Study of noise level at Raja Haji Fisabilillah airport in Tanjung Pinang, Riau Islands

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Abstract. Raja Haji Fisabilillah International Airport is a central airport located in Kampung Mekarsari, Pinang Kencana District, Tanjung Pinang City, Riau Islands Province. The aims of this study are to determine noise level at the airport and to calculate noise index using WECPNL (Weighted Equivalent Continuous Perceived Noise Level) method. The method using recommendations from the International Civil Aviation Organization (ICAO), the measurement point is based on at a distance of 300 meters parallel to the runway, as well as 1000 meters, 2000 meters, 3000 meters and 4000 meters from the runway end. The results at point 3 was 75.30 dB(A). Based on the noise intensity result, Boeing aircraft 737-500 was considered as the highest in the airport surrounding area, which is 95.24 dB(A) and the lowest was at point 12 with a value of 37.24 dB(A). Mapping contour shows that 3 areas of noise and point 3 with 75.30 dB(A) were considered as second level area and were complied to the standard required.

Keywords: noise level airport, noise contour WECPNL method

1. Introduction
The plane is one of the most popular modes of transportation today. The shortest reachable distance and the facilities offered also make the plane into one of the alternatives transportation at this time. The airport is a gateway to connect economic centres, tourist areas, and government centres [1]. Activities in the airport area, among others, is the administrative activities of the airport management headquarters Raja Haji Fisabilillah PT. Angkasa Pura II, activities around the runway in the form of fire stations, shuttle passengers from the terminal to the plane, delivery facilities passenger plane and take off and the landing of the aircraft.

The noise is the physical environmental factors that can disrupt the work or activity in both in terms of health with high noise levels for workers who are exposed to such noise exposure. Humans who received the noise in lasts for long time, it should be controlled or prevented [2], [3], [4]. Noise with a high enough level above 70 dB can cause anxiety, discomfort, hearing problems and narrowing of blood vessels. If, the noise level above 80 dB can lead to serious deterioration in a person's health in general and if it lasts long may cause temporary or permanent loss of hearing [5], [6].

2. Research Method

2.1. Time and Location
The study was conducted in October–November 2016, sampling data was conducted every 14 hours/day in runway and settlements around the airport.
2.2. Data collection

The primary data obtained in the field by measured the noise using the Sound Level Meter for 14 hours during 07.00 am - 21.00 pm. Data was collected when activities the aircraft as take off and landing. Meanwhile, the secondary data collected include frequency data of aircraft movement, type of aircraft, layout of airport and total data of passengers in 2015-2016 coming from Raja Haji Fisabilillah Airport management agency, Tanjung Pinang. The flight schedule show in Table 1.

| No. | Name of Airlines | Departure Schedule | Arrival Schedule |
|-----|------------------|---------------------|------------------|
| 1   | Garuda Indonesia | 12:10               | 13:20            |
| 2   | Lion Air         | 10:00               | 10:35            |
| 3   | Nam Air          | 19:00               | 07:00            |

2.3. Noise measuring point

The measurement point is based on recommendations from the International Civil Aviation Organization (ICAO) [8] at a distance of 300 meters parallel to the runway, as well as 1000 meters, 2000 meters, 3000 meters and 4000 meters from the runway end. In detail the location of the measurement point show in Table 2.

| No. | Sampling Points Location                             | Distance from Runway (m) | Coordinate                  |
|-----|-----------------------------------------------------|--------------------------|------------------------------|
| 1   | Tower ATC Raja Haji Fisabilillah Airport            | 300                      | 0°55’12.74”N;               |
|     |                                                     |                          | 104°31’39.74”E              |
| 2   | Airport surveillance radar AIR NAV Raja Haji Fisabilillah airport | 300                      | 0°55’28.08”N;               |
|     |                                                     |                          | 104°31’53.28”E              |
| 3   | Runway-22 at Raja Haji Fisabilillah Airport         | 300                      | 0°55’40.87”N;               |
|     |                                                     |                          | 104°32’05.26”E              |
| 4   | at Rajawali street, Kampung Sumber Rejo, Kelurahan Pinang Kencana | 300                      | 0°55’31.90”N;               |
|     |                                                     |                          | 104°32’15.33”E              |
| 5   | at Rajawali street, Kampung SumberRejo Kelurahan Pinang Kencana | 300                      | 0°55’17.48”N;               |
|     |                                                     |                          | 104°32’02.86”E              |
| 6   | at Rajawali, Kampung Sumber Rejo Kelurahan Pinang Kencana | 300                      | 0°55’01.88”N;               |
|     |                                                     |                          | 104°31’50.05”E              |
| 7   | at Merpati street, Kampung Sidojadi, Kelurahan Batu IX | 1000                     | 0°54’31.24”N;               |
|     |                                                     |                          | 104°31’10.29”E              |
| 8   | at Radar street, Kampung Bangun Rejo, Kelurahan Batu IX | 2000                     | 0°54’12.94”N;               |
|     |                                                     |                          | 104°30’52.55”E              |
| 9   | at Karya street, Kampung Sido Jasa, Kelurahan Batu IX | 3000                     | 0°53’48.38”N;               |
|     |                                                     |                          | 104°30’31.19”E              |
| 10  | at Garuda street, Kelurahan Batu IX                 | 4000                     | 0°53’31.86”N;               |
|     |                                                     |                          | 104°30’12.99”E              |
| 11  | Obstacle Runway-22                                  | 750                      | 0°56’05.28”N;               |
|     |                                                     |                          | 104°32’38.74”E              |
| 12  | at Tirta Madu street, Kelurahan Batu XIV            | 2500                     | 0°56’25.39”N;               |
|     |                                                     |                          | 104°32’55.46”E              |

2.4. Noise measurement method

The noise level at Raja Haji Fisabilillah Airport was measured using Sound Level Meter (SLM). Measurements were conducted using a tripod with a height of 1.20 meters from ground. Data were taken when the plane movement that landing and take off. The instrument was used show in Table 3.
Table 3. Measuring equipment.

| No | Equipment               | Figure | Function                                                                 |
|----|-------------------------|--------|--------------------------------------------------------------------------|
| 1  | Sound Level Meter (SLM) | ![Sound Level Meter](image) | Measure the level of sound violence or to search for a sound source       |
| 2  | Tripod                  | ![Tripod](image)           | to lay a sound level meter                                              |
| 3  | GPS                     | ![GPS](image)              | To determine the coordinates of the sampling point                      |

2.5. Method of calculating the noise index at the airport

Noise calculation used by Weightened Continuous Perceived Noise Level (WECPNL) method. This method is based on the standards of the International Civil Aviation Organization (ICAO).

\[
\overline{dB(A)} = 10 \log \left[ \frac{L_1}{10^{\text{L}_1/10}} + \frac{L_2}{10^{\text{L}_2/10}} + \frac{L_3}{10^{\text{L}_3/10}} + \ldots + \frac{L_n}{10^{\text{L}_n/10}} \right] \quad (1)
\]

Description:
\( \overline{dB(A)} \): Average Noise Intensity
\( L \) : The Noise Value at the Time of plane activities
\( N \) : Number of Aircraft

After obtained the noise intensity value of the plane from each point, then the calculation to measure the noise index at the airport is formulated in the following equation:

\[
\text{WECPNL} = \overline{dB(A)} + 10 \log N - 27 \quad (2)
\]

Description:
\( N \) : Number of arrivals and departures in 24 hours
\( \overline{dB(A)} \) : Average Noise Intensity

3. Results and Discussion

3.1. The Noise Intensity

In Table 4 shows that the highest noise intensity is at point 3 and 4. This is due to the 3 and 4 points are the starting point of the aircraft take off.
Table 4. Maximum and minimum noise measurement results by distance.

| No | Sampling Points Location                                           | Distance from Runway (m) | Noise Level dB(A) | Min | Max |
|----|-------------------------------------------------------------------|--------------------------|-------------------|-----|-----|
| 1  | Tower ATC Raja Haji Fisabilillah Airport                          | 300                      | 89.42             | 90.60 |
| 2  | Airport surveillance radar AIR NAV Raja Haji Fisabilillah airport| 300                      | 91.97             | 93.20 |
| 3  | Runway-22 at Raja Haji Fisabilillah Airport                       | 300                      | 93.80             | 95.24 |
| 4  | at Rajawali street, Kampung Sumber Rejo, Kelurahan Pinang Kencana| 300                      | 82.90             | 88.50 |
| 5  | at Rajawali street, Kampung Sumber Rejo Kelurahan Pinang Kencana | 300                      | 81.50             | 86.20 |
| 6  | at Rajawali, Kampung Sumber Rejo Kelurahan Pinang Kencana        | 300                      | 78.39             | 81.61 |
| 7  | at Merpati street, Kampung Sidojadi, Kelurahan Batu IX           | 1000                     | 88.16             | 89.20 |
| 8  | at Radar street, Kampung Bangun Rejo, Kelurahan Batu IX          | 2000                     | 88.76             | 93.43 |
| 9  | at Karya street, Kampung Sido Jasa, Kelurahan Batu IX            | 3000                     | 79.39             | 86.37 |
| 10 | at Garuda street, Kelurahan Batu IX                              | 4000                     | 78.12             | 84.65 |
| 11 | **Obstacle Runway-22**                                           | 750                      | 43.06             | 47.77 |
| 12 | at Tirta Madu street, Kelurahan Batu XIV                          | 2500                     | 37.24             | 41.82 |

Refer to Table 4, then can determined the intensity of each plane noise at all sampling point. Following the noise intensity of the plane at a distance can be seen in Table 5.

Table 5. Table aircraft noise intensity of each point.

| No | Aircraft Noise intensity of each point dB(A) |
|----|--------------------------------------------|
|    | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1  | 90.60 | 93.19 | 95.24 | 88.50 | 86.20 | 81.61 | 88.56 | 93.43 | 79.39 | 79.16 | 47.77 | 41.82 |
| 2  | 90.10 | 92.16 | 94.35 | 82.90 | 84.11 | 80.30 | 89.20 | 88.76 | 84.53 | 84.65 | 42.91 | 38.76 |
| 3  | 89.42 | 91.97 | 93.80 | 86.73 | 81.50 | 78.39 | 88.16 | 90.83 | 86.37 | 78.12 | 43.06 | 37.24 |

3.2. Average noise intensity

Raja Haji Fisabilillah Tanjungpinang Airport can serve the arrival and departure using Boeing Aircraft approximately 6 times a day. The intensity of noise generated by 3 aircraft units has an average intensity value at all sampling points. So, at each point it has the average noise intensity generated by all types of aircraft. The following Table 6 shows the intensity of the aircraft noise, the highest average noise intensity is at point 3 and 4 which is the initial position of the aircraft to take off. More over, the lowess noise intensity obtained at obstacle runway-22 area and Tirta Madu Street where no activity take off and landing around there. The take off and landing only at one way of the runway.

3.3. The WECPNL index (ICAO)

The frequency of flights in one day occurred between the hours of 07:00 to 21:00. At the time of the study obtained the number of aircraft movements (N) in one day (14 hours). Total N that uses runways is 6 movements within 14 hours, be it commercial aircraft or cargo planes. The assumption of any aircraft movement exposes the noise for 60 seconds based on each aircraft’s movement per day at each point. The following Table 7 show the The highest WECPNL index [9] where the highest WECPNL index obtained at Obstacle runway and Tirta Madu street that the area not influence the aircraft activity.
Tabel 6. Average noise intensity.

| No.  | Sampling Points Location                        | Distance from Runway (m) | dB(A)  |
|------|-------------------------------------------------|--------------------------|--------|
| 1    | Tower ATC Raja Haji Fisabilillah Airport       | 300                      | 90.10  |
| 2    | Airport surveillance radar AIR NAV Raja Haji Fisabilillah Airport | 300 | 92.47  |
| 3    | Runway-22 at Raja Haji Fisabilillah Airport   | 300                      | 94.50  |
| 4    | at Rajawali street, Kampung Sumber Rejo, Kelurahan Pinang Kencana | 300 | 86.61  |
| 5    | at Rajawali street, Kampung Sumber Rejo Kelurahan Pinang Kencana | 300 | 84.34  |
| 6    | at Rajawali, Kampung Sumber Rejo Kelurahan Pinang Kencana | 300 | 80.30  |
| 7    | at Merpati street, Kampung Sidojadi, Kelurahan Batu IX | 1000 | 88.66  |
| 8    | at Radar street, Kampung Bangun Rejo, Kelurahan Batu IX | 2000 | 91.43  |
| 9    | at Karya street, Kampung Sido Jasa, Kelurahan Batu IX | 3000 | 84.28  |
| 10   | at Garuda street, Kelurahan Batu IX            | 4000                     | 81.65  |
| 11   | **Obstacle** Runway-22                        | 750                      | 45.21  |
| 12   | at Tirta Madu street, Kelurahan Batu XIV       | 2500                     | 39.70  |

Tabel 7. WECPNL index (ICAO) at each location

| No.  | Sampling Points Location                        | Distance from Runway (m) | Noise dB(A) | WECPNL |
|------|-------------------------------------------------|--------------------------|-------------|--------|
|      | | | Min | Max | |
| 1    | Tower ATC Raja Haji Fisabilillah Airport       | 300                      | 89.42       | 90.60  | 70.90  |
| 2    | Airport surveillance radar AIR NAV Raja Haji Fisabilillah Airport | 300 | 91.97  | 93.19  | 73.25  |
| 3    | Runway-22 at Raja Haji Fisabilillah Airport   | 300                      | 93.80       | 95.24  | 75.30  |
| 4    | at Rajawali street, Kampung Sumber Rejo, Kelurahan Pinang Kencana | 300 | 82.90  | 88.50  | 67.42  |
| 5    | at Rajawali street, Kampung Sumber Rejo Kelurahan Pinang Kencana | 300 | 81.50  | 86.20  | 65.12  |
| 6    | at Rajawali, Kampung Sumber Rejo Kelurahan Pinang Kencana | 300 | 78.39  | 81.61  | 61.10  |
| 7    | at Merpati street, Kampung Sidojadi, Kelurahan Batu IX | 1000 | 88.16  | 89.20  | 69.44  |
| 8    | at Radar street, Kampung Bangun Rejo, Kelurahan Batu IX | 2000 | 88.76  | 93.43  | 72.21  |
| 9    | at Karya street, Kampung Sido Jasa, Kelurahan Batu IX | 3000 | 79.39  | 86.37  | 65.06  |
| 10   | at Garuda street, Kelurahan Batu IX            | 4000                     | 78.12       | 84.65  | 62.43  |
| 11   | **Obstacle** Runway-22                        | 750                      | 43.06       | 47.77  | 26.00  |
| 12   | at Tirta Madu street, Kelurahan Batu XIV       | 2500                     | 37.24       | 41.82  | 20.48  |

4. Conclusion
The highest noise intensity value is at point 3 which at this point is the start of the aircraft to take off. At this point the noise intensity is 90.6 dB (A). In the calculation of the average noise intensity and WECPNL index calculation the highest noise intensity is at point 3 where point 3 is the initial position of the aircraft to take off, but for residential areas outside the airport the noise intensity is not comply with the ministers of No. KM 48 2002.

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