Handayani, et al (2003) reported that motor vehicle

emission has been contributed 73% of NO_x in air pollution could effect human lung health. World Bank (1994) *in* Handayani, et al (2003) has been predicted air pollution in some cities in Indonesia in 2000 would be as twice worse as in 1990 and nine times worse in 2020.

3. METEOROLOGICAL FACTOR

The meteorological factor is very influencing in air pollutant dispersing, and it could be influence to air pollutant in the atmosphere. (Suwarto, 1997) illustrates that air pollutant phenomenon could not only be described by pollutant concentration from the emission source, but also we should estimate the meteorological condition. Some importance factors considered could influence the air pollutant concentration are:

3.1 Wind Factor

Wind speed will affect the particulate matter dispersing, while wind rose will effect the direction of air pollutant dispersion. Therefore, wind is one factor could influence air pollutant concentration in the ambient air.

3.2 Temperature

In general, there are 2 (two) turbulent processes in ambient air e.g., mechanical turbulence and thermal turbulence. The unstable air in the earth surface can be caused by temperature differences and could make wind flow with the medium speed or high speed, until the air pollution substances could fast disperse into atmosphere and their concentrations could decrease. If the ambient air is stable and wind speed is low, so there is limitedness of air pollutant dispersion while concentration of the emission is still high in around its source.

3.3 Rainfall

Rainfall could influence the air pollutant concentration particularly suspended particulate matter is floating in ambient air. Suspended particulate matter could soluble by the rainfall and it produces the acid rain. Therefore, when the rainy days come, the atmosphere looks clearer.

3.4 Topography

Suryani (2003) illustrates that topography is another importance factor and it could influence the air circulation pattern in the area, which is influencing the concentration of some ambient air pollutants. For the example, the air circulation condition in the hilly area, which its surrounding area has a lower topography, is inclined to better air circulation than in the valley area.

4. AMBIENT AIR QUALITY STANDARD

Ambient air quality protection was made compulsory for it could fulfill its normal function. It means the clean and healthy ambient air is safe for human's and other creature's health.

Ambient air quality standard shown in Table 1 is the maximum standard of some air pollutants that people who lives in the environment could still be able to hold out without moan and complain about their symptoms and illness from its communities.

Table 1. Ambient Air Quality Standard

No.	Parameter	Time of Measurement	National Ambient Air Quality Standards* ($\mu g/Nm^3$)	DKI Jakarta Ambient Air Quality Standards** ($\mu g/Nm^3$)
1.	CO (Carbon Monoxide)	1 hour 24 hours	30 $\mu g/Nm^3$ 10 $\mu g/Nm^3$	26 $\mu g/Nm^3$ 9 $\mu g/Nm^3$
2.	NO_2 (Nitrogen dioxide)	1 hour 24 hours 1 year	400 $\mu g/Nm^3$ 150 $\mu g/Nm^3$ 100 $\mu g/Nm^3$	400 $\mu g/Nm^3$ 92.5 $\mu g/Nm^3$ 60 $\mu g/Nm^3$
3.	PM_{10} (Particle <10mm)	24 hours	150 $\mu g/Nm^3$	

Source: * Government Regulation No. 41 in 1999 concerning Air Pollution Control
** DKI Jakarta Governor Decree No. 551 Year 2001 concerning the Stipulation of Ambient Air Quality Standard and Noise for the Capital City of Jakarta.

5. ENVIRONMENTAL HEALTH

According to WHO *in* Kusnoputranto (1992), health is an ecological balancing condition that should have correlation between human and the environment in order to have a good human health. Ecological balancing illustration depends on some related factors, which are three classes in general e.g.: Agent (A), Host (H), and Environmental (E).

Agent factor is something could cause illnesses to the human-being and in this research, agent is the traffic condition in DKI Jakarta that most of the time contributed to DKI Jakarta air pollution. The host is human; particularly some factors are related to the biological factor (something that has characteristic are related to human body invulnerability and resistance to the disease) or human behavior (are related to habitual and culture). In this research the host is the population at risk in all research area and could affected its community's health particularly in respiratory diseases in year 2002. The environments are all aspects except agent and human are various and generally they are classified into 3 (three) categories, e.g.: they are related to the physical, biological, and social-economic aspects.

John Gordon *in* Kusnoputranto (1992) analyzed the interaction of those three factors as a pair of scales and a lever, which is rest on the environmental factor. There are correlations between those factors and they are always trying to reach the equilibrium, for more details see Figure 1(a). This condition could be equal when Agent and Host are running their role in equilibrium.

The increasing of population growth could cause public health problems. The centralized community in some cities can cause worsen pollution than human or its natural environment capacities in neutralizing the water and air pollution. Some illnesses are causing by pollution

are spread out the city. Decreasing of public health is one problem to be thought of by Department of Health official. The expansion of commercial/business area that is mostly in the middle of the city is one attractive factor of the increasing number of generation traffic on the weekday. Moreover, it can cause the increasing number of few gas concentrations in the ambient air.

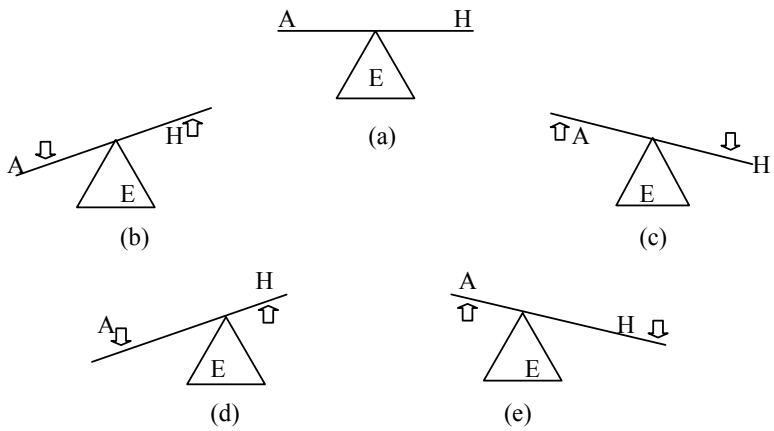


Figure 1. Types of Reciprocal Relationship between Host (H) factor, Agent (A) factor, and Environmental (E) Factor, in order to Get The Equilibrium Condition
(John Gordon *in* Kusnoputranto; 1992)

Air pollution could influence public health, e.g.: eye irritating, headache, and few respiratory diseases. Air pollution could be damage to our lung and respiratory systems, moreover, other functions of our body could be damaged by it. (Kusnoputranto, 1995).

In general, there are 2 (two) types of air pollutions influencing public health, e.g.: first, as a gas 'or' fume is depending on the gas type, its concentration, and other things that related to gas pollution; second, as particulate 'or' mist is depending on even its common physical, chemistry, and also physiological characteristic. According to one of its epidemiological, that few respiratory disease cases are caused by air pollution. There are more lung cancer cases that can be found in urban area than in rural area. It is caused by one factor called urban factor.

Compared to other gas pollution, carbon monoxide (CO) has different characteristic. In general, other air pollution could influence respiratory system, however, when CO come into our body and after passed by respiratory system and lung system, it will reach the arterial and perform a reaction with hemoglobin (Hb) creating a Carboxyhemoglobin (CO-Hb). Displaying symptoms of having been poisoned of CO are: first, someone could hardly breathe caused by lack of oxygen in her/his blood, and the patient is deadly pale if she/he is not having fresh air and immediately she/he becomes dead.

The public health is direct influenced by nitrogen oxide (NO_x) is not clear enough, however, in adequate concentration of nitrogen monoxide could react with hemoglobin in our blood system and also could cut off the normal function of hemoglobin in blood. Other side, nitrogen dioxide can cause irritate the eyes and respiratory system.

The influencing of suspended and liquid particulate is in the ambient air is depending on the size of its own particulate. Particulate matter size in general is around 5 micro can move into

the lung and suspended in alveoli. It doesn't mean the bigger size is not danger to our health. The bigger particle could, in some extent, irritate the upper respiratory systems.

6. HYPOTHESES

Research hypotheses are defined as followings: 1) There are positive and significant correlations between traffic congestion at five research areas in DKI Jakarta and concentration of some ambient air parameters (CO, NO_x, and PM_{10}) caused by motor vehicle's emission (agent), 2) There are positive and significant correlations between concentration of some ambient air parameters (CO, NO_x, and PM_{10}) in DKI Jakarta are caused by motor vehicle's emission and the amount of few respiratory disease cases in DKI Jakarta (host).

7. RESEARCH FRAMEWORK

- Land use differences in DKI Jakarta could make difference in the amount of traffic congestion in some area in this city. DKI Jakarta local government needs transportation utility and infrastructures in every development activities.
- Now, transportation activities could affect DKI Jakarta ambient air quality is getting worse. In other words, environmental degradation in DKI Jakarta is obvious seen in the air environment quality could impact social environment. Few emission gases are directly coming from motor vehicle emission or other motors emission that are using fossil fuel, are stated as primary air pollution.
- Some factors could effect air pollution concentration, primary air pollutant disperse direction that are like wind rose and wind speed, rainfall, humidity, temperature, etc. Besides meteorological factor, there is a chemical/physical transformation/reaction could be changed the primary pollutant into secondary air pollutant.
- Ambient air consists of both primary and secondary air pollutant that locations are in the ambient areas and almost inhaled by human being.
- Parts of polluted ambient air are going through some buildings and human settlement, etc.. With the time is passing by, it could effected to public health.
- Components have been used in this research were taking place throughout DKI Jakarta in year 2002 are as follow: traffic congestion, ambient air quality (PM_{10}, NO_x, and CO) data, and evaluates their impact on human health (asthma and acute respiratory disease cases).

8. METHODOLOGY

All data in this research collected as denoted in Table 2. First, it is using the amount of motor vehicle data; second, it is using ambient air quality data and tracks them throughout Jakarta city in year 2002, and evaluates their impact on human health.

Table 2. Type and Source of Data

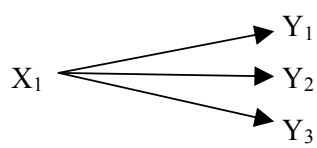
Data Type (unit)	Data Source
The amount of traffic congestion in some transportation network in 5 (five) DKI Jakarta municipalities in year 2002 (pcu/mo).	Consultant of Transportation and Traffic Forecasting Study; and JICA – SITRAMP.
PM_{10} (□g/m^3) concentration in DKI Jakarta ambient air in year 2002	BPLHD – Jakarta.
The amount of acute respiratory disease (ISPA) cases and asthma cases (patient/mo) at some districts are including in research area (around 1 km from AQMS fixed station) in year 2002.	5 (five) Local Health Government Departments in DKI Jakarta are including in research area.

8.1 Research Variables

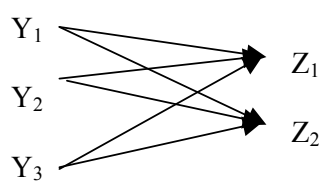
Variables were used in this research were dependent variables (Y) and independent variables (X). For details are as follows:

1st Paradigm

Independent variable: X_1 = traffic congestion (pcu/mo).
Dependent variables: Y_1 = PM_{10} (□g/m^3) concentration
Y_2 = CO (□g/m^3) concentration
Y_3 = NO_x (□g/m^3) concentration



2nd Paradigm



Independent variable: $y_1 = PM_{10}\left(\mu g / m^3\right)$ concentration

$y_2 = CO\left(\mu g / m^3\right)$ concentration

$y_3 = NO_x\left(\mu g / m^3\right)$ concentration

Dependent variables: $Z_1 = ISPA\left(person / mo\right)$ cases

$Z_2 = Asthma\left(person / mo\right)$ cases

To verify both hypotheses, this study approved correlation between motor vehicle emission and its impact on human health throughout DKI Jakarta by Product Moment Pearson Correlation as follows:

$$r = \frac{n\Sigma xy - \Sigma x \Sigma y}{\sqrt{((n\Sigma x^2 - (\Sigma x)^2) \times (n\Sigma y^2 - (\Sigma y)^2))}}$$

and descriptive analysis is approaching by Gordon's theory (figure 1). Secondary Data should be collected in some institutional, text books, journal, internet, etc.).

Some assumptions have been used in this research as:

- The research area is cylinder which were has $(\pi r^2 \times h)$ 'or' $(\pi km^2 \times 1km)$
- Wind speed was moving to the height of research area was the same value or homogenous and vertical wind turbulence was neglectful.
- Wind speed was moving in research area, was the same value, however there was no time function, length of the road, and the height of research area.
- The interference height was pretended in the same for all research locations.
- The interference of some pollutant substances was only under the interference height (H).
- Motor vehicles, which are crossing over the research transportation network, were using gasoline for their fuel.
- The PM_{10} concentration in research areas is homogenous.
- Research area land use should not be changed along the year 2002.

Some Research Operasional Definition, e.g.:

pcu (passenger car unit = *satuan mobil penumpang*) is the unit used for traffic capacity and is not in number of vehicles per hour but in pcu (passenger car unit) (Warpani; 1985).

Agent in this research is the correlation between the increasing of transportation activities could increase the emission and it has far reaching consequence of DKI Jakarta's air quality.

Host in this research is the correlation between public health characteristics to the air pollution.

Environmental is research area that is in physically has no change in land use condition in the whole year 2002, however, there is decreasing in air quality could hampered the biological environment, particularly its own community.

9. LAND USE AND TRAFFIC CONGESTION OF DKI JAKARTA IN 2002

Figure 2. Map of 5 (Five) Research Area at DKI Jakarta
(Source: Gunther W. Holtorf, 2001)

Research area is taken from 5 (five) areas in 5 (five) regions in DKI Jakarta – Indonesia, with 1 km radius from the Air Quality Monitoring System (AQMS) (see fig.2). At the moment, DKI Jakarta land use in 2002 is divided into 5 (five) types of activities in 5 (five) regions, e.g.: commercial area, human settlement area, green area; irrigation (river, pond, and swamp) area; transportation area (road, bridge, underpass, etc) with detail percentage in figure 3. Human settlement area is the big activities in the west, south, and east region of DKI Jakarta. However, most of the community who lives in those regions has daily activities in central Jakarta. Data of traffic congestion in central Jakarta is around 14,484,795-smp/mo. Infrastructure areas for transportation activity in central Jakarta is 237,735m^2.

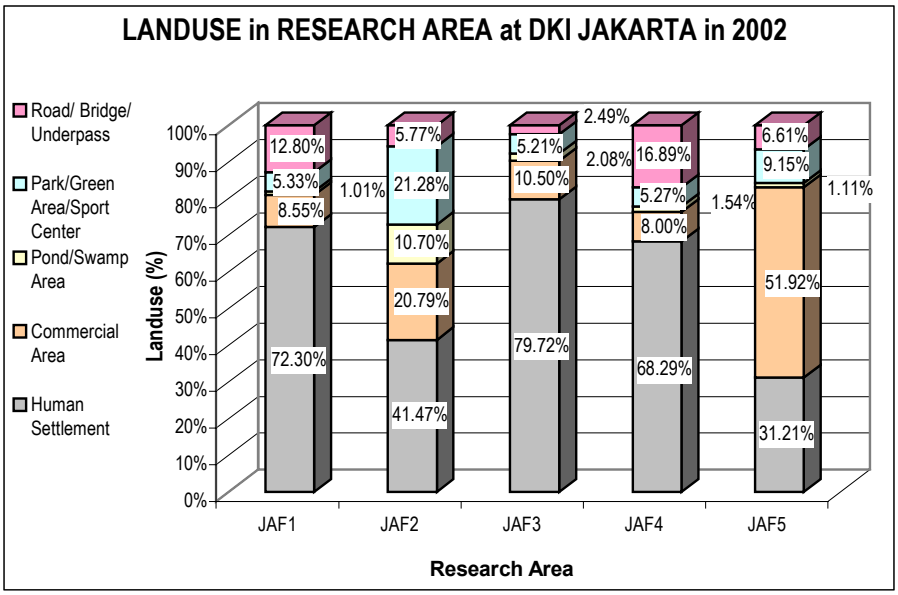


Figure 3. Land Use in 5 (five) Research Areas at DKI Jakarta in 2002

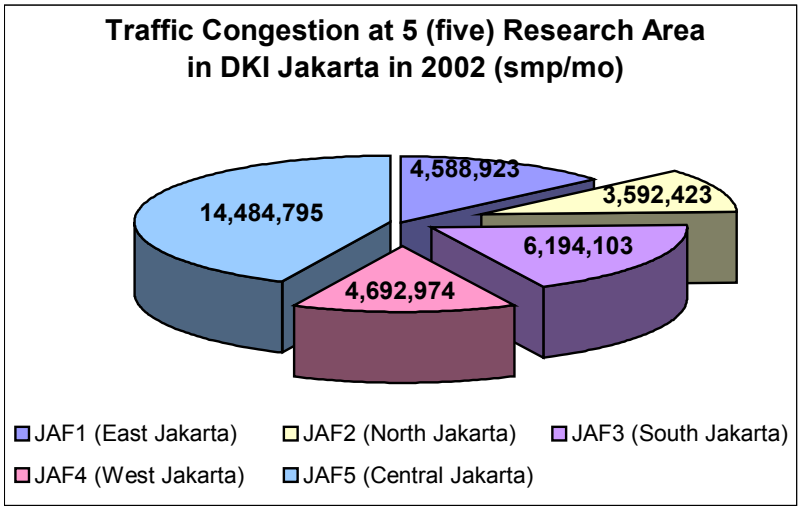


Figure 4. Traffic Congestion at 5 (Five) Research Areas in DKI Jakarta in 2002

10. CORRELATION BETWEEN MOTOR VEHICLE EMISSION AND PUBLIC HEALTH

There are two phases on correlation. First, correlate the traffic congestion condition with 3 (three) ambient air concentrations (PM_{10}, CO, and NO_x). Second, correlate between each ambient air concentration (PM_{10}, CO, and NO_x) and few respiratory disease cases. The results are seen in some charts (fig. 5 – fig. 8). In this case, the researcher indicate that if the correlation coefficient is in $-1 < r < 0$, the pattern of this correlation is negative or it has different pattern. Meanwhile, if the correlation coefficient is in $0 < r < 1$, the pattern of this correlation is positive or it has same pattern.

10.1 Correlation between Traffic Congestion and 3 (three) Ambient Air Concentration (PM_{10}, CO, and NO_x)

The findings of study in Jakarta application, was analyzed based on product moment Pearson correlation analysis as the underlying:

The heavy rainfall could more influence particulate matters (PM_{10}) concentrations, moreover, could influence the correlation pattern between traffic congestion and maximum average of PM_{10} have different patterns in rainy season. Meanwhile, PM_{10} in dry season, which have correlation to traffic congestion, show the same patterns.

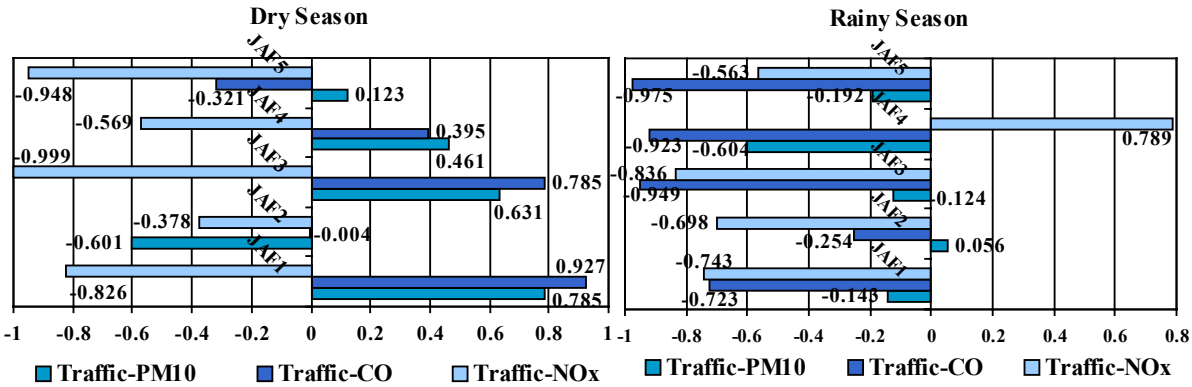


Figure 5. Correlation between Traffic Congestion and 3 (Three) Ambient Air Concentration (PM_{10}, CO, and NO_x)

10.2 Morbidity Associated with Particulate Matters

Particulate matters, even in liquid particulate or suspended particulate matters are in the ambient air, and they depend on their size could influence human health. In general, particulate in around 5 (five) micrometers could move into human lung and are retained in the alveoli. This means, particulate in bigger than 5 (five) m still threaten human health and it can irritate human upper respiratory symptoms. Moreover, smaller particulate matters of less than 5 (five) m flying and flowing in the air, could irritated our eyes.

Hodges (1976) *in* Satudju (1991) illustrates that there are four types of illnesses caused by particulate matters in the air, e.g.: chronically bronchitis, asthmatic bronchitis, emphysema, and lung cancer.

10.3 Correlation between Particulate Matters (PM_{10}) and Few Respiratory Disease Cases

Either in rainy season or dry season, the average of correlations between particulate matters (PM_{10}) concentrations and the amount of few respiratory disesase cases (acute respiratory illness cases/ISPA and asthma) shows similar patterns. It means either PM_{10} concentration or the amount of few respiratory disease cases is mounted up.

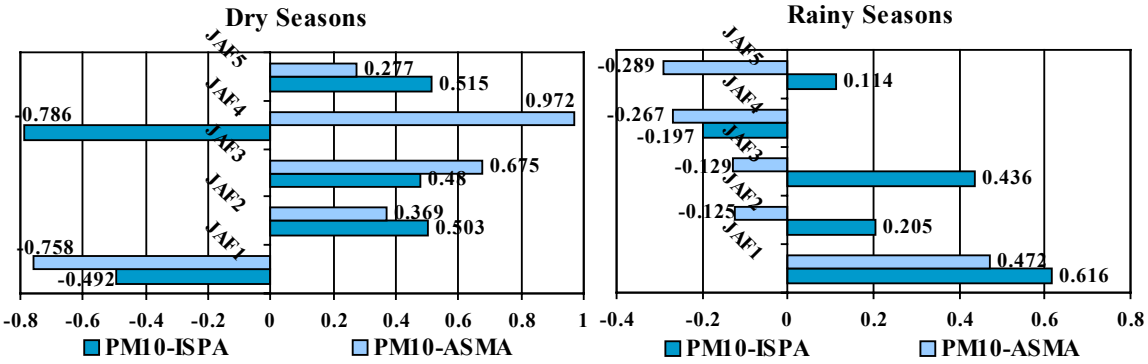


Figure 6. Correlation between Particulate Matters (PM_{10}) and Few Respiratory Disease Cases

Those indications showed that averagely when it comes to dry season, both factors within the all research locations in DKI Jakarta performed similar patterns. That means the increasing

value of agent (correlation between traffic congestion and PM_{10}) will lessen the vulnerability of public's health and vice versa. Meanwhile, in rainy season, averagely the correlation between agent and host (correlation between PM_{10} and few respiratory disease cases) showed the opposite pattern. It means if PM_{10} concentration arises the amount of few acute respiratory disease cases will decrease.

10.4 Correlation between Carbon Monoxide (CO) and Few Respiratory Disease Cases

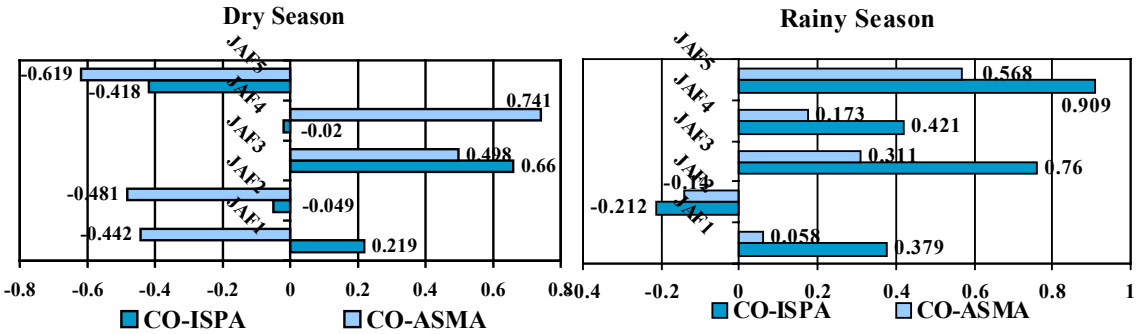


Figure 7. Correlation between Carbon Monoxide (CO) and Few Respiratory Disease Cases

In rainy season, the average of correlations between carbon monoxide (CO) concentrations and the amount of few respiratory disease cases (acute respiratory disease cases/ISPA and asthma) show similar patterns except in the northern region of Jakarta (JAF2) showed the opposite pattern. Averagely means, either CO concentration or the amount of few respiratory disease cases is mounted up. Meanwhile in dry season, the correlation showed opposite patterns. It means, if CO concentration arises the amount of few respiratory disease cases will decrease. Those indications showed that level CO concentration, is polluted the air environment, could not considered as the main factor that causing the acute respiratory disease cases (ISPA).

10.5 Correlation between Nitrogen Oxide (NO_x) and Few Respiratory Disease Cases

Either in rainy season, the average of correlations between nitrogen oxide (NO_x) concentrations and the amount of few respiratory disease cases (acute respiratory disease cases/ISPA and asthma) show similar patterns. It means either NO_x concentration or the amount of few respiratory disease cases is mounted up. Meanwhile in dry season, the correlation showed opposite patterns. It means, if NO_x concentration arises the amount of few respiratory disease cases will decrease.

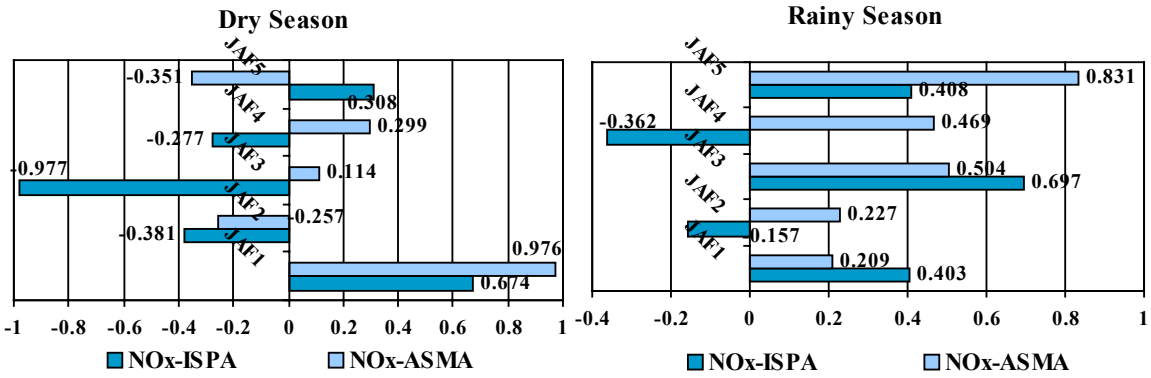


Figure 8. Correlation between Nitrogen Oxide (NOx) and Few Respiratory Disease Cases

The Agent and Host patterns as it seen in Table 3, there are 4 (four) patterns correlation in particular environment. The patterns possibilities are as follows:

1. The first pattern, when the agent (+) and host (+) showed the same pattern. Means, the wider commercial area in one community the more air pollution is emitted by motor vehicles are passing in that community. When the ambient air condition is getting worse, it will influence the public health that seen in arising number of asthma and acute respiratory disease cases is (fig. 1e).
2. The second pattern, when the agent (+) and host (–) showed the opposite pattern. Means, when the air pollution is getting worse, the amount of asthma and upper respiratory disease cases will decrease. In other words, the public health could be better is causing by few environmental factors could help in dilution/dispersing air pollution process or the increasing of public resistance to a few illnesses (fig. 1b).
3. The third pattern, when the agent (–) and host (+) showed the opposite pattern. Means, when the air pollution is getting worse, the amount of asthma and upper respiratory disease cases will decrease. In other words, the public health could be better is causing by few environmental factors could help in dilution/dispersing air pollution process or the increasing of public resistance to a few illnesses. It showed in arising the amount of asthma and acute respiratory disease cases (fig. 1c).
4. The fourth or the last pattern is the opposite direction from the first one. Means, in the peak time on traffic condition in the rainy seasons is getting worse, however, there are few factors that could dilute/disperse the pollution. Moreover, when ambient air is getting better, the public health is better too, particularly in respiratory disease cases (fig. 1d).

Table 3. Correlation Pattern between Motor Vehicle Emission and Public Health in 5 (Five) Research Areas in DKI Jakarta

Research Area	Season	PM_{10}		CO		NO_x	
		Agent	Host	Agent	Host	Agent	Host
East Jakarta (JAF1)	Rainy	–	+	–	+	–	+
	Dry	+	–	+	–/+	–	+/–
North Jakarta (JAF2)	Rainy	+	+	–	–	–	+/–
	Dry	–	+	–	–	–	–/+
South Jakarta (JAF3)	Rainy	–	+	–	+	–	+
	Dry	+	+	+	+	–	–
West Jakarta (JAF4)	Rainy	–	–	–	+	+	+/–
	Dry	+	+/–	+	+	–	+/–
Central Jakarta (JAF5)	Rainy	–	–	–	+	–	+
	Dry	+	+	–	–	–	–/+

Notes: this mark (–) in Agent column, is indicated that the number of traffic is not influencing the air pollutant concentration worse; in Host column, is indicated that air pollutant concentration is not influencing the number of asthma and acute respiratory disease cases in research areas,
this mark (+) in Agent column, is indicated that the number of traffic is influencing the air pollutant concentration worse; in Host column, is indicated that air pollutant concentration is influencing the number of asthma and acute respiratory disease cases in research areas,
this mark (+/–) or (–/+) indicated that dominance correlation pattern is the first pattern.

11. CONCLUSION

Based on the analysis, it can be concluded that, the heavy rainfall could more influence some air pollutant (PM_{10}, CO, and NO_x) concentrations, moreover, could influence the correlation patterns between traffic congestion and maximum average of three pollutants have different patterns in rainy season. Meanwhile, few parameters (PM_{10} and CO) in dry season, which have correlation to traffic congestion, show the same patterns. In addition, the average of correlations between air pollutant concentrations and the amount of few respiratory disease cases, either in rainy season or dry season, show similar patterns. It means either the air pollutants concentration or the amount of few respiratory disease cases is mounted up. In exception with CO concentration in dry season, which is correlated to the amount of few respiratory disease cases, shows different direction.

Those indications showed that averagely when it comes to dry season, both factors within the all research locations in DKI Jakarta performed similar patterns. That means the increasing value of agents will lessen the vulnerability of public's health and vice versa. Meanwhile, in rainy season, averagely the correlation between agent and host showed the opposite pattern. It means if pollutant concentration arises the amount of upper respiratory disease cases will decrease.

Therefore, several recommendations are accomplished due to the improvement of pollution reduction. Air pollution phenomenon related with public health can be used as critical consideration either for Jakarta Local Government or the planners in re-planning the Jakarta's land use, and as well as new policies related with the city's transportation activities, such as:

- Supply more "environmental-friendly" fuels,
- Restraint in usage duration for motor vehicles,
- Improving public transportation services in order to make any passengers feel more safety and comfortable.

In addition, the management of town planning should take into account the dispersion of activities and air condition that could decline to a poor level when there is no good solution for traffic congestion, and also the results of monitoring conducted regularly and individually by government agencies can be used as integrated subjects for evaluation, and provide valuable information for Jakarta Local Government to improve its development plan in the future.

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