

Analysis of the Relationship Between LEB and PM 2.5 for Some Developed and Developing Countries in Asia from 2014 to 2023

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Abstract: Research regarding the relationship between LEB and PM2.5 in several developed and developing countries in ASIA is interesting to be analyzed, because it is not many discussed by researchers. The data to be analyzed is taken from several developed countries in ASIA (China and Japan) and several developing countries in ASIA (Indonesia and Malaysia). The aim of this research is to determine the effect of PM2.5 on LEB. The data analysis used is multiple regression with dummy variables for the categories of developed and developing countries. The analysis results show that there is a negative relationship between PM2.5 and LEB. This shows that the healthier the environment, which is characterized by low PM2.5, the higher the LEB. Developed countries (Japan and China) has a high LEB, while developing countries (Indonesia and Malaysia) have a low LEB compared to developed countries. Because countries in developed countries generally have better access to pollution control technology and better infrastructure.

1 INTRODUCTION

World Bank statistics for 2022 state that LEB in East Asia and the Pacific generally has an increasing trend in LEB from 1960 to 2021 with LEB between 65 and 85 years. In Asia, Japan has the highest LEB and PNG has the lowest. The increase in LEB is due to many factors such as access to health services, increasing living standards, and advances in the medical field. However, several countries in Asia face air pollution problems, including high levels of PM2.5. Large cities and industrial areas tend to have higher levels of air pollution. PM2.5 are small particles found in the air and can have a negative impact on human health when inhaled.

The research results of Kiesewetter et al (2015), shows that there is a correlation between the level of exposure to PM2.5 and the life expectancy of residents of a region. Exposure to PM2.5 can cause serious health problems such as respiratory problems, cardiovascular disease, and cancer, which in turn can

affect life expectancy. Furthermore, research conducted in Southeast Asian countries, including ASEAN countries, found that exposure to PM2.5 contributed to an increased risk of premature death and decreased life expectancy, Fann et al (2012), Chen et al (2019). High PM2.5 is closely related to economic growth and the level of development of a country Badulescu et.al (2019). But, countries with high GDP generally have better access to pollution control technology and better infrastructure, which allows them to reduce emissions of air pollutants, including PM2.5.

Based on this literature review, it is appropriate to research the relationship between PM2.5 and LEB between developed and developing countries in Asia. Is there a difference in the impact of PM2.5 and LEB between developed and developing countries in Asia based on descriptive analysis and the best statistical modelling.

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2 LITERATURE REVIEW

Human exposure to PM_{2.5} produces various negative health impacts with significant social impacts, Martins & Da Graca (2018). PM_{2.5} enters the human body through air that flows into the respiratory tract and reaches the alveoli of the lungs. Ultimately, PM_{2.5} has been identified as the cause of a large number of deaths in various regions of the world (Harrison et al., 2017; Gao et al, 2016). In 2019, air pollution, which mostly consists of PM_{2.5}, was found to be the cause of nearly 800 thousand deaths per year in Europe. In 2015, in China, 15.5% of all deaths, CongBo et al, (2017) and 32% of deaths in China's major cities, Fang et al, (2016) were attributed to exposure to PM_{2.5}. Many of these health impacts, most of which affect the respiratory and cardiovascular systems, are similar to the effects of smoking tobacco (CongBo et al, 2017; Britton, 2017; Kurt et.al, 2016). Likewise, the impact of PM_{2.5} also causes a decrease in LEB. Furthermore, research on the relationship between PM_{2.5} and LEB in developed and developing countries conducted by Chen (2021), found that PM 2.5 did not have a significant effect on LEB in developed countries; but it has a negative impact on LEB in developing countries. Apart from that, it was also found that carbon dioxide emissions have a negative impact on LEB in both developed and developing countries.

3 METHOD OF ANALYSIS

In this research, the data that will be analyzed are LEB, PM_{2.5} and several developed and developing countries. The dependent variable is LEB and the independent variable is PM_{2.5} and the country as a dummy variable. The model to be used is as follows:

Model linear the relationship of LEB, PM_{2.5} and countries:

$$LEB = \mu + \beta_1 PM_{2.5} + \beta_2 D1 + \varepsilon \quad (1)$$

Where

LEB : Life expectancy at birth

PM_{2.5} : Particle

D1 : 1 if developed country

0 if developing country

ε : residual

4 RESULTS AND DISCUSSION

In this research, we will discuss the relationship between PM_{2.5} and LEB from several developed and developing countries in Asia. For developed countries, Japan and China are taken, while for developing countries Indonesia and Malaysia are taken. The analysis used in this research is multiple regression with dummy variables for the categories of developed countries and countries.

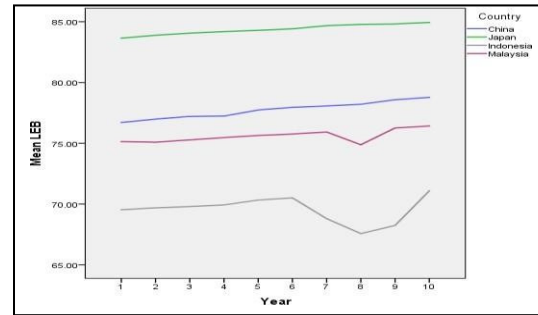


Figure 1: LEB data for China, Japan, Indonesia and Malaysia from 2014 to 2023.

Figure 1 shows that Japan's LEB is higher than China, Indonesia and Malaysia, China's LEB is higher than Indonesia's and Malaysia's LEB, and Malaysia's LEB is higher than Indonesia. Figure 1 shows that the LEB Plot for Malaysia and Indonesia from 2020 to 2022 has changed with the LEB decreasing, this happened during the Covid-19 pandemic. However, during Covid-19, there is no influence of LEB in Japan and China (Figure 1).

Figure 2 shows that PM 2.5 conditions in China are relatively high compared to three other countries, Japan, Indonesia and Malaysia. The minimum PM_{2.5} value was 25.20 and the highest was 59.77 in China. Japan's PM_{2.5} conditions are relatively low compared to China, Indonesia and Malaysia. The minimum PM_{2.5} value is 9.10 and the highest is 13.20 in Japan. Figure 2 shows that PM_{2.5} conditions in Indonesia and Malaysia are relatively the same.

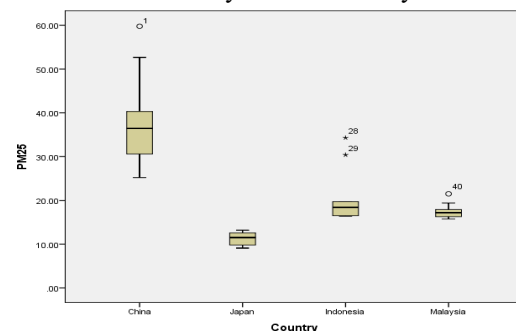


Figure 2: Box plot of PM_{2.5} in China, Japan, Indonesia and Malaysia from 2014 to 2023.

From the analysis by using model 1, it was found that:

Table 1: Analysis variance for model (1)

Source	DF	Sum of Squares	Mean Square	F-Value	P-value
Model	2	936.92215	468.46107	84.66	<.0001
Error	37	204.72761	5.53318		
Corrected Total	39	1141.64976			

R-Square = 0.8207

Table 1 shows the model 1 test with the null hypothesis that the model is not significant. From the results of the F test=84.66 with p-value<0.0001, we can conclude that the null hypothesis is rejected, which means the model can be used to explain LEB. The results of R-square = 0.8207 indicate that 82.07% of LEB variation can be explained by the model.

The estimate model is as follows:

$$\hat{LEB} = 76.486 - 0.205PM2.5 + 9.618 D1$$

The parameter test results are presented in Table 2 below.

Table 2: The estimation and test parameter model 1.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	76.48605	0.81897	93.39	<.0001
PM25	1	-0.20508	0.03285	-6.24	<.0001
D1	1	9.61837	0.76539	12.57	<.0001

Table 2 shows that the test for the Intercept, PM2.5, and D1 parameters each has a p-value <0.0001, which shows that the test results are very significantly different from zero.

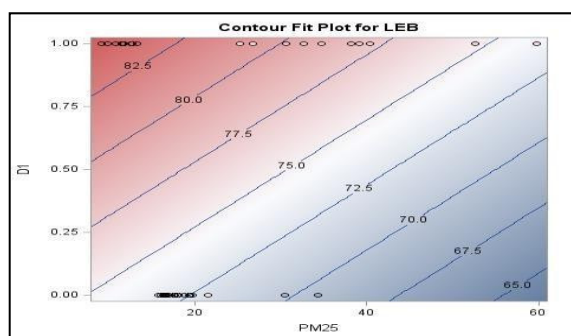


Figure 3: Contour Fit Plot for LEB Model (1)

The contour shows that the LEB of developed countries (Japan and China) has a high LEB value in red, while developing countries (Indonesia and Malaysia) have a low LEB value compared to

developed countries. Figure 3 and the analysis results in table 2 where the coefficient of the PM2.5 parameter is negative, namely (-0.20508) which shows that there is a negative relationship between PM2.5 and LEB, which means the lower the PM2.5 the higher the LEB or in other words the higher environmentally healthy LEB is getting higher. This is also shown from the analysis results presented in Figure 4 below.

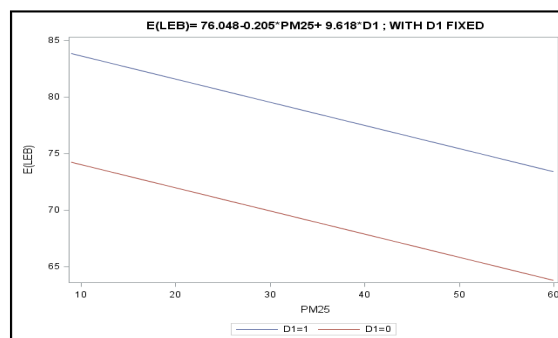


Figure 4: Comparison of LEB between developed countries (China and Japan) and developing countries (Indonesia and Malaysia)

Figure 4 confirms the results of the analysis above that there is a negative relationship between LEB and PM2.5 in the four countries discussed in this research, namely the lower the PM2.5 conditions, the higher the LEB value, which means a healthy environment will cause high LEB.

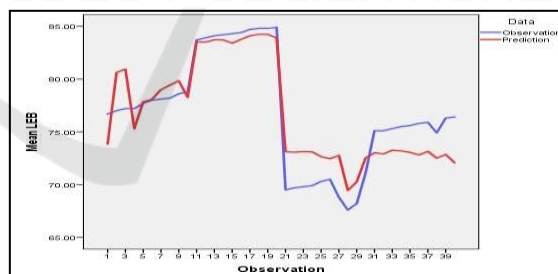


Figure 5: Observed and predicted LEB values by using model 1

Figure 5 shows that the observed and predicted LEB values have the same pattern and are relatively close to each other, this shows that the modeling used is quite good.

5 CONCLUSION

Research on the relationship between environmental conditions (PM2.5) and LEB has attracted many

researchers in the health sector. In this research, the relationship between LEB and PM_{2.5} between developed countries (China and Japan) and developing countries (Indonesia and Malaysia) in Asia is discussed using multiple regression analysis with dummy variables. The results show that the model is significant. The relationship between LEB and PM_{2.5} with data from 2014 to 2023 shows a negative relationship, this shows that the healthier the environment, the higher a country's LEB.

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