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AIR MALAYSIA POLLUTION INDEX GENERATION BY USING FUZZY LOGIC AIR QUALITY INDEX (FLAQI) SYSTEM

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ABSTRACT

Air pollution refers to the release of pollutant into the air that is detrimental to human health and the planet. In Malaysia, air pollution index was generated by the Air Pollution Index in Malaysia (APIMS) under the Department of Environment (DOE). This study aims to analyze air pollution in Malaysia by using fuzzy logic to determine the performance of Fuzzy Logic Air Quality Index (FLAQI) by comparing the value with the APIMS. The method used in this system is a fuzzy logic system. This method is preferred since it is user-friendly, and the rules set up are from the hierarchical fuzzy systems. Besides, the membership of each input and output is entered in the MATLAB software to generate the output of FLAQI based on parameters (suspended specific matter of less than 25 microns in size 5, ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and suspended particular matter of less than 10 microns) and the IF-THEN rules. 362 data have been analyzed and compared to the actual data from DOE. Therefore, the fuzzy logic approach can generate the air pollution index as it shows 82.32% of accuracy between actual data with the output of FLAQI.

1. Introduction

Lately, there has been much news about wildlife fires and the increasing number of forest burning. New York Times (2019) highlighted the forest burning worldwide, such as fire burning in Amazon, Indonesia, and Siberia. National Institute for Space Research (INPE) has released data showing an increased of 80 percent in fire burning in the Brazilian Amazon than last year

(Alejandra, 2019). It is about 76,000 fire burning cases. Since this issue is an international crisis, it will worsen the environment and spreads to other places that people will see, raising fear and causes climate change. The percentage of fire burning stated by INPE shows that 80 percent of fire burning makes the environment worse and will affect the human's health. Even more, satellite shows that the intensity of burning will increase due to upcoming dry season months.

According to New York Times (2019), the forest in South Kalimantan, Indonesia, was burned due to the hot weather that causes the forest fires to abruptly and rapidly spreads due to dead and dry plants. This stimulates and speeds up forest fires and causing a haze in Malaysia, Singapore, and Indonesia. The haze reaches some parts of Malaysia, such as Putrajaya. Certain areas were required to be closed as the air quality index from the Air Pollution Index of Malaysia (APIMS) is unhealthy, and the index value hits 200.

According to the Cambridge Dictionary, air pollution is a harmful substance in the air, often containing waste. In other words, air pollution is a combination of molecules solid and gases that can reach detrimental concentrations of the suspended specific matter of less than 25 microns in size ($PM_{2.5}$), ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and suspended specific matter of less than 10 microns in size (PM_{10}), volatile organic compounds (VOCs) and toxins in the air. Most of the pollutants are human made, but some of them are due to natural causes such as volcanic eruptions

Indirectly, air pollution will cause respiratory diseases, cardiovascular diseases, adverse pregnancy outcomes, and even death. World Health Organization (WHO) stated that the number of deaths in 2014 reached up to 7 million, caused by air pollution.

In Malaysia, APIMS released the result of the air quality index every hour on a daily basis which will inform people about the air quality based on their respective places. It will make them alert on their surrounding areas and prepare them for what they need to do when the air quality classification reaches moderate, unhealthy, very unhealthy, or hazardous level. Besides using the conventional method used by APIMS, the researcher wants to find out other methods used compared to conventional methods that can be utilized to determine the air pollution index proposed in this study, namely, fuzzy logic. This method will produce an accurate value the same as the value provided by APIMS. Thus, this study was proposed to analyze air pollution in Malaysia by using fuzzy logic and to determine the performance of the Fuzzy Logic Air Quality Index (FLAQI) by comparing the value with the Air Pollution Index of Malaysia (APIMS).

2. Literature Review

According to the report, the use of atmospheric, Sager. L (2019) has researched air pollution, such as the impact of air pollution on road safety. Parham, Hossein, and Behnaz (2017) researched the analysis of an air pollution monitoring network in Tehran, Iran, to produce maps of urban air pollution. Whanhee et al.(2019) have been researched mortality air pollution in North-East Asia.

Meanwhile, Koo et al.(2020) have compared several models such as the artificial neural networks (ANN), autoregressive integrated moving average (ARIMA), trigonometric regressors, Box-cox transformation, ARMA errors, trend and seasonality (TBATS), and several fuzzy time series (FTS) to predict the air pollution index (API) of Kuala Lumpur, Malaysia. They found that the fuzzy time series model is the most effective model to forecast API values in the accuracy of forecasted values and computation time.

Fuzzy logic is an extension of Boolean Logic or Binary classical logic. It is valuable and flexible because it can present the view of a degree in confirming a condition in which the condition can be in a stated other than true or false. According to Feng (2010), to formalize human reasoning, the advantage of fuzzy logic is that the rules are set in the natural language.

Fuzzy logic has a major impact on the researchers as it could uncertainly govern multiple types. In modifying the unknown variable, Fuzzy logic used the appropriate parameter. So, it could easily change the question. Gurrea, Alfaro-saiz, J., Rodriguez, R., and Verdecho (2014) said that many difficulties could be handled because it is multivariate, it is practically permitted.

Fuzzy logic is rationally applied and provides the basis for uncertainty, which considers how people think and process reasoning and reception (Bai Varadharajan, Bai, Raman & Bouwmeester, and Reiner, 2009). Fuzzy logic is an effective method that could address the environmental policy problem, such as interpretation ambiguity, confusion, inaccuracy in parameters, and indirectness of the validity of decisions.

3. Research Methodology

Data that have been used in this study is secondary data. This data will be collected from January 2018 until December 2018. The data is the daily data from the Department of Environment (DOE). In Malaysia, the researcher will focus on six parameters of the study, which are suspended specific matter of less than 25 microns in size ($PM_{2.5}$), ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and suspended specific matter of less than 10 microns in size (PM_{10}), which DOE has set.

Based on this study, the researcher will apply the Fuzzy Logic Air Quality Index (FLAQI) to analyze air pollution in Malaysia and determine its quality. To complete this analysis, the researcher will first define the air quality membership function using a simple configuration of a fuzzy system, as shown in Figure 1.

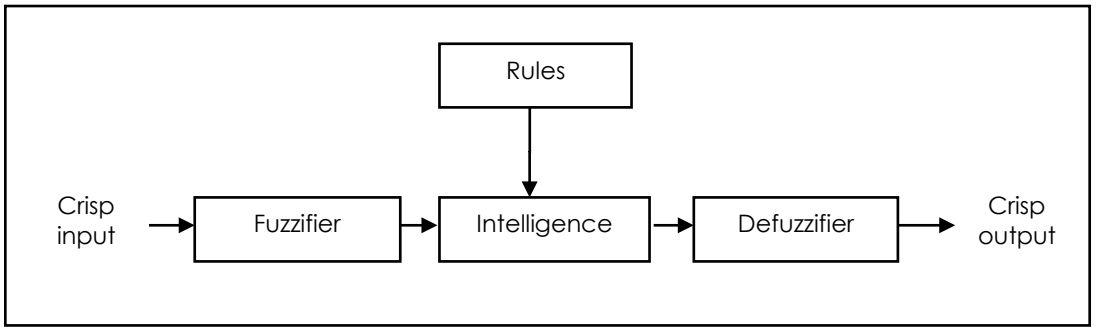

Figure 1: Fuzzy Logic System

Fuzzification is the first step in a fuzzy system. Fuzzification is the method of translating or transforming the input of the value of the crips into a fuzzy quantity of membership structure in the range of zero to one according to the six inputs parameters, suspended specific matter of less than 25 microns in size ($PM_{2.5}$), ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and suspended specific matter of less than 10 microns in size (PM_{10}).

Linguistic variables and the value of membership are also contained in the fuzzy sets. According to the Air Pollution Index of Malaysia (APIMS), air quality is divided into six categories which are good, moderate, unhealthy for the sensitive group, unhealthy, very unhealthy, and hazardous. Linguistic variables are variable if words can be taken as its values in natural languages in which words are characterized by a fuzzy set that is defined in the universe of discourse where the variable is defined. In contrast, a fuzzy set membership function is a set that is mapped continuously to a membership value between zero and one that is defined by the element in the universe of discourse. The membership function's value represented the degree of the membership or the degree of belongingness of an element x in a fuzzy set. The parameters and the corresponding linguistic degrees in the rules base are presented in Table 1.

Table 1: Parameter and the Corresponding Linguistic Variable

Parameter	Linguistic Variables
Suspended specific matter of less than 25 microns in size ($PM_{2.5}$)	{Good, Moderate, Unhealthy for Sensitive Group, Unhealthy, Very Unhealthy, Hazardous}
Ozone (O_3)	{Good, Moderate, Unhealthy for Sensitive Group, Unhealthy, Very Unhealthy, Hazardous}
Carbon monoxide (CO)	{Good, Moderate, Unhealthy for Sensitive Group, Unhealthy, Very Unhealthy, Hazardous}
Nitrogen dioxide (NO_2)	{Good, Moderate, Unhealthy for Sensitive Group, Unhealthy, Very Unhealthy, Hazardous}
Sulfur dioxide (SO_2)	{Good, Moderate, Unhealthy for Sensitive Group, Unhealthy, Very Unhealthy, Hazardous}
Suspended specific matter of less than 10 microns in size (PM_{10})	{Good, Moderate, Unhealthy for Sensitive Group, Unhealthy, Very Unhealthy, Hazardous}

In fuzzification, the Fuzzy Expert System (FES) structure is illustrated, and the membership function is defined for the input variables. The membership function defined on the input variables is applied to the input variables' actual values to determine the degree of truth for each rule. The following Figure 2 is the structure of FES.

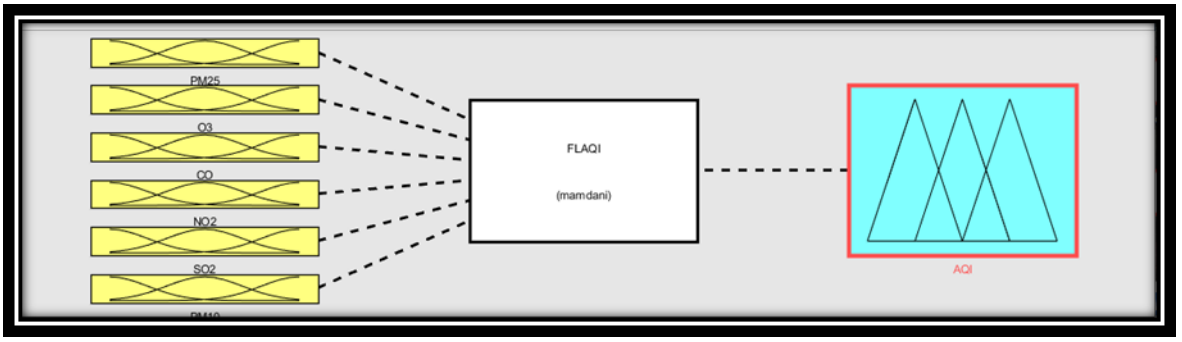

Figure 2: FES – Fuzzy Expert System

In order to form a fuzzy set, the membership value for each variable must be assigned in the interval of [0,1]. The trapezoidal function affiliation defines the membership function. Let *X* denotes the universe of discourse, where x represents an element of the universe, and *A* denotes a fuzzy set that characterized its membership function $\mu_A(x)$.

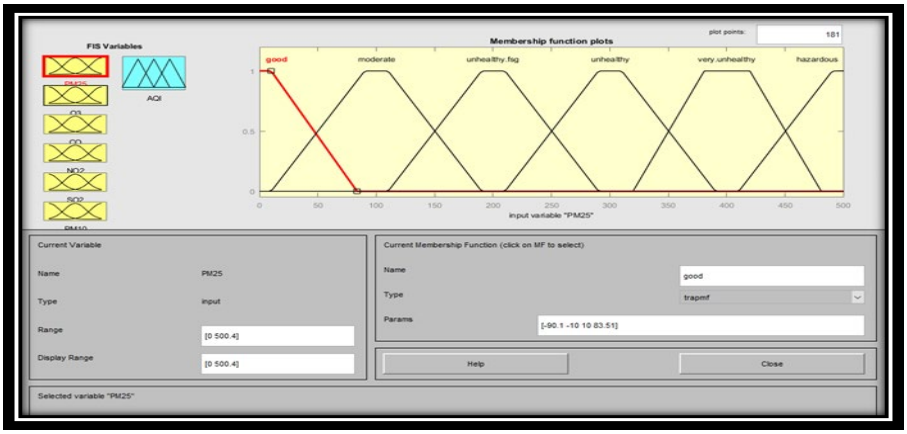

Figure 3: Membership Function of $PM_{2.5}$

Figure 3 shows the membership function obtained from the MATLAB for the input variable of $PM_{2.5}$, whereby the range is between 0 (µg/m3) to 500.4 (µg/m3). This input linguistic variables are good, moderate, unhealthy for a sensitive group, unhealthy, very unhealthy, and hazardous. The membership function of PM_{25} represented, as shown below:

Good

$$\mu(x) = \begin{cases} 0 & , \quad otherwise \\ 1 & , \quad 0 \leq x \leq 10 \\ \dfrac{90-x}{80} & , \quad 10 \leq x \leq 90 \end{cases}$$

Moderate

$$\mu(x) = \begin{cases} 0 & , \quad otherwise \\ \dfrac{x-10}{80} & , \quad 10 \leq x \leq 90 \\ 1 & , \quad 90 \leq x \leq 110 \\ \dfrac{190-x}{80} & , \quad 110 \leq x \leq 190 \end{cases}$$

Unhealthy for Sensitive Group

$$\mu(x) = \begin{cases} 0 & , \quad otherwise \\ \frac{x-110}{80} & , \quad 110 \leq x \leq 190 \\ 1 & , \quad 190 \leq x \leq 210 \\ \frac{290-x}{80} & , \quad 210 \leq x \leq 290 \end{cases}$$

Unhealthy

$$\mu(x) = \begin{cases} 0 & , \quad otherwise \\ \frac{x-210}{80} & , \quad 210 \leq x \leq 290 \\ 1 & , \quad 290 \leq x \leq 310 \\ \frac{390-x}{80} & , \quad 310 \leq x \leq 390 \end{cases}$$

Very Unhealthy

$$\mu(x) = \begin{cases} 0 & , \quad otherwise \\ \frac{x-310}{80} & , \quad 310 \leq x \leq 390 \\ 1 & , \quad 390 \leq x \leq 410 \\ \frac{490-x}{80} & , \quad 410 \leq x \leq 490 \end{cases}$$

Hazardous

$$\mu(x) = \begin{cases} 0 & , \quad otherwise \\ \frac{x-410}{80} & , \quad 410 \leq x \leq 490 \\ 1 & , \quad 490 \leq x \leq 500 \end{cases}$$

A rule-based system or an expert system is a collection that uses "if-then" statements based on the assumptions and the inference to be easily understood. It also governs how to act on the claims made. According to this study, there are six criteria to be measured, suspended air quality of less than 25 microns ($PM_{2.5}$), ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and suspended air quality of less than 10 microns (PM_{10}).

The two most popular fuzzy techniques used are max-min inference and max-product inference. In the inference sub-process, the truth-value for each rule's premises is computed, and the conclusion is applied to each part of the rule. Every rule will be assigned to each output variable as the fuzzy subset.

There are three types of fuzzy inference mechanisms: Mamdani, Sugeno, and Tsukamoto fuzzy model. The Mamdani used in this study, as the obtained output, will be in the fuzzy set. The

composition-based inference is when all fuzzy subsets assigned to each output variable are combined from a single fuzzy subset to each output variable. IF-THEN rule is the structure of the fuzzy rule base.

36 rules are generated by using Mamdani IF-THEN Rules. The following Table 2 depicts the several rules constructed and ways to set up the linguistic variables in each of the variables to create the Mamdani IF-THEN Rules.

Table 2: The Arrangement of the Linguistic Variable for each Variable

Input Variable						Output
$PM_{2.5}$	O_3	CO	NO_2	SO_2	PM_{10}	AQI
Good	Good	Good	Good	Good	Good	Good
Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Unhealthy for sensitive group	Unhealthy for sensitive group	Unhealthy for sensitive group	Unhealthy for sensitive group	Unhealthy for sensitive group	Unhealthy for sensitive group	Unhealthy for sensitive group
Unhealthy	Unhealthy	Unhealthy	Unhealthy	Unhealthy	Unhealthy	Unhealthy
Very unhealthy	Very unhealthy	Very unhealthy	Very unhealthy	Very unhealthy	Very unhealthy	Very unhealthy
Hazardous	Hazardous	Hazardous	Hazardous	Hazardous	Hazardous	Hazardous

Hence the rules constructed are "If the $PM_{2.5}$ is good and O_3 is good, and CO is good, and NO_2 is good, and SO_2 is good, and PM_{10} is good, then the AQI is good".

The last step in the fuzzy system is defuzzification. Defuzzification is a process of converting the output of a fuzzy set to a crisp set. Some methods can be applied as the defuzzifying method: Weight Average Method, Centroid Method, or the Center of Gravity, Height Method, and Middle of Maxima Method. But, the most common method used is the Centroid Method.

The centroid method's function is to rely on using the centre of gravity (COG) of the membership function to calculate the crisp value of the output variable. The formula of the Centroid Method is as follow:

$$x = \frac{\int x \cdot \mu(x) dx}{\int \mu(x) dx} \tag{3.1}$$

Where X is the defuzzified output, μ_x is a degree of membership, and x is the output variable.

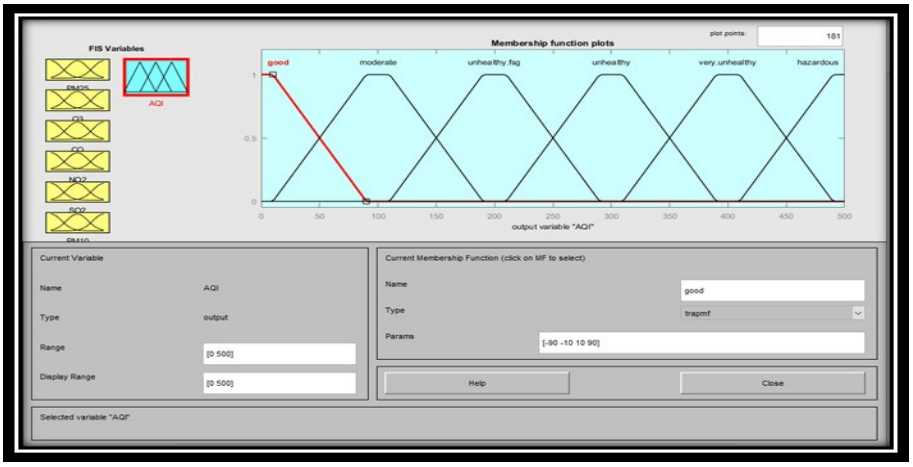

Figure 4: Membership Function of AQI

Figure 4 shows the membership function obtained from the MATLAB for the input variable of AQI, whereby the range is between 0 to 500. This input linguistic variables are good, moderate, unhealthy for a sensitive group, unhealthy, very unhealthy, and hazardous. The membership function of AQI represented, as shown below:

Good

$$\mu(x) = \begin{cases} 0, & otherwise \\ 1, & 0 \le x \le 10 \\ \frac{90-x}{80}, & 10 \le x \le 90 \end{cases}$$

Moderate

$$\mu(x) = \begin{cases} 0, & otherwise \\ \frac{x-10}{80}, & 10 \le x \le 90 \\ 1, & 90 \le x \le 110 \\ \frac{190-x}{80}, & 110 \le x \le 190 \end{cases}$$

Unhealthy for Sensitive Group

$$\mu(x) = \begin{cases} 0, & otherwise \\ \frac{x-110}{80}, & 110 \le x \le 190 \\ 1, & 190 \le x \le 210 \\ \frac{290-x}{80}, & 210 \le x \le 290 \end{cases}$$

Unhealthy

$$\mu(x) = \begin{cases} 0, & otherwise \\ \frac{x-210}{80}, & 210 \leq x \leq 290 \\ 1, & 290 \leq x \leq 310 \\ \frac{390-x}{80}, & 310 \leq x \leq 390 \end{cases}$$

Very Unhealthy

$$\mu(x) = \begin{cases} 0, & otherwise \\ \frac{x-310}{80}, & 310 \leq x \leq 390 \\ 1, & 390 \leq x \leq 410 \\ \frac{490-x}{80}, & 410 \leq x \leq 490 \end{cases}$$

Hazardous

$$\mu(x) = \begin{cases} 0, & otherwise \\ \frac{490-x}{80}, & 410 \leq x \leq 490 \\ 1, & 490 \leq x \leq 500 \end{cases}$$

Figure 5: Output of the Air Quality Index from MATLAB

Based on Figure 5, the air quality index's membership function is used to find out the centroid value of the grade manually, as the value of MATLAB output. Based on the output that was generated from MATLAB, it explained if the suspended specific matter of less than 25 microns in size ($PM_{2.5}$) is 250 μg/m^3, ozone (O_3) is 0.252 ppm, carbon monoxide (CO) is 20.2 ppm, nitrogen dioxide (NO_2) is 402 ppm, sulfur dioxide (SO_2) is 402 ppm and suspended specific matter of less than 10 microns in size (PM_{10}) is 252 μg/m^3, the predicted value for air quality index is 250 which is AQI in group unhealthy.

Table 3 shows the Air Pollutant Index (API) index classification and the effect on health.

Table 3: Classification of Air Pollution Index (DOE, 2017)

API	Status	Health Effect
0-50	Good	Low pollution without any bad effect on health.
51-100	Moderate	Moderate pollution does not pose any bad effect on health.
101-200	Unhealthy for sensitive group	Worsen the health condition for the elderly, pregnant women, children and people with heart and lung complications.
201-300	Unhealthy	Worsen the health condition and low tolerance of physical exercises to people with heart and lung complications.
301-400	Very unhealthy	Affect public health and worsen health.
401-500	Hazardous	Hazardous to risk people and public health

4. Results and Discussion

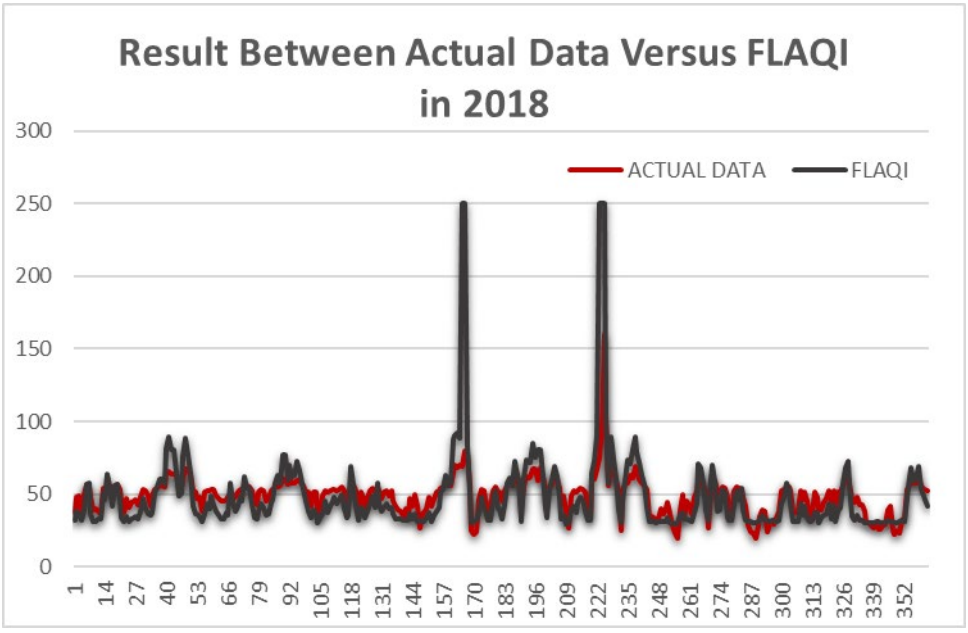

Figure 6: Graph of Result Between Actual Data Versus FLAQI in 2018

Table 4: Value of MSE, RMSE and MAPE

MSE	0.1768
RMSE	0.4205
MAPE	0.0393

Figure 6 shows the result between the actual data from APIMS and FLAQI from MATLAB output. Based on the result, minor differences in the output, which is 91 out of 362 data, is not parallel to the actual data from APIMS. The value for Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) is 0.1768, 0.4205, and 0.0393, as shown in Table 4. The result that was obtained by using the fuzzy logic system indicates that there is a 17.68 % error for MSE, and it can consider as small. This method shows that this method, the Fuzzy Logic Air Quality Index (FLAQI), is suitable for generating the Air pollution index's value by APIMS.

5. Conclusion

In conclusion, the best way to generate the Fuzzy Logic Air Quality Index (FLAQI) result is by using the Mamdani Fuzzy Inference System. This study is more focused on determining the performance of FLAQI by comparing the value with the Air Pollution Index of Malaysia (APIMS). The parameters used in this study are suspended specific matter of less than 25 microns in size ($PM_{2.5}$), ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and suspended specific matter of less than 10 microns in size (PM_{10}). According to the parameters, there are 36 rules constructed by using Mamdani IF-THEN rules. All the rules were used to determine the performance and value of FLAQI. The result obtained using the fuzzy logic system indicates a 17.68 % error (MSE), and it can be considered small. Since the value of MSE is small, it shows that the method Fuzzy Logic Air Quality Index (FLAQI) is suitable for generating the value for air pollution index by APIMS. Therefore, fuzzy logic approach can be used to generated the air pollution index as it shows 82.32% of accuracy between actual data with the output of FLAQI.

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References

Alejandra Borunda. (2019). Deforestation Rates Across the Amazon have Spiked This Year, Driving the Devastating Blazes. *National geography,* from *(*https://www.nationalgeographic.com/environment/2019/08/amazon-fires-cause-deforestation-graphic-map/*)*.

Bai Varadharajan, raman, Bai, raman V, & Bouwmeester, Reinier. (2009). Fuzzy Logic Water Quality Index and Importance of Water Quality Parameters. *Air, Soil and Water Research*, 2, 51-59.

Department of Enviroment, Air Pollution Index In Malaysia from (http://apims.doe.gov.my/)

Feng, G. (2010). Introduction to Fuzzy Logic Control, *20102151*(January), 1-12.

Gurrea, V., Alfaro-saiz, J., Rodriguez, R., & Verdecho, M. (2014). Application of Fuzzy Logic in Performance Management : a literature review. *International Journal of Production Management and Engineering.* 2, 93-100.

Koo, J.W., Wong, S.W., Selvachandran, G., Long, H.V., & Son, L. (2020). Prediction of Air Pollution Index in Kuala Lumpur using fuzzy time series and statistical models. *Air Quality, Atmosphere & Health, 13*, 77-88.

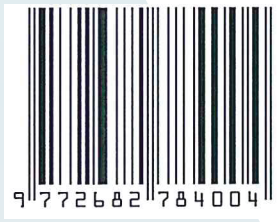
New York Times. (2019, September 01). The Amazon, Indonesia, Siberia: A World on Fire. *New Straits Times,* from *(*https://www.nst.com.my/world/2019/09/517867/amazon-indonesia-siberia-world-fire)

Official Portal of Department of Enviroment (2017), Ministry of Enviroment and Water of Malaysia, from (https://www.doe.gov.my/)

Parham Pahlavani, Hossein Sheikhian & Behnaz Bigdeli. (2017). Assessment of an Air Pollution Monitoring Network to Generate Urban Air Pollution Maps Using Shannon Information Index, Fuzzy Overlay and Dempster-Shafer Theory, A Case Study : Tehran, Iran. *Atmospheric Enviroment.* 167 (2017) 254-260.

Sager L. (2019). Estimating the effect of air pollution on road safety using atmospheric temperature inversion. *Journal of Enviroment Economics and management.* 98 (2019) 102250.

Whanhee Lee, Hayon Michelle Choi, Dahye Kim, Yasushi Honda, Yue-Liang Leon Guo, Ho Kim. (2019). Synergic Effect Between High Temperature and Air Pollution on Mortality in Northeast Asia. *Enviroment Research* 178 (2019) 108735.



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