

Analysis of train noise level at bandar khalipah station, deli serdang using sound level meter 130 dB

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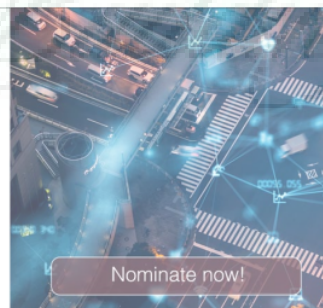
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Analysis of train noise level at bandar khalipah station, deli serdang using sound level meter 130 dB

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Abstract. The Bandar Khalipah train station is a class B station which is located very close to residential areas. This has an impact on the noise level that occurs in the area. This study aims to analyze train noise using a sound level meter (SLM) and analyze the effect of train operating time on noise levels. The research method was carried out experimentally. Where noise is measured using SLM at a distance of 1.5 meters from the train and the location of the SLM parallel to an adult's ear, namely 1.5 meters. Measurements were taken as much as 14 arrivals and 14 departures during the week. The result obtained is that the noise that occurs at departure is 98.4 dB greater than the noise at arrival at 97.7 dB. This is because the sound produced by the engine occurs due to the combustion process which requires air and heat, resulting in smoke gas and sound in the chimney. It turns out that the highest noise occurs at 10.42 to 17.22 WIB, with the largest at 98.4 dB at 12.35 WIB. This is due to the greater daytime conditions of air pressure and temperature. Meanwhile, the lowest noise occurred in the morning and evening, namely at 6.45 WIB at 80.2 dB. Train noise at the Bandar Khalifah station that occurs above the threshold required by the Noise Level Standard in Various Activity Areas according to the Decree of the Minister of Environment of the Republic of Indonesia, No. 48 of 1996 that is 70 dB.

Keywords : noise, train, Sound Level Meter (SLM)

1. Introduction

The train is land transportation that is most in demand by people in big cities. Apart from being anti-jammed, by train people can get to their destination faster. The train is a transportation with multiple comparative advantages, namely saving land and energy, low pollution, mass nature, adaptive to technological changes that are entering the era of competition. In addition, the potential is expected to be mobilized on a national scale, so as to create advantages and competition for domestic production and services in the global market. Even though it is low in pollution, it turns out that trains have high levels of air pollution in the form of noise [1-5] and vibrations [3,6-7]. In driving conditions, the higher the speed of the train, the noise and vibrations that will be generated will be stronger like a fast train [1]. So that this situation will disturb the comfort and in the long term it can cause health problems for people who live around the railroad and contribute to noise in urban areas.

Medan City is the capital city in North Sumatra which has a large class A type train station with a dense number of visitors every day. Apart from the Medan City station, there are also other supporting stations, one of which is the Bandar Khalipah railway station in Deli Serdang Regency. Bandar Khalipah Railway Station is a class B station and its location is very close to residential areas [8].



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According to the Decree of the Minister of Environment, Number: KEP-48 / MENLH / 11/1996 states, "noise is an unwanted sound from a business or activity in a certain level and time that cause human health problems and environmental comfort. Along also based on the Decree of the Minister of Manpower Number: KEP.51 / MEN / 1999, concerning the Threshold Value (NAB) of the physics factor attachment II concerning noise in the workplace. The threshold value for noise in the workplace is the highest intensity and is the average value that can still be accepted by the workforce without causing a permanent loss of hearing power for continuous working time. Therefore it is necessary to conduct research on the noise of the incoming trains, and go to the area so as not to have a negative influence on the environment [4]. Previous research on noise caused by trains has also been carried out both experimentally [2], [9] and computer simulations [10-13]. In this article, the purpose of this research is to analyze the results of data processing from noise measurements using Sound Level Meter on a train and to determine the impact and influence of the sound intensity level at the train station upon departure and arrival.

2. Literature Review

Transportation is a tool used to transport humans, animals and goods to their destination. Or another definition of transportation is moving humans, animals or goods from their place of origin to their destination by using a device that can be moved by living things or machines.

The train is a means of transportation that moves on rails, trains can run alone or be connected to other vehicles. Trains are a popular means of transportation today because they are free from traffic jams and can carry large numbers of passengers and goods. Trains generally consist of locomotives and a series of carriages.

Sound or sound, which can be heard by the ear, is caused by vibrating the lining of the ear due to exposure to longitudinal waves in the air, these longitudinal waves come from the sound vibrated in the air around it. Thus sound or sound is called a wave in the air and air acts as the medium, the sound or sound produced is none other than a source of vibration. Vibration can come from mediums such as wire, rod or the like.

Sound can also be defined as a mechanical vibration wave in the air or in a solid object, which in the process produces a sound that can be heard by the human ear which is still in a normal state, with a range between 20-20,000 Hz [14]. Usually, the human ear has a sensitivity to a sound range of 20-20,000 Hz according to age and age. In addition to the frequency bands, there is a frequency range below 20 Hz is called infrasound (infrasonic) and above 20,000 Hz is called ultrasound (ultrasonic).

Basically, the ear is always responsive to a very wide range of sound pressure even though the pressure itself is very small. The weakest sound has a maximum pressure variation of 1000 Hz, for the same displacement amplitude with a pressure amplitude of approximately 10^{-9} cm, so that when viewed from this variation the human ear is a very sensitive organ.

Deviation in atmospheric pressure, caused by vibrations of air particles due to sound waves, is called sound pressure. The standard scale, which is used to measure sound pressure in physical acoustics, has a wide range, making it difficult to use. The scale shows the calculation that the human ear is not responsive to changes in sound pressure at all levels of intensity if done the same way.

For the reasons mentioned above, for the scale measured logarithmically, which is called decibels (dB), there is the word Bell written in honor of Alexander Graham Bell with the equation of sound intensity levels, as follows:

$$Ti = 10 \log \frac{I}{I_0} \quad (1)$$

Ti, Level sound intensity (dB); I, Measured sound intensity (W / m^2); and I_0 , Intensity hearing threshold 10-12 (W / m^2)

Sound intensity is the amount of sound energy produced by sound per unit area, which unit is measured by watts / m^2 . For the energy of a reference sound source from the sound level is 10-12 W / m^2 .

$$I = \frac{P_{average}}{4 \pi r^2} \quad (2)$$

I (W / m²); P, power (Watt); and r, distance of the listener from the sound source (meters)

Sounds with an intensity range of 30 - 50 dB are safe sounds to be heard by the human ear, for example, like the voice of a person having a conversation. The ears will hurt if you hear a sound ≥ 90 dB. Noise level standard is the maximum limit of noise level obtained from the environment from a business or activity so that it does not cause health problems and environmental comfort (Life Environment Ministry Policy No. 48 of 1996) can be seen in Table 1.

Table 1. Noise Level Standards in Various Environmental Areas Activities (Source: Life Environment Ministry Policy No. 48 of 1996 year.)

No.	Area Designation /Environment	Noise level (dB)
1.	Housing and Settlements	55
2.	Trade and Service	70
3.	Offices and Trade	65
4.	Green Open Space	50
5.	Industry	70
6.	Government and Public Facilities	60
7.	Recreation	70
8.	Airport	70
9	Railway station	70
10	Seaport	70
11	Cultural heritage	60
12	Hospital or environmental health	55
13.	School	55
14	Places of worship	55

In the regulation of the Minister of Health of the Republic of Indonesia Number 718 on 1987 year concerning noise noted that the noise levels are divided into several zones, as seen in Table 2.

Table 2. Noise Zonedivision according to the regulation of the Minister of Health of the Republic of Indonesia

Zone	Intensity (dB)	Places
Zone A	35-45	Place of research, hospitals, facilities, health care and the like.
Zone B	45-55	Housing, education, recreation, and the like.
Zone C	50-60	Markets, offices, and the like
Zone D	60-70	Industrial environment, factories, train stations, bus terminals, and the like.
Zone	Intensity (dB)	Places

3. Method

This research was conducted in Bandar Khalifah type B station located in Deli Serdang District North Sumatra Provincelocated at $2^{\circ} 57' - 3^{\circ} 16' \text{North Latitude} - 98^{\circ} 33' - 99^{\circ} 27' \text{East Longitude}$ with an area of 2,241.68 km² consisting of 22 sub-districts and 403 villages / state, which spans 3.07% of the area of North Sumatra. Administratively, Deli Serdang is bordered by the North with the Sumatra Strait, in the west by Langkat Regency, in the East by Serdang Bedagai Regency, and South with Karo Regency. The map of the research location taken through the google map is shown in Figure 1.

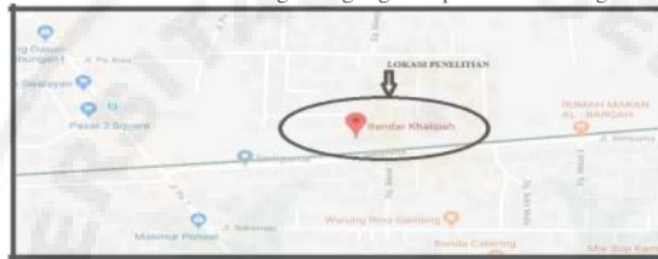


Figure 1. Map of Research Location

Bandar Khalifah Railway Station has a high enough noise level, due to a large number of community activities and heavy traffic conditions. The research was conducted in an experimental way, The data was taken by measuring noise using the SLM Krisbow brand with a frequency limit of 31.5 to 8 kHz, measuring range 35 to 130 dB, resolution 0.1 dB, 0.5 inch microphone condenser, 4 digit LCD, 0.5 second response speed. Set-up of SML equipment at a distance of 1.5 meters from the train and a height of 1-1.5 meters from the waiting room floor. Measurements were made 14 times at the time of train arrival and 14 times during departure every day for a week (3 - 8 March 2020), at 06.30 am to 11.45 pm. The data obtained were analyzed with statistics [7], [11]. The set-up of noise measurement tools using SLM is shown in Figure 2 below.

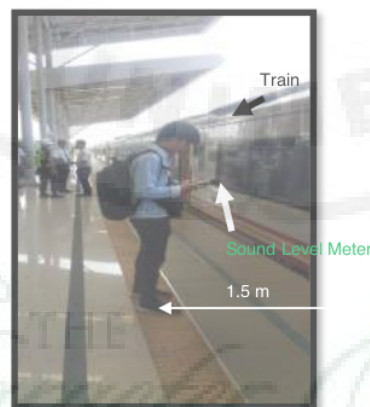


Figure 2. Set-up noise measurement with SLM equipment

Table 3. Schedule of train departures and arrivals at Bandar Khalipah Station (source: PT. Kereta Api Indonesia, North Sumatra regional division) Ministry Policy No. 48 of 1996 year.)

No	Arrival hours (local time)	Departure hours (local time)
1	6:42	6:45
2	8:42	8:06
3	10:06	10:13
4	10:42	10:47
5	11:05	11:13
6	12:27	12:35
7	12:53	13:03
8	14:12	14:17
9	15:17	15: 22
10	16:30	16:38
11	17:22	17:24
12	20:14	20:16
13	22:37	22:43
14	23:34	23:38

4. Results and Discussion

Table 4 is shows the train noise that measure from 3 March to 8 March for train arrival. The data were obtained in the morning 06.30-11.30 am, noon 12.30-17.30 pm and evening 20.00-23.45 when arrival and departure schedule. The schedule is obtained according to the schedule set by PT. Kereta Api Indonesia, the regional division of North Sumatra for 1 week.

Table 4. Results of measurements of train noise upon arrival (dB)

No.	Hours	3 March	4 March	5 March	6 March	7 March	8 March
1	6:42	84.3	85.3	86.2	84.1	85.1	85.2
2	8:42	85.1	88.4	88.4	86.6	85.9	85.6
3	10:06	86.4	88.9	88.9	85.4	86.4	87.2
4	10:42	93.2	95.3	94.1	87.3	89.3	95.3
5	11:05	90.3	90.2	90.2	85.3	90.3	89.4
6	12:27	95.6	96.3	96.6	95.8	94.6	94.1
7	12:53	90.2	90.7	89.4	89.4	89.1	89.3
8	14:12	92.8	95.8	96.1	97.2	94.2	95.3
9	15:17	85.4	92.1	94.2	95.2	95.3	96.1
10	16:30	92.2	91.1	91.1	90.1	90.2	90.1
11	17:22	93.7	94.9	96.9	97.7	93.2	93.5
12	20:14	87.6	90.2	90.1	86.1	84.3	90.4
13	22:37	84.3	90.7	88.3	88.4	85.1	90.2
14	23:34	90.8	87.2	85.4	85.3	84.7	89.1

Besides that the train noise at the departure time also observed start from 3 March to 8 March and can be seen in Table 5.

Table 5. Results of measurements of train noise at the time of departure (dB)

No.	Hours	3 March	4 March	5 March	6 March	7 March	8 March
1	6:45	80.2	86.3	90.7	85.1	85.3	92.3
2	8:06	90.4	87.5	93.5	86.5	86.7	93.1
3	10:13	91.1	90.8	85.8	90.4	84.4	84.4
4	10:47	90	96.4	96.4	91.6	88.6	93.9
5	11:13	94.1	90.3	89.3	92.3	85.8	87.2
6	12:35	96.6	98.1	98.4	96.2	96.1	95.2
7	13:03	91.3	91.2	91.7	90.6	86.5	87.7
8	14:17	93.8	96.3	97.3	96.3	95.6	97.5
9	15:22	85	95.1	96.1	95.1	89.1	97.1
10	16:38	93	90.3	90.3	90.9	94.5	88.3
11	17:24	92.7	96.7	96.7	95.4	96.6	92.4
12	20:16	91.2	94.3	93.3	92.4	92.3	91.3
13	22:43	90.4	85.9	87.9	88.1	85.4	84.5
14	23:38	89.3	93.8	90.8	89.8	90.7	90.5

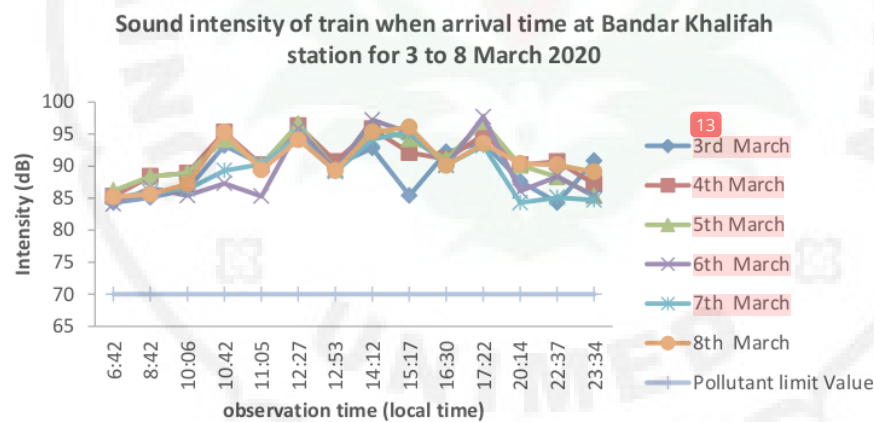


Figure 3. Train sound intensity when arrival schedule

In Figure 3 above, it can be seen that, the measurement results for 1 week, starting from 3-8 March 2020, when the train arrives at the Bandar Khalifah station is above the threshold value required by KepMen LH RI No. 48 of year 1996 and Permenkes RI No. 718 of 1987 year on noise. The lowest measurement value was 84.1 dB on March 6, 2020 at 6:42 WIB and the highest was 97.7 dB at 17:22 WIB. Whereas in Figure 5 below, it can be seen that the lowest measurement results for the sound intensity of the train at departure are 80.2 dB on March 3, 2020 at 6:45 WIB and the highest is 98.4 dB on March 5, 2020 at 12:35 WIB.

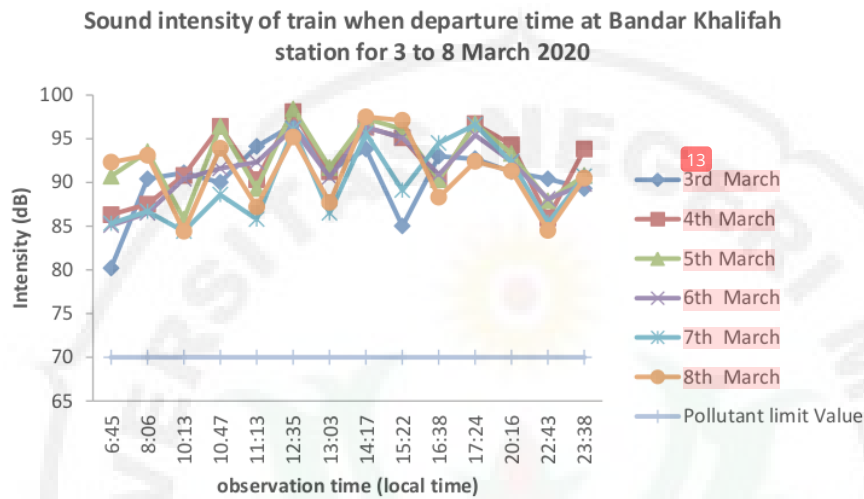


Figure 4. Train sound intensity when departure schedule

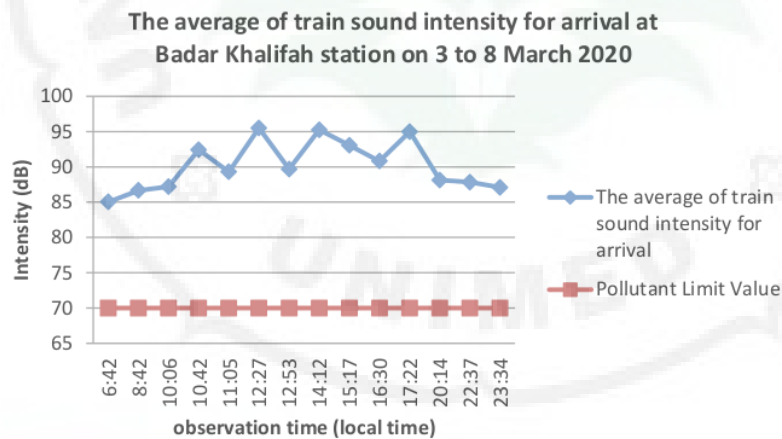


Figure 5. Average train sound intensity on arrival schedule for a week

The average of train sound intensity for departure at Badar Khalifah station on 3 to 8 March 2020

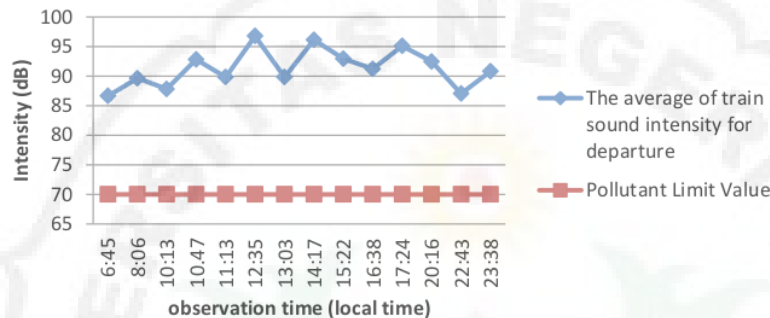


Figure 6. Average train sound intensity on departure schedule for a week

In Figure 5 and Figure 6 average graph measuring sound intensity at train arrival at Bandar Khalifah station for 1 week shows that the lowest value is 85.03 dB at 6.42 WIB and the highest is 95.5 dB at 12.27 WIB. While the sound intensity when the train departs from the Bandar Khalifah station for 1 week shows that the lowest value is 86.65 dB at 6.45 WIB and the highest is 96.77 dB at 12.27 WIB.

The overall measurement results obtained are above the required threshold value but can still be permitted by the Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016 concerning Standards and Health Requirements for Industrial Work Environment, in the attachment concerning the duration of noise exposure in the workplace for 15 minutes 100 dB with without using personal protective equipment in the form of ear plugs. Assuming that when the train comes to the station and departs from the station, it is no longer than 15 minutes.

The impact of the sound intensity level at the Bandar Khalifah train station on humans is hearing loss in people around the station which usually occurs when understanding a conversation. Noise can also cause long-term hearing loss if exposed to continuous, and communication disruptions in which the sound source comes from the engine in the locomotive, the clashing of the wheels with the ends of the rails, notification speakers, and train horns.

Furthermore, for secondary data obtained from interviews with train drivers. The data from interviews with train drivers at the Bandar Khalifah train station on train speed can be summarized in Table 4.

Table 6. Schedule of train departures and arrivals at Bandar Khalifah Station (source: PT. Kereta Api Indonesia, North Sumatra regional division) Ministry Policy No. 48 of 1996.)

Crossing	Speed (km/h)	Description
Average speed of the train at railroad crossing.	60-70	Very fast
Speed at intersections railroad crossings.	40-50	Fast
The train speed at departing from station Bandar Khalifah.	20-30 is quite	fast
Train speed attimes arrival at Bandar Khalifah. station	10-20	less fast

5 Conclusions

Based on research that has been carried out using a Sound Level Meter can be concluded that the measured sound average intensity level on the Bandar Khalipah Railway Station (1) sound intensity level at the highest sound intensity level for arrival was obtained on March 6 2020 at 17.22 WIB of = 97.7 dB, and trains that go and stop at a fairly fast speed (± 25 km / hour). While the lowest sound intensity level was obtained on the morning of March 6 2020 at 06.42 WIB at = 84.1 dB, so trains that go and stop slowly (± 20 km / hour) and the highest sound intensity level for departures are obtained at noon. day 5 March 2020 at 12.35 WIB amounting to = 98.4 dB, as well as trains that are moving and continuing to depart at a fairly fast speed (± 25 km / hour). Meanwhile, the lowest sound intensity level was obtained in the morning of March 3, 2020 at 6:38 a.m., at = 80.2 dB, so the train was moving and departing slowly at a speed (± 20 km / hour). (2) The impact of the sound intensity level at the Bandar Khalipah train station on humans is the disruption of hearing when understanding a conversation. Noise can also cause long-term hearing loss if exposed to continuous, and communication disruptions in which the sound source comes from the engine in the locomotive, the clashing of the wheels with the ends of the rails, notification speakers, and train horns

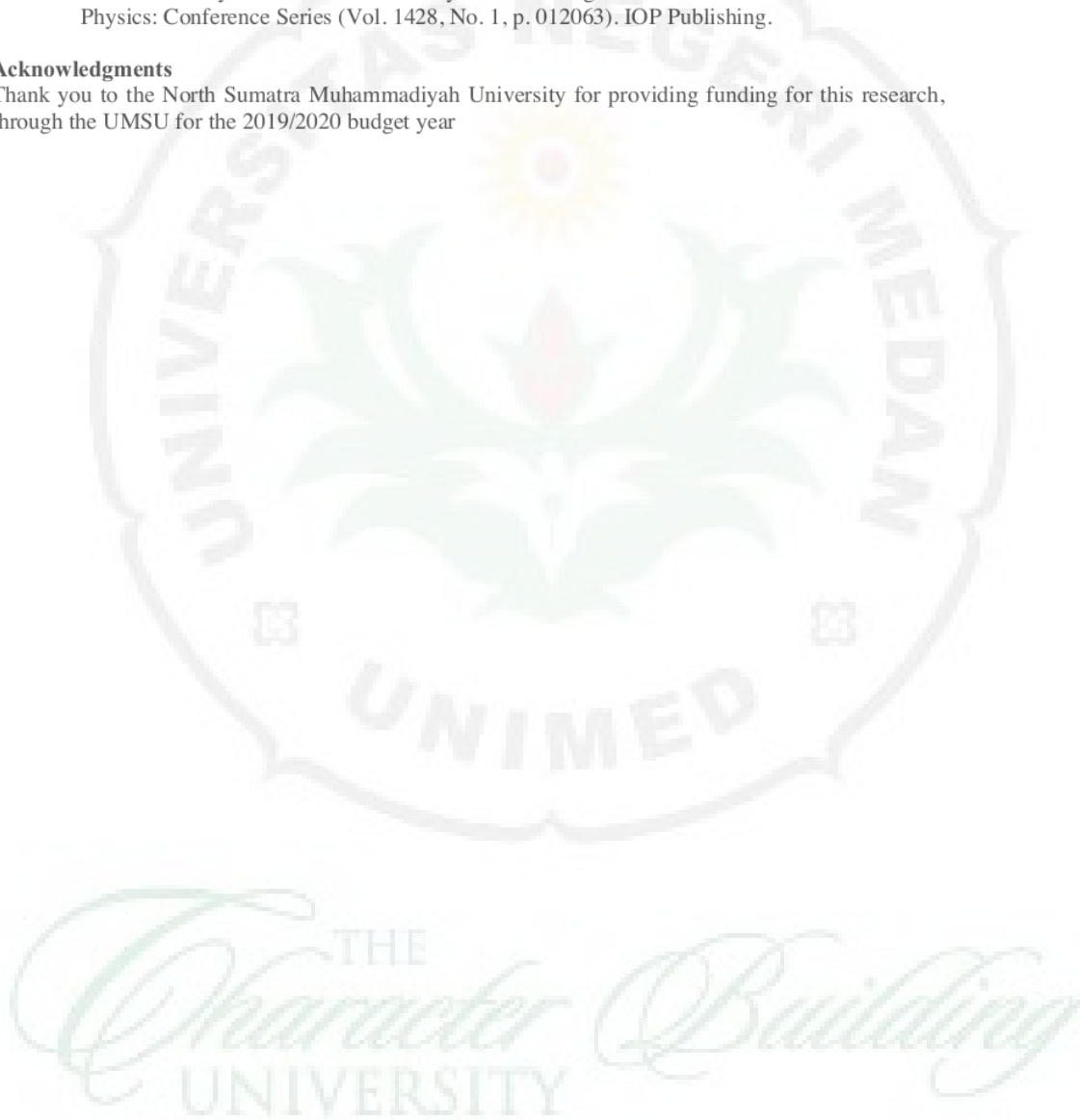
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