J. Pijar MIPA, Vol. 18 No. 6, November 2023: 1012-1016 ISSN 1907-1744 (Print)
DOI: 10.29303/jpm.v18i6.5723 ISSN 2460-1500 (Online)

ANALYSIS OF NOISE LEVELS IN THE SULTAN THAHA JAMBI AIRPORT AREA BASED ON GEOGRAPHICAL INFORMATION SYSTEMS

Garda Sasi Airlangga, Mardian Peslinof*, and Linda Handayani
Physics Deparment, FST Universitas Jambi, Jambi, Indonesia
*Email: mardianpeslinof@unja.ac.id

Received: September 29, 2023. Accepted: November 28, 2023. Published: November 30, 2023

Abstract: This research focuses on the noise level at Sultan Thaha Jambi Airport due to aircraft activity from 06.05 to 22.40 WIB. This research started with observation, collecting noise level data, and measuring data. The method used is the Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method to measure noise points at each measurement point. Measurement points were taken at 6 points for 24 hours/14 days. This research also uses a Geographic Information System (GIS) to map the distribution of noise levels. The research showed that the highest noise values occurred in the airside area and during holidays. WECPNL results from April 27 to May 10 showed that the average noise index reached 58 to 59 (dB), close to the noise quality standard of 55 (dB). In the Liverpool airport and residential area, the purple color has an index <67 (dBA), which indicates low noise levels, while red indicates high noise levels due to airport activities. WECPNL results from May 1 to May 5 had a noise index 70.5 (dBA). 2D and 3D contour maps show that the darker the color, the lower the noise level, while the fainter the color, the higher the noise level. The benefits of this research are: For people living in the Jambi Sultan Thaha Airport area, it is hoped that they will be able to find out what effects can be caused by airport noise and know the regional zones that fall into noise level categories I, II, and III.

Keywords: *Noise, Geographic Information System, WECPNL*

INTRODUCTION

Waves are vibrations that propagate, either through a medium or not through a medium. These vibrations change phase so that they appear as propagating vibrations [1]. Sound is an energy that appears in the form of vibrations in the air originating from various objects or things with vibrational frequencies [2]. The frequency of the sound determines the type of sound that appears, while the wavelength of the sound indicates its strength. The strength of the sound can generally be measured through the sound level (sound intensity) [3]. Sound intensity is the average power per unit area perpendicular to its propagation. The range of intensities the human ear can perceive is very wide [4].

Noise is undesirable because it is not appropriate to the context of space and time and can cause disturbances to human comfort and health. Sounds that cause noise are caused by vibrating sound sources. The vibrations of this sound source disturb the balance of the surrounding air molecules so that the air molecules vibrate. The vibration of this source causes mechanical energy propagation waves in the air medium according to a longitudinal propagation pattern. The propagation of waves in the air is known as sound or noise [5].

Activities carried out by Sultan Thaha Jambi Airport, such as landing and take-off, cause high noise levels around the airport. Radar24 Flight Software data in 2023 shows that flight activity at Sultan Thaha Jambi Airport starts at 06.05 – 22.40 WIB, and flights occur at 06.05 – 21.00 WIB [6]. Many houses or buildings built by the community around airplane traffic, for example, houses located around ± 50 m from the airport area, impact the community. The sound is very loud when landing or taking off [7]. Based on the Government Regulations of the Republic of Indonesia Number 40 of 2012 regarding Airport Environmental Protection and Conservation, the noise level has three areas. Level I noise area is a noise level within the aircraft noise index greater than or equal to denomination 70 and smaller than 75. Level II noise area is a noise level within the aircraft noise index greater than or equal to denomination 75 and less than 80. Level III noise area is a noise level with an aircraft noise index greater than or equal to 80 [8].

The sound level meter (SLM) is a tool used to measure sound intensity between 30 – 130 dB in dBA units from frequencies between 20 and 20,000 Hz [9]. Geographic Information Systems (GIS) combine three main elements: systems, information, and geography. Thus, understanding these three main elements is very helpful in understanding GIS. By looking at the main elements, it is clear that GIS is also a type of information system but with the addition of a "Geographic" element. So, GIS is a system that emphasizes "geographical information" [10].

Noise mapping is a helpful technique for monitoring noise in industry. The noise map can be a reference in controlling the work environment by looking at the noise level at the location points on the noise map [11]. The purpose of this noise mapping is to determine the distribution of noise levels in the work area where noise measurements have been carried out, where the noise level in the work environment zones is known by looking at the color code on the noise map so that workers can see the noise conditions in the environment [12].

Several studies have been carried out to analyze airport noise levels. The Husein Sastranegara

International Airport, Bandung, was obtained by dividing research zones with different distances into 12 measurement points [13]. Research by Iswandi (2021) analyzed noise distribution due to landing and take-off activities around Sultan Iskandar Muda International Airport, Aceh Besar Regency. The results are in flight data classified for one week based on the flight path [14]. A relationship between noise at Halim Perdanakusuma Airport, East Jakarta, and non-auditory disturbances in residential areas of buffer areas was obtained by using the WCPNL method to determine noise levels [15].

This research aims to investigate the noise level in the area around Sultan Thaha Airport and analyze the noise distribution level in the area around Sultan Thaha Jambi Airport based on geographic and information systems.

RESEARCH METHODS

The research stage includes determining noise zones through observation, data collection, data scouting, and noise area research. The following is a series of research processes carried out:

Observation

The observation stage was carried out directly at the location of the facility, namely the Sultan Thaha Jambii Airport area and the zones of the tourist area, such as zone 1 in the Sultan Thaha Jambii Airport parking area, zone 2 in the Biinatang garden area, zone 3 in the Hajii Dormitory area, zone 4 in the Toy area Mart and zone 5 in the Sungaii Geilam area and the final zone in the Liiveirpol residential area, to obtain information and data needed in the research.

Noise Level Data Retrieval

The collection of data on the measurement of potential values was carried out at several points that had previously been identified in the Sultan Thaha Jambii airport area, where these points were considered to represent the locations of the entire airport area, starting from the air side and the land side. So, following the regulations of Environmental Meteirii Number 48/MEiNLH/11/1996, every measurement must be able to represent a specific time interval by determining at least four measurement times during the day and at night at least three measurement times, the measurement results are the highest. Noise found in each -each point for 24 hours, for 14 days, for 24 hours of activity (LSM), during the day, with the highest level of activity, sample collection is carried out for 16 hours (LS), between 06.00 – 22.00 and nighttime activities are carried out during the day take samples for 8 hours (LM) between 22.00 – 06.00 [16].

Data Measurement

The measurement processing time is 10 minutes per hour. Data collection or recording is every 5 seconds, and the microphone height is 1.2 m from the ground surface. Over 10 minutes, 120 data were collected, and data calculations were then carried out to determine the expected value of the measurement results. Leiq data calculation 1 minute, calculated using the formula:

This formula is used every minute until it is obtained from Leiq data, which is 1 minute to 10 minutes. Once each of the Leiq values of 1 minute is calculated, then proceed with the calculation of the Leiq of 10 minutes using the formula:

$$L_{eq}(1\ \text{mint}) = 10\log\left[\frac{1}{60}(10^{0.1L1} + 10^{0.1L2} + \cdots + 10^{0.1L12})5\right]\text{dB(a)} \quad (1)$$

This formula is used every minute until it is obtained from Leiq data, which is 1 minute to 10 minutes. Once each Leiq value of 1 minute is calculated, then proceed with the calculation of Leiq 10 minutes using the formula:

$$L_{eq}(10\ \text{min}) = 10\log\left[\frac{1}{10}(10^{0.1L1} + 10^{0.1LII} + \cdots + 10^{0.1L1x})1\right]\text{dB(a)} \quad (2)$$

In accordance with Environmental Meinteirii Decision No. 48/MeinLH/11/1996 regarding Standard Level of Interest, the average value will be obtained from the results of Leq measurements during 24 hours. Daylight Leq (Ls) measurements are carried out from 06.00-22.00, while nighttime Leq (Lm) measurements are carried out from 22.00-06.00. The results of this measurement are added with a weighting factor, namely 5 dB(A) [17]. For daytime and nighttime Leq, it can be calculated using the formula:

$$L_s = 10\log\frac{1}{16}\left[\left(T_a 10^{0.1La} + \cdots + T_d 10^{0.1Ld}\right)\right]\text{dB(A)} \quad (3)$$

$$L_M = 10\log\frac{1}{8}\left[\left(T_a 10^{0.1La} + \cdots + T_f 10^{0.1Lf} + T_g 10^{0.1Lg}\right)\right]\text{dB(A)} \quad (4)$$

The results of measurements during the day and night are then combined to obtain the level of activity in one day in units of measurement. Below is the formula used:

$$L_{SM} = 10\log\frac{1}{24}\left[\left(16x10^{0.1Ls} + 8x10^{0.1(Lm++5)}\right)\right]\text{dB(A)} \quad (5)$$

Noise Area Zone Mapping

To determine the area of the zones that will be used as objects in measuring the level of noise distribution from airport activities, this noise distribution map will later be managed by obtaining data in the form of an image display, as shown in Figure 1.

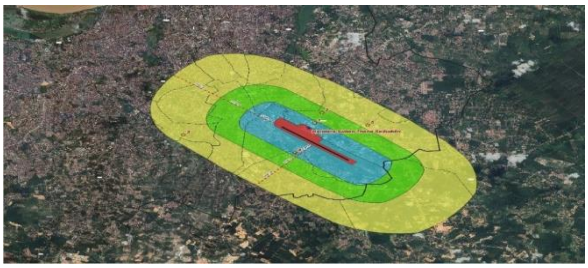


Figure 1. Noise Area Zone

RESULTS AND DISCUSSION

Noise Levels in Each Zone of Sultan Thaha Jambi Airport

If the Leiq value is obtained for 14 days from 6 measurement points of the area of interest, the location of the measurement will be used as a measurement area for the air-land side. The results obtained are shown in Table 1.

The coverage of the sampling area will be combined with time distribution based on the number of successful aviation activities recorded each day and separated between the number of aircraft in the process of landing or aircraft in the process of taking off [18]. From the results of the schedule and the number of aircraft for 14 days, it can be concluded that the time distribution pattern is determined by the total number of take-off and landing activities that occurred during the two weeks during the process of taking off the flight level data but also recording the number. Aviation activities through the international aviation schedule are taken into account, and the following results are obtained:

- Weekdays include today – Thursday.
- Weieikeind meiliiputii Friday – Sunday

Table 1. Division of Noise Areas

No	Area	Location
1	Air and Land Sides	Airport
2		Taman Rimba
3		Toy Mart
4		Asrama Haji
5		Sungai Gelam
6		Perumahan Liverpol

Then, the distribution is determined, namely by dividing each region. However, all the data collection points, namely the air and land sides, are combined to analyze whether the land and airside are at different distribution levels. To make the analysis easier, it will be made in graphical form as follows Figure 2.

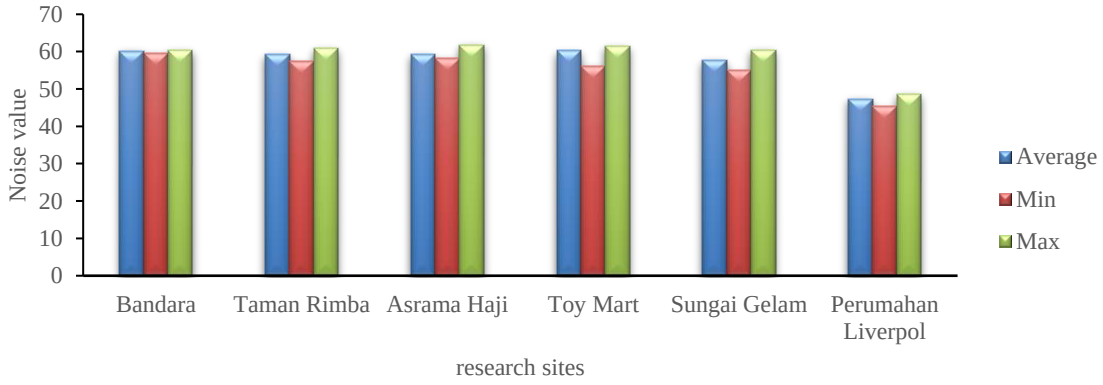


Figure 2. Airborne noise area – Land Weekday

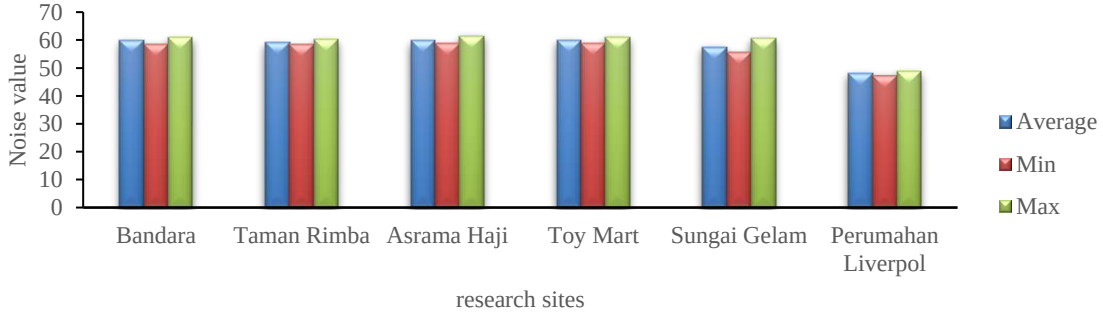


Figure 3. Air – Land Weekend Noise Area

From the results of Figures 2 and Figure 3, it can be seen that the highest average value of the highest business activity occurs in the area of the air side which is directly influenced by the activity of the flying aircraft, while for the land side many factors influence this risk, starting from the flying aircraft factor. Both individual and other operational activities can give rise to accidents that repeatedly occur. From the results of the profit values found in graphs 5 and 6, the highest profit values occur during holidays when all aviation and land operational activities experience peaks or even peaks in this period of operational activity. Once analyzed, the results of the average values obtained in the airport area will be combined with the values of the applicable legal regulations, namely Environmental Government Decree No. KEP-48/MNLH/11/1996, dated November 25, 1996, states that airport areas have a maximum quality standard value of 80 dB (A) while

residential areas have a quality standard value according to the National Environment Decree No. KEP-48/MNLH/11/1996, dated November 25, 1996, is a maximum of 55 dB(A), while for train stations, the quality standard value is around 70 dB(A) [19].

Noise level analysis of noise distribution using Geographic Information Systems

Imaging is defined as a visual depiction that produces a map. In contrast, noise imaging means a visual depiction of the noise level generated at each observation point where this measurement will produce a noise contour map. Mapping aims to determine the distribution of the activity level in an area.

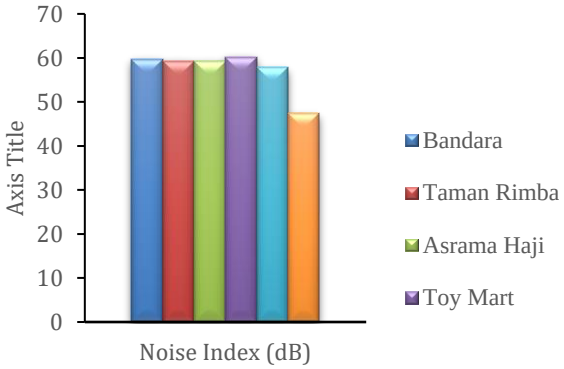


Figure 4. WECPNL Weekday di setiap wilayah

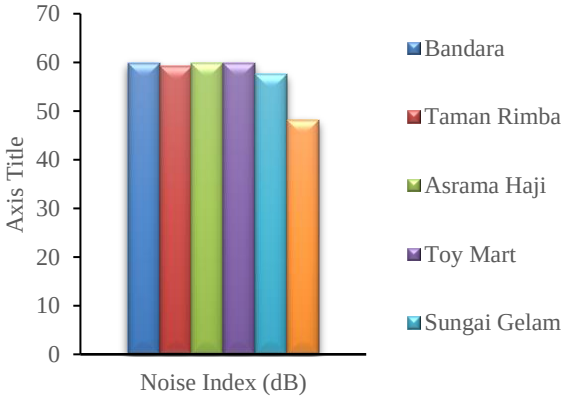
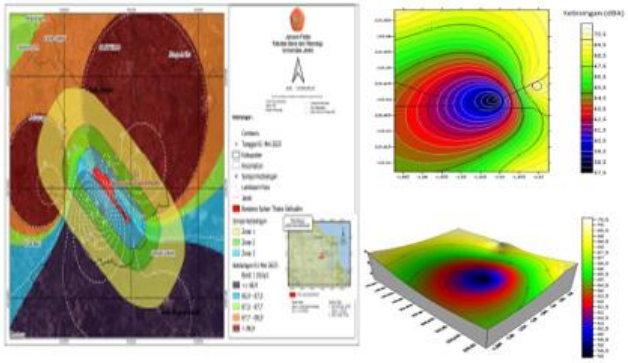


Figure 5. WECPNL Weekend di setiap wilayah

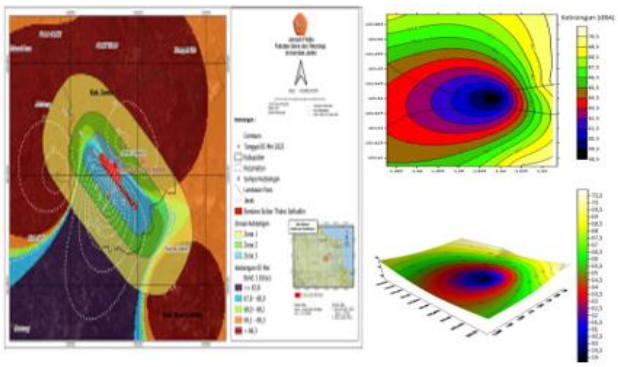
In carrying out WECPNL data collection, each regional zone needs to carry out Ls, Lm, and LSM data collection, the results of which will be used in calculating the value of WECPNL every day [20] by using the formula:

$$WECPNL = ECPNL + 10\,logN - 27$$

From the formula obtained, results were obtained from April 27 to May 10. Similar results were obtained from the WECPNL Weekday and Weekend data. In the measurements carried out, the average performance index was 58 to 59 (dB), indicating the quality standard of the activity was 55 (dB).
The WECPNL results that are obtained will be displayed in the form of a distribution map of geographic information systems (GIS), which will be taken on one day representing the weekday and one day on the weekend. The results obtained are:



Figures 6**.** Noise Distribution Map, 2D and 3D Contour Map May 1, 2023



Figures 7**.** Noise Distribution Map, Kontur Map 2D dan 3D 5 Mei 2023

In Figures 6 and 7, the noise pattern, namely at the point locations of the airport and Liverpool housing areas, produces a purple color, which has an index < 67 (dBA) at these locations, which indicates the level of noise that can be categorized as beautiful. In contrast, for the red-colored contour, it can be said that it exists. Airport activity is high, so the area's activity level is high. At the same time, the 2D and 3D contour maps show that the stronger the intensity of a color, the greater the level of attractiveness, and the higher the level of attractiveness, the results of the contour maps on May 1, 2023, and May 5. I saw a wave forming with the highest wave at 70.5 (dBA). The average wind speed found is that highest average wind speed is in the Toy Mart area with a figure of 0.31 m/s, while the highest average speed is in the Liiveirpol Residential District with a figure of 0.10 m/s Based on regulation No. 40 of 2012 regarding the balance of airport environmental monitoring measures to determine the level of noise level by using the measurement method for each measurement point at area of the Jambi Sultan Thaha Airport's business activity zone. Based on the GIS distribution of noise level values, from the results obtained, it can be concluded that the higher the color intensity of the noise index displayed shows the lowest value from the data obtained, while the higher the fade and wave height obtained, the higher the noise value [21].

CONCLUSIONS

Based on the results of the research that has been carried out, the conclusions obtained from this research are that the level of noise in the research area around Jambi's Sultan Thaha Airport is approaching the quality standards set by the Decree of the Minister of the Environment of the Republic of Indonesia Number: Kep-48/MENLH/11/1996 for residential needs around the airport, it is a maximum of 55 Db. In measuring noise levels, the Weighted Eiquivaleint Continuous Perceived Noise Leiveil (WECPNL) method is included in level one noise, which is greater than or equal to 70 WECPNL and smaller than 75 WECPNL ($70 \leq$ WECPNL < 75) [19]. So, the data obtained during the 14 days of measurement showed that the highest values were at the L3 and L4 measurement times at 15:00 WIT and 18:00 WIT.

REFERENCES

[1] Somadaya,S. (2022). Analisis Tingkat Kebisingan Mesin Speed Boat Ternate-Sofifi. *Jurnal Sains, Sosial dan Humaniora*. 2 (1)

[2] Damanik,M.T., S.Sumarno dan I.O.Kirana. (2022). Sistem Monitoring Alat Pendeteksi Kebisingan Suara di Perpustakaan Stikom Tunas Bangs Pematangsiantar Berbasis Mikrokontroller Arduino Uno. *Jurnal Penelitian Inovatif*. 2 (1)

[3] Gabriel,J.F. (2016). *Fisika Kedokteran*. Jakarta:EGC

[4] Kua,M.Y., C.M.M.Maing., Y.F.Tabun., A.Jibril., J.Setiawan., I.G.A.N.K.Sukiastini., L.Heriyanto., N.W.Suparmi., F.Resmaningsih dan F.X.Dolo. (2021). *Teori dan Aplikasi Fisika Dasar*. Banda Aceh : Yayasan Penerbit Muhammad Zaini

[5] Kiswanto, H. (2022). *Fisika Lingkungan : Memahami Alam dengan Fisika.* Banda Aceh : Syiah Kuala University Press

[6] Amalia A.V., Amidi.,Prasetyo B.,Pambudi M.D, dan Tasya D.F. (2022). Analisis Kebisingan Lalu Lintas (Studi Kasus Pengukuran Jalan Raya Semarang – Surakarta dan Jalan Raya Ungaran – Bandungan). *Jurnal Proceeding Seminar Nasional IPA*. 2 (3)

[7] Buchari dan Matondang, N. (2017).*The Impact of Noise Level on Students'Learning Performance at State Elementary School in Medan.* 040002.

[8] Perrina, M.G. (2021). *Literature Review* Sistem Informasi Geografis (SIG). *Journal of Information Technology and Computer Science).* 10 (10)

[9] Albab, Z.U dan N.N.Mulyaningsih (2020). Pengukuran Tingkat Polusi Suara di Desa Prasutan-Ambal, Kebumen dengan Menggunakan Aplikasi Sound Level Meter. *Seminar Nasional Fisika*.

[10] Chimayanti, R.L (2022). Analisis Penentuan Barrier pada Bandar Udara Berdasarkan Peta Kontur Kebisingan. *Jurnal Unbara Environmental Engineering*. 3 (1)

[11] Fariz,T.R. (2022). Pemetaan Kebisingan Lalu Lintas di Perkotaan – Sebuah Tinjauan. *Jurnal Ilmiah Terkait Lingkungan*. 14 (2)

[12] Buchari dan Matondang, N. (2019*). The Impact of Noise Level on Students' Learning Performance at State Elementary School in Medan*. 040002

[13] Ramadhan,N.P., M.F.Fachrul dan Widyatmoko. (2019). Kawasan Kebisingan Bandar Udara Internasional Husein Sastranegara, Bandung Provinsi Jawa Barat. *Journal of Engineering dan Waste Management.* 4 (2)

[14] Iswandi, M (2021). Analiss Sebaran Kebisingan Akibat Aktivitas Landing dan Take-offf di Sekitar Bandara Internasional Sultan Iskandar Muda Kabupaten Aceh Besar. *Doctoral dissertation, UIN Ar-Raniry Banda Aceh*

[15] Hernayati, M.A., T.Joko dan H.L.Dangiran. (2021). Hubungan Kebisingan di Bandara Halim Perdanakusuma Jakarta Timur Terhadap Gangguan Non-Auditori Permukiman Penduduk Wilayah Buffer. *Jurnal Kesehatan Masyarakat (Undip)*. 6 (6)

[16] Almadhany M, dan Rosariawari,F. (2021). Pemodelan Kebisingan Lalu Lintas Berdasarkan Volume Lalu Lintas Menggunakan Multiple Linear Regression Pada Jalan Kedung Cowek Surabaya. *Jurnal Teknik Lingkungan*. 2 (1)

[17] Amin, D. A., Sholawati, A., Riswanti, N., & Irsyad, A. (2023). Aplikasi Sistem Informasi Geografis Dalam Pemetaan Rumah Sakit Saskatchewan, Kanada. *Kreatif Teknologi dan Sistem Informasi (KRETISI)*, *1*(1), 23-25.

[18] Pamurti, A.A dan W.Wahjoerni (2023). Pelatihan Pengukuran Kebisingan Lingkungan Semarang. *Jurnal Pengabdian Masyarakat Berkemajuan*. 7(1)

[19] Keputusan Menteri Negara Lingkungan Hidup Nomor 48 Tahun 1996 tentang Baku Mutu Tingkat Kebisingan

[20] Keputusan Menteri Perhubungan Nomor 48 Tahu 2002 Tentang Penyelenggaraan Bandar Udara Umum, Metode Weightened Equivalent Continuous Perceived Noise Level (WECPNL)

[21] Fajrin, R. (2019). Pengembangan Sistem Informasi Geografis Berbasis Node. JS untuk Pemetaan Mesin dan Tracking Engineer dengan Pemanfaatan Geolocation pada PT IBM Indonesia. *Jurnal Komputer Terapan.* 3 (10).