Noise mapping in campus a Rawamangun-Jakarta State University environment and its effect on academic atmosphere

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Abstract. The aim of this research was to map the noise level. The survey method with a questionnaire for 30 respondents taken at random was used to obtain data on effects on the academic atmosphere during the period August - October 2019. Measurement noise levels based on Equivalent Continuous Noise Level Data during the day (L_S), night (L_M) and one-day (L_SM). This data is collected from 256 coordinates by a digital sound level meter and two application software. Mapping using the Surfer application ver11, results show that the noise level category into 5 areas: (1) Red zone, 75-80 dB(A); (2) Yellow zone, 65-75 dB(A); (3) Green zone, 55-65 dB(A); (4) Dark blue zone, 50-55 dB(A); and (5) the blue/bright zone, 45-50 dB(A). Noise levels in near or inside building and students gather is close to the threshold. At near to highways, canteen and near housing, open space and parking area indicate that exceed the threshold of 55 dB(A) and 33.1% of students perceived disturbed when the noise level is at 61 + 3 dB(A). As a result, to improve the academic atmosphere, the area near the highway built physical barriers or tree planting and manage the parking area better.

1. Introduction

The professional educational settings such as schools, preschool facilities and other learning environments, information is predominantly presented orally to the learner. Thus, listening is an important precondition for successful learning. Hearing clarity is affected by noise levels which play a major role. Noise levels that are higher than required, are not suitable for the teaching-learning process which makes the academic climate make unconducive.

Noise has become a part of our daily lives in modern society. Its presence affects the ability to concentrate and communicate and will even interfere brain's speech function [1]. The effect of road traffic annoyance affects the interaction between the ability to focus attention and visual factors [2]. Other analysis results show that traffic noise exposure affects their academic performance, health, and future potential [3], and might act synergistically on cognitive function in adults [4] including accelerating the risk of cognitive impairment and Alzheimer's disease [5] and even may influence mental health [6].

Traffic noise has been known to severely affect human population including the educational environment. The results of noise research in several educational institutions in Indonesia all exceed the noise threshold is 55 db(A) [7], such as at the Sekolah Tinggi Teknologi Adisutjipto (STTA) 55 db(A)
[8], STIKES Insan Unggul Surabaya 67-74 dB(A) [9], Polytectnic Negeri Surabaya 57 dB(A) [10] and Putra Putra Padang University 67.91-59.93 dB(A) [11], and Lampung University 71-85 dB(A) [12]. These all the results of this study did not make noise mapping.

Strategies to minimize noise exposure by making more green open space or greenspace [13] with vegetation/plant [14], improvement of the façade acoustic [15,16] and design criteria [17]. This noise will disrupt the academic atmosphere. Its play a significant role in student success. Academic atmosphere is the atmosphere in which one attempts to learn, which can aid in the learning experience or distract from and diminish it. Other findings show that the possible relationship between green space and academic performance is complex and tenuous [18]. The positively perceived learning environment contributes to better academic performance [19] and even socio-emotional skill [20] The efforts implemented to improve the academic performance is create favorable educational environment, that noise pollution is the main cause of discomfort among teachers and students which appears in the form of discomfort, irritability, lack of concentration, drowsiness, fatigue, depression and headache [21–23]. Noise levels can not only be measured at one point, but represent an area of studied. Noise maps are calculated according to noise directives that evaluate the level of noise exposure in the educational environment and compared with the standard threshold level of noise. Noise mapping to provide better recommendations for policy makers and ensure a more efficient use of noise control strategies [24]. The noise map is a helpful and important tool for noise management and acoustical planning [25]. The results of this investigation can help design and improve the academic atmosphere due to noise exposure.

Based on the description above, how to influence of noise on the academic atmosphere, noise level mapping is carried out. It is to analyze the noise level in the education area at UNJ Campus A - Rawamangun. Noise level data is obtained from measurements using a noise level measuring tool and 2 smartphone applications with measurement points based on google coordinates. Furthermore, the data is mapped using the mapping application. Mapping is used to classify area (zone) according to noise levels, whether they meet the noise threshold values set (Nilai Ambang Batas/NAB) for the educational environment or similar activities which 55 dB(A) [7,26]. The perceived noise impact is measured using interview survey with one verbal question. Regression analysis is used to analyze the effects of noise perceived by students.

2. Method
The focus of research is to produce noise maps and analyze their effects on the academic climate, which are as follows,

2.1. Instrument and time measurement
The most common measurement in environmental noise is the dB(A) level. Its measurement can be done two ways [7], that are: (1) simple measurement with sound level meter which measures the sound pressure level for 10 minutes for each measurement. The reading is every 5 (five) seconds in dB(A), and (2) The direct measurement with an integrating sound level meter that has a $L_{eq}$ measurement facility ($L_{eq}$ with a sampling time every 5 seconds). $L_{eq}$ is equivalent continuous noise level, usually the sound pressure level (SPL). Its a measurement time every 5 seconds, measuring for 10 (ten) minutes [26].

Three measuring instruments are used (1) HT-80A / Digital Sound Noise Level Meter; (2) the Sound Level Meter application using the android Smart PRO Mobile, and (3) the Sound Meter Smart Tool application co. Measurement data from the three devices are then averaged, as a result of readings per-5 seconds. Time of measurement is done during 24 hour activity ($L_{eq}$) by taking measurement data as shown in Table 1, by way of daytime the highest level of activity for 16 hours ($L_{eq}$ during daytime) at intervals of 6:00 to 22:00 and night activities for 8 hours ($L_{eq}$ during the night) between 22.00 - 06.00. Because education activities only until 18:00 hours for the daytime and carried out only outside the building for ($L_{eq}$); ($L_{eq}$) and ($L_{eq}$). Data to analyze the effect of noise were obtained from the results of an interview survey with one verbal question "Does the noise from traffic (from the Pemuda street or from the Rawamangun Muka street) interfere with learning activities?" With four statements using a
Likert scale: 1–undisturbing, 2–sometimes disturbed, 3–quite disturbed, and 4–disturbed. Data is taken randomly from 30 respondents (students) at Campus A - Jakarta State University.

### Table 1. Time measurement.

| Date           | Point | Date           | Point | Night-time, \(L_M \) (\(L_s^1; L_s^2; L_s^3; L_s^4\)) |
|----------------|-------|----------------|-------|-------------------------------------------------|
| 27 August 2019 | 1 - 25| 6 Sept 2019    | 101 - 125 |                                                |
| 29 August 2019 | 26 - 50| 9 Sept 2019    | 126 - 150| 28 August 2019                                |
| 3 Sept 2019    | 51 - 75| 10 Sept 2019   | 151 - 163| 1 – 50                      |
| 4 Sept 2019    | 76 - 100| 19 Sept 2019   | 164 - 232| 2 Sep 2019                         |
|                |       | 20 Sept 2019   | 233 - 256| 29 Sept 2019                                |

\(L_1\) at 07.00 representing 06.00 – 09.00, \(L_2\) at 10.00 representing 09.00 – 11.00, \(L_3\) at 15.00 representing 14.00 – 17.00, \(L_4\) at 18.00 representing 17.00 – 22.00.

2.2. Methods

The method used are a survey study and data analysis. The survey was conducted using a sound intensity measuring instrument tool. Equivalent continuous noise level \((L_{eq})\) data is taken according to the coordinates of the "google maps" for Campus A - UNJ with 256 coordinates. Each coordinate data was using three measuring instruments with a sampling time every 5 seconds, \(L_{eq(1)}\) to \(L_{eq(7)}\). To calculated \(L_{eq}\) at the daytime \((L_3)\), nightday \((L_M)\) and day-night \((L_{SM})\) by using the average value of three measurement results, which is calculated [7] according to Eq. 1 [26].

\[ L_s = 10 \log \left( \frac{1}{16} \left( T1.10^{0.1L_1} + T2.10^{0.1L_2} + T3.10^{0.1L_3} + T4.10^{0.1L_4} \right) dB(A) \right) \]  

(1)

where \(L_s\) is \(L_{eq}\) daytime; \(T1\); \(T2\); \(T3\) and \(T4\) are time measurement for \(L_{eq(1)}\); \(L_{eq(2)}\); \(L_{eq(3)}\) and \(L_{eq(4)}\). \(L_{eq}\) for nightday \((L_M)\) calculated by Eq. 2. To find out whether the noise has exceeded the noise level it is necessary to find the \(L_{SM}\) value from the measurements, calculated by Eq. 3. Result of \(L_{SM}\) value compared with noise level threshold is set with tolerance \(\pm 3\ dB(A)\).

\[ L_M = 10 \log \left( \frac{1}{8} (T5.10^{0.1L_5} + T6.10^{0.1L_6} + T7.10^{0.1L_7}) dB(A) \right) \]  

(2)

\[ L_{SM} = 10 \log \left( \frac{1}{24} (16.10^{0.1L_5} + 8.10^{0.1L_6} + 4.10^{0.1L_7}) dB(A) \right) \]  

(3)

where \(L_M\) is \(L_{eq}\) night-time; \(T5\); \(T6\) and \(T7\) are time measurement for \(L_{eq(5)}\); \(L_{eq(6)}\) and \(L_{eq(7)}\).

The measurement results are then mapped using the Surfer application ver11 and determine areas where noise levels exceed threshold levels and to produce noise maps. The influence of noise on the academic atmosphere in this research uses the statistical hypothesis: \(H_0: \mu_0 = \mu_1\) and \(H_1: \mu_0 \neq \mu_1\), with \(\mu_0\) there is no influence of noise level on a scale of 1-4 (1–undisturbing, 2–sometimes disturbed, 3–quite disturbed, and 4–disturbed) on the academic atmosphere and \(\mu_1\) is the influence of noise levels. The results are also then compared with noise at a threshold exceeding 55 dB(A) (educational environment) \(\pm 3\ dB(A)\).

3. Result and discussion

Data is collected during the period August - October 2019 as in Table 1. Collecting data with an ordinary sound level meter is measured the sound pressure level dB(A) for 10 (ten) minutes for each measurement. The reading is done every 5 (five) seconds.
3.1. Noise mapping

Southern Latitude and East Longitude coordinates of "Google Maps", then plotted using the Surfer Ver11 application. Corresponds to the latitude and longitude coordinates for the noise level value in dB(A). On average three measuring devices are then mapped and contoured based on Eq.3 as Figure 1 for one day (day and night) and Figure 2. 3D visual appearance for measuring.

Based on the results of the mapping, using the Surfer Ver11 Application software the noise level area can be mapped according to the zone (region) at UNJ, Campus A – Rawamangun as shown in Figure 3. The results of the noise level zone mapping are 1–Red (75–80) dB(A), near Pemuda street, motorcycle parking, canteen; 2–Yellow (65–75) dB(A), near residential housing, Rawamangun Muka street, field or open space in the A-campus; 3–Green (55–65) dB(A), near the building, student gather; 4–Dark Blue (50–55) dB(A), in the building; and 5–Light Blue to purple (45–50), in the building (up to 3–story). In the zone close to the road the noise level exceeds the threshold [7,27]. This is consistent with the results of previous studies. [8–12].

3.2. Noise influence in academic atmosphere

Data on the results of verbal questions and noise levels prior to further analysis were performed testing of the analysis requirements including uniformity and normality of data using one-sample Kosmogorov-smirnov with SPSS Application. Data is then discussed to see the effect of noise level using simple linear regression. Test results at a significant level $\alpha = 0.05$ indicate that the data are normally distributed and meet the uniformity element (uniform). So the data can be analyzed further.

Result of regression analysis, $H_0$ accepted, it means that there is no influence of noise level on the academic atmosphere at UNJ Campus A - Rawamangun. This relationship is stated by Eq. 4,

$$\text{Noise Influence} = 0.060\text{dB}(A) - 1.597$$

(4)
The coefficient of variance of 0.331 shows that only about 33.1% of students were disturbed when the noise level increased, with the strength of the relationship of 10.9%. Eq. 4 also shows that at the noise level according to the threshold of 55 dB(A) for the educational environment it produces a value of 1.7 (between 1 and 2 on an undisturbed scale - sometimes disturbed). When the value of the noise level increases at intervals of 55 - 65 dB(A), the academic atmosphere will be influential and students will be quite disturbed and the noise level above 80 dB(A) produces an effect on the 4-disturbed, meaning that when the noise level reaches this level will affect the academic atmosphere because students are disturbed by noise caused by traffic. This is consistent accordance with the results of previous studies [2,21,23], that traffic activity has the potential to be one source of noise that can interfere with the effectiveness of teaching and learning activities in educational environment.

The results of the measurement of noise levels by taking the average value of observations for one day. During the day the noise is at intervals of 65 - 70 dB(A) in a zone close to the highway, i.e. Pemuda and Rawamangun street, motorcycle parking, canteen, near residential housing and open space with the threshold set is still above. At night, the interval is 40-45 dB(A) below the threshold. Overall, for one day in the August-October 2019 period, the noise level average of 61 + 3 dB(A). The value exceeded the threshold of 55 dB(A) according [7,26]. Strategies to minimize noise impact by increasing green open space [13], improvement of the façade acoustic [14,15].

4. Conclusion
Based on the focus of the research it can be concluded (1) the noise level at UNJ, Campus A - Rawamangun, is divided into 5 zones, namely: (a) Red Zone, 75 - 80 dB(A), (b) Yellow Zone, (c) Green zone, 55 - 65 dB(A) and (e) Light Blue/Purple Zone, 45 - 50 dB(A). Average noise level in UNJ Campus is 61+3 dB(A) exceeded the threshold of 55 dB(A) and 33.1% of student perception are disturbed when the noise level increases which is expressed by Noise Influence = 0.060dB (A) -1.597. The influence of noise level on a scale of 1-4 (1–undisturbing, 2–sometimes disturbed, 3–quite disturbed, and 4-disturbed).

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