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Measuring and Monitoring Sound Levels in the Heavy Traffic Areas within Phuket City Municipality, Phuket Province

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ABSTRACT

This research studied the sound levels in the intersection areas with heavy traffic in the Phuket Municipality which included: Phuket Satree School Intersection, Saphan Hin Intersection, Chaofa-Patiphat Intersection, Jui Tui Intersection and Bang Neaw intersection. The objectives were 1) to measure the sound level in areas with heavy traffic in Phuket Municipality, Phuket Province and 2) to compare the sound level in the study area with general sound level standards in the atmosphere. Sound levels at the intersection with heavy traffic in the Phuket Municipality were measured during the rush hours on business days and public holidays for 15 days from February 1 - April 30, 2022. It was found that the average sound level in 2 hours (Leq,2hr) of every measurement point had a value in the range of 66.4 - 71.9 dBA with an L90 value in the range of 57.8 - 64.9 dB(A). The lowest sound level was 66.4 dBA at Saphanhin intersection and the highest sound level was 71.9 dBA at Bang Neaw intersection which did not exceed 115 dBA according to the Environmental Commission Announcement No. 15 (1997). The results of the study also indicated that most sensitive areas had sound levels exceeding the standard values. Therefore, measures to reduce traffic noise should be considered to prevent impacts on the health of people in Phuket Municipality, Phuket Province.

Keywords : Sound levels; Heavy Traffick Areas; Phuket City Municipality

INTRODUCTION

Sound is a factor that humans are exposed to on a daily basis, including sound is important to living life. Because sound is necessary for communication between humans. Nonetheless, exposure to very loud noises, including exposure over a long period of time may cause adverse effects on hearing. Noise pollution is an important environmental problem today. The noise pollution from various engines and traffic is considered a particular environmental problem in large cities. Noise pollution is considered a significant environmental issue, particularly in densely populated urban areas and communities with large cities [1]. The noise generated from various engines and traffic contributes to this problem.

Phuket Province is considered one of the densely populated cities in Thailand, despite its relatively small area. This is due to rapid economic development facilitated by the provincial authorities. According to data from the Air and Noise Quality Management Division, Pollution Control Department, the average sound level measured at the noise quality monitoring station in Phuket Province was 60.6 for 1-hr average and 63.0 for “24-hr average (latest data: January 9, 2022). The monitoring station is located in Talat Yai Subdistrict, Mueang Phuket District, measuring sound levels along the roadside [2].

Traffic is a major source of noise pollution, impacting the hearing of road users such as traffic police officers and part-time workers like students in the area. The rapid increase in tourists and population has led to heavier traffic congestion, exacerbating noise pollution issues. As a result, the severity of noise pollution problems is expected to worsen in the future.

Therefore, researchers are interested in conducting surveys and monitoring sound levels in the Phuket City Municipality area to study and map sound levels. This data will serve as a basis for relevant authorities to develop guidelines for preventing future noise pollution problems resulting from traffic congestion. Comparing measured sound levels with general ambient noise standards in the area of study, including those from traffic, road improvements, or human conversations, is an intriguing aspect. High sound levels in heavy traffic areas can disrupt the activities of personnel or businesses, necessitating sound level studies to gather data for prevention and mitigation strategies.

Noise pollution is an environmental problem, especially in Phuket Municipality, which is the center of economic prosperity and development resulting in the expansion of various construction activities, including buildings, residences, offices, transportation systems, public utility systems. Moreover, the number of vehicles increases because Phuket is a province with natural beauty and attracts both Thai and foreign tourists for travelling in Phuket province. All of these various activities are sources of noise pollution. Very loud noise for a long time can cause mental and hearing impairment. Workers who work in noisy factories are more likely to have heart disease and hearing problem than people who work in quiet areas. Loud noises are harmful to health and the mind. It interferes with rest, sleep, work, and reduces work efficiency. Stress and loss of mental health may be the cause of high blood pressure. If there is an increase in noise, it directly affects the auditory system, causing hearing loss, which is harmful to the ear membranes, which may eventually result in deafness and hearing loss [3].

Phuket Province is considered a city with a large number of people living in Thailand. Even though there is little space. This is because Phuket Province has developed a rapid economic expansion. From the sound level measurement results of the Air Quality and Noise Management Division Pollution Control Department, it was found that the sound level from the sound quality measurement station in Phuket province averaged 1 hour per day was 60.6 dBA and the average for the past 24 hours was 63.0 dBA (latest information: 9 Jan. 2022) [3]. Traffic is the main source of noise pollution problems that affect the hearing of people using roads such as traffic police and a group of students who work part-time in that area. The rapid increase in the number of tourists or population causes more dense transportation traffic and causes noise pollution problems in the future. The problem of noise pollution will become more serious.

Therefore, the researcher is interested in surveying and carrying out sound measurement in the Phuket Municipality area in order to study sound levels as information for guidelines for preventing noise pollution from traffic that will have an impact in the future. It is interesting to measure the sound level and compare the sound level in the study area with general sound level standards in the atmosphere. At present, there is noise such as from traffic, road improvements or from people talking in the heavy traffic area. There is a sound level that causes disturbance to those performing duties or selling goods in that area. Therefore, the sound level should be studied in order to obtain information on noise pollution and then use it to prevent and correct it further.

METHODOLOGY

1. The researchers had designated five areas for monitoring sound levels and creating sound level maps in the traffic-congested areas within Phuket City Municipality, Phuket Province. These areas are: Satree Phuket School Intersection, Saphanhin Intersection, Chao Fah-Pattithan Intersection, Jui Tui Intersection, and Bang Neaw Intersection.

2. Sound levels were measured throughout the day, including both regular and holiday periods, using the Sound Level Meter model 407740. The measured sound levels were compared to general ambient noise standards, and a sound level map in heavy traffic areas within Phuket City Municipality was created.

3. Sampling of noise samples was conducted within Phuket City Municipality, Phuket Province, over a period of 15 days, from February 1 to April 30, 2022. Measurements were taken during two periods each day, from 07:00 to 09:00 in the morning and from 17:00 to 19:00 in the evening, as these are periods of heavy traffic congestion.

4. Tools and equipment

1) Sound Level Meter model 407740

2) Counter

3) Camera

4) Notebook

5) Pencil/Pen

6) Stopwatch

7) Data recording form

8) Computer

9) Microphone

10) Tripod

11) Windshield

12) Global Positioning System (GPS)

Saphanhin Intersection

Jui Tui Intersection

Bang Neaw Intersection

Chao Fah-Pattithan Intersection

Satree Phuket School Intersection

In studying the sound level in the Phuket Municipality area, the study was conducted and data was collected as follows.

5. Survey of the sampling area

1) Criteria for selecting areas for sampling were as follows:

(1) Suitability of the area: it is an area where people live on the roadside and heavy traffic.

(2) Period: the area must be convenient for maintaining the operation of the equipment and replace the memory card of the camcorder.

(3) Safety of tools and research collectors: because sound measurement equipment sets are expensive. Therefore, you must choose an area that is monitored by staff at all times to prevent loss of equipment

2) Sound level measurement

(1) Select a sound measurement point by setting the sound measurement device not less than 1.2 meters above the ground in a radius of 3.5 meters horizontally. There must be no walls or anything else that has the ability to reflect in the way.

(2) Check the readiness of sound level meters, microphones, signal cables, and wind protection equipment. Set up the battery, data logger as well as adjusting the sound level measurement equipment to read correctly

(3) Measure sound levels in the general atmosphere. Set the microphone facing up above or facing in any direction.

(4) Set the desired parameters. Check accuracy before and after measurement by following the sound meter's manual. Measure according to the desired objectives or standards.

(5) Measure the sound level (Leq) for 2 hours. Check that the sound measuring instrument has enough batteries for the time required.

3) Record the sound level from traffic in the area of Phuket Municipality, namely Chaofa-Patiphat intersection, Saphan Hin Intersection, Jui Tui Intersection, Phuket Satree School Intersection and Bang Neaw intersection. Record the results of measuring traffic sound levels. Measurements at each point were carried out on random business days and public holidays. In the morning the measurement would be from 7:00 AM - 9:00 AM and in the evening the measurement would be from 5:00 PM - 7:00 PM as this is a period with heavy traffic and it's an urgent time.

RESULTS AND DISCUSSIONS

The general ambient sound level, averaged over 24 hours, should not exceed 70 dBA-weighted (dBA), and the maximum sound level at any given time should not exceed 115 dBA (National Environmental Board Announcement No. 15, 1997). This is calculated by averaging the sound level from sources over 8 hours or 24 hours to adjust the sound level occurring during the operating hours of machinery to an average level over 8 hours or 24 hours using Equation (1)

$$L_{Aeq,Tr} = \left[10\log_{10}(10^{0.1LAeq,TS} - 10^{0.1LAeq,R})\right] + 10\log_{10}(\frac{Ts}{Tr})$$

By

$L_{Aeq,Tr}$ = sound level during disturbance (dBA)

$L_{Aeq,Ts}$ = sound level during sound generation of the source (dBA)

$L_{Aeq,R}$ = sound level when there is no disturbance (dBA)

Ts = duration of time during which the sound source occurs (Minutes)

Tr = Reference period established for calculating sound levels during disturbances.

1. The sound level in the areas with traffic congestion in Phuket City Municipality, Phuket Province and comparing sound levels in the study areas with general ambient noise standards, it was found that:

Table 1: The sound level in the areas with traffic congestion in Phuket City Municipality

Sample point	L_{Aeq},Ts	(L_{Aeq},R)	(L_{Aeq},Tr)	(LA90)	Sound level
Satree Phuket School Intersection	71.2	56.2	71.1	64.0	7.1
Saphanhin Intersection	68.0	51.7	67.9	59.3	8.6
Chao Fah-Pattithan Intersection	70.5	56.4	70.3	63.5	6.8
Jui Tui Intersection	69.2	55.4	62.8	62.8	0.0
Bang Neaw Intersection	71.5	57.0	62.8	64.4	-1.6

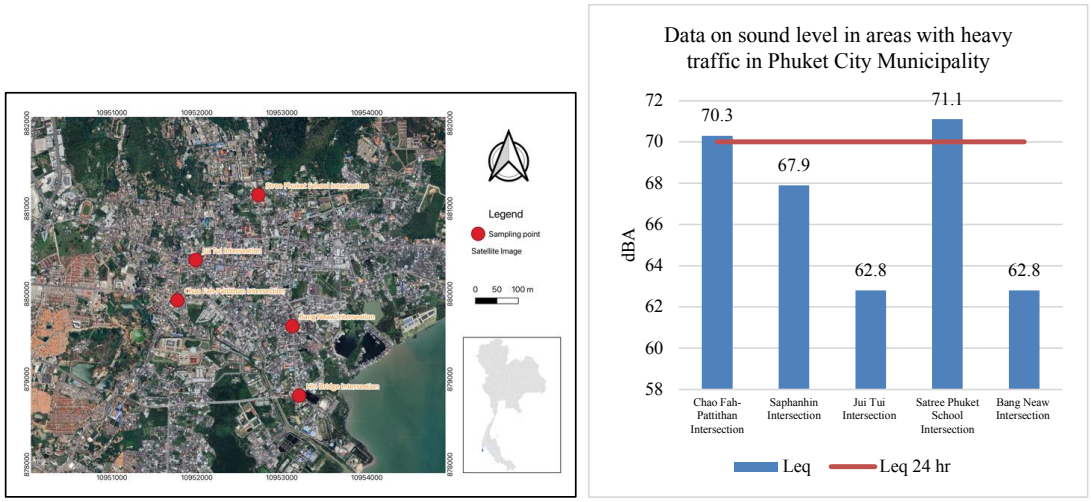

Figure 1 The sound level in the areas with traffic congestion within Phuket City Municipality, Phuket Province.

The average sound level over 24 hours in the area of Satree Phuket School Intersection was a maximum of 71.1 dBA, with the highest maximum sound level (Lmax) recorded as 101.20 dBA.

The average sound level over 24 hours in the area of Saphanhin Intersection was a maximum of 67.9 dBA, with the highest maximum sound level (Lmax) recorded as 109.60 dBA. This is because the measurement point is situated in front of the open water area of the public garden at Hin Bridge, which is a wide, open pond with few sound barriers. Consequently, this measurement point has the lowest sound level, consistent with the research by Wallicka, 2021, which found that environments with wide open spaces and minimal obstructions tended to have the lowest average sound levels [2]. The average sound level over 24 hours in the area of Chao Fah-Pattithan Intersection was a maximum of 70.3 dBA, with the highest maximum sound level (Lmax) recorded as 95.20 dBA. The average sound level over 24 hours in the area of Jui Tui Intersection was a maximum of 62.8 dBA, with the highest maximum sound level (Lmax) recorded as 98.80 dBA.

The average sound level over 24 hours in the area of Bang Neaw Intersection was a maximum of 62.8 dBA, with the highest maximum sound level (Lmax) recorded as 100.00 dBA. This is due to the fact that this measurement point is on a small road that leads to a shopping mall, causing slow traffic flow and continuous congestion, especially during the evening when many people visit the mall for shopping. Additionally, there are numerous noise sources from various activities such as conversations and commercial activities in nearby shops. Consequently, the sound level at this measurement point is relatively higher compared to others, consistent with Wallicka's research in 2021, which found that environments with high human density or high traffic density, such as roads leading to shopping malls with various activities, tended to have higher sound levels [3].

When comparing these sound levels to the general ambient noise standards, which specify that the average sound level over 24 hours should not exceed 70 dBA and the maximum sound level at any given time should not exceed 115 dBA (as per the National Environmental Board Announcement No. 15, 1997) [4], it can be observed that the sound levels in the study areas generally comply with these standards. This is because traffic volumes can move but slow down only near intersections. This finding aligns with the research by Supakit [5], which studied sound levels and disturbances in heavy traffic areas within municipal boundaries. Continuous traffic movements may affect the highest average sound levels.

Sound levels in areas with heavy traffic in Phuket Municipality Phuket Province were measured for 2 hours continuously in the morning and in the evening, then calculated the average sound level for 2 hours as the Leq value of every measurement point in 5 heavy traffic areas. It was found that the average sound level value in 2 hours (Leq, 2hr) of every measurement point had a value in the range 66.4 - 71.9 dBA with an L90 value in the range 57.8 - 64.9 dB(A).

When considering the value of the lowest Leq,2hr measured from the measurement point, it was found that the sound level in the Saphan Hin intersection area was equal to 66.4 dBA because this measurement point was in front of the fountain area at Saphan Hin Public Park. It has the appearance of a wide-open pond with only traffic noise sources and no obstructions in the fountain area, make this measurement point have the lowest sound level. Consistent with the research of Wanlika Wansanoh (2018), measuring sound levels in the environment of Pattaya City School 8 (Pattayanukul), Chonburi Province, it was found that a wide-open area with a few obstacles had the least average sound because the sound level has only one sound source.

For the highest Leq,2hr value measured from every measurement point, it was found that the sound level in the Bang Neaw intersection area has a maximum value of 71.9 dBA because this measurement point is a road that passes to a shopping mall and the road is small, causing cars to move slowly. Therefore, there is continuous traffic congestion. Especially during the evening, there is a lot of people going to shopping malls to make purchases. There are many sources of noise from various activities, such as talking or various activities of nearby shops. The sound of this measurement point was therefore relatively higher than other measurement points. Consistent with the research of Wanlika Wansanoh (2018), measuring sound levels in the environment of Pattaya City School 8 (Pattayanukul), Chonburi Province, it was found that in areas with many people or high density due to road use which is the route that passes to the department store and there are various activities, there would be many sound sources, therefore affecting the sound level as well.

Compare the sound level in the study area with general sound level standards in the atmosphere, it was found that the 24-hour average sound level for all 3 days at Satree Phuket School intersection area was equal to 63.5 dBA, which does not exceed the general sound level standards in the atmosphere. The 24-hour average was not more than 70 dBA. The highest sound level at any one time was not more than 115 dBA.

The 24-hour average sound level for all 3 days at Saphan Hin intersection area was equal to 60.30 dBA, which does not exceed the general sound level standards in the atmosphere. The 24-hour average was not more than 70 decibels. The highest sound level at any time was not more than 115 decibels.

Chaofa-Patiphat intersection area (Abattoir) had a 24-hour average sound level for all 3 days equal to 62.80 dBA, which does not exceed the general standard for sound levels in the atmosphere with a 24-hour average of not more than 70 dBA. The highest sound level at any time is not more than 115 dB.

The 24-hour average sound level for all 3 days at Jui Tui intersection area was equal to 61.4 dBA, which does not exceed the general sound level standards in the atmosphere. The 24-hour average was not more than 70 decibels. The highest sound level at any time was not more than 115 decibels.

The 24-hour average sound level for all 3 days at Bang Neaw intersection area was 63.8 dBA, which does not exceed the general standard for sound levels in the atmosphere with a 24-hour average of not more than 70 dBA.

From studying the sound levels in all 5 areas to compare with the sound level standards in the general atmosphere, it was found that the 24-hour average sound level measured was close to the standard which did not exceed the standard value for the general sound level in the atmosphere, averaging 24 hours, not more than 70 dBA. The highest sound level at any one time was not more than 115 dBA (Announcement of the National Environment Board, No. 15 B.E. 1997). This is because traffic volume can still move but it would slow down only near the intersection. This is consistent with the research of Suphakit Anyong *et al*. (2017), a study of sound and sound levels in heavy traffic areas in Kamphaeng Phet Municipality. The flow of traffic affects the sound level at the measurement point. Traffic with continuous movement has the highest average sound level.

CONCLUSION

The sound levels from traffic within Phuket City Municipality ranged from 60.3 to 63.7 dBA. The intersection with the lowest sound level from traffic was Saphanhin Intersection, with a sound level of 60.3 dBA, while the intersection with the highest sound level from traffic was Bang Neaw Intersection, with a sound level of 63.6 dBA. Upon considering the overall study area, it was found that measurement points with predominantly high sound levels were those located near shopping malls or various commercial activities. In summary, the sound levels measured at all 5 points within Phuket City Municipality did not exceed the general sound level standard as specified.

When considering the value of the lowest Leq,2hr measured from the measurement point, it was found that the sound level in the Saphan Hin intersection area was equal to 66.4 dBA because this measurement point was in front of the fountain area at Saphan Hin Public Park. It has the appearance of a wide-open pond with only traffic noise sources and no obstructions in the fountain area, make this measurement point have the lowest sound level. Consistent with the research of Wanlika Wansanoh (2018), measuring sound levels in the environment of Pattaya City School 8 (Pattayanukul), Chonburi Province, it was found that a wide-open area with a few obstacles had the least average sound because the sound level has only one sound source.

For the highest Leq,2hr value measured from every measurement point, it was found that the sound level in the Bang Neaw intersection area has a maximum value of 71.9 dBA because this measurement point is a road that passes to a shopping mall and the road is small, causing cars to move slowly. Therefore, there is continuous traffic congestion. Especially during the evening, there is a lot of people going to shopping malls to make purchases. There are many sources of noise from various activities, such as talking or various activities of nearby shops. The sound of this measurement point was therefore relatively higher than other measurement points. Consistent with the research of Wanlika Wansanoh (2018), measuring sound levels in the environment of Pattaya City School 8 (Pattayanukul), Chonburi Province, it was found that in areas with many people or high density due to road use which is the route that passes to the department store and there are various activities, there would be many sound sources, therefore affecting the sound level as well.

Compare the sound level in the study area with general sound level standards in the atmosphere, it was found that the 24-hour average sound level for all 3 days at Satree Phuket School intersection area was equal to 63.5 dBA, which does not exceed the general sound level standards in the atmosphere. The 24-hour average was not more than 70 dBA. The highest sound level at any one time was not more than 115 dBA.

The 24-hour average sound level for all 3 days at Saphan Hin intersection area was equal to 60.30 dBA, which does not exceed the general sound level standards in the atmosphere. The 24-hour average was not more than 70 decibels. The highest sound level at any time was not more than 115 decibels.

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The 24-hour average sound level for all 3 days at Jui Tui intersection area was equal to 61.4 dBA, which does not exceed the general sound level standards in the atmosphere. The 24-hour average was not more than 70 decibels. The highest sound level at any time was not more than 115 decibels.

The 24-hour average sound level for all 3 days at Bang Neaw intersection area was 63.8 dBA, which does not exceed the general standard for sound levels in the atmosphere with a 24-hour average of not more than 70 dBA.

From studying the sound levels in all 5 areas to compare with the sound level standards in the general atmosphere, it was found that the 24-hour average sound level measured was close to the standard which did not exceed the standard value for the general sound level in the atmosphere, averaging 24 hours, not more than 70 dBA. The highest sound level at any one time was not more than 115 dBA (Announcement of the National Environment Board, No. 15 B.E. 1997). This is because traffic volume can still move but it would slow down only near the intersection. This is consistent with the research of Suphakit Anyong *et al*. (2017), a study of sound and sound levels in heavy traffic areas in Kamphaeng Phet Municipality. The flow of traffic affects the sound level at the measurement point. Traffic with continuous movement has the highest average sound level.

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