EVALUATION OF NOISE LEVEL IN WOMAN TRAIN CABIN AT KTM KOMUTER BERHAD

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Abstract: Measuring the level of noise is one of the ergonomic risk factors that should be emphasized not to be exposed to this noise pollution for too long with values exceeding the normal limits. The aim of this study is to evaluate the actual value of noise measurement in KTM (Keretapi Tanah Melayu) Komuter Berhad based on operating hours; morning and afternoon. A concept to reduce noise level during train operation was proposed after that. Three sitting or standing points (gangway, near at the train exit door and middle of the train cabin’s) were measured using Sound Level Meter (TECPEL), at the same time the number of passengers had to be counted. The trip took exactly two hours which covered 18 stations. The results showed that the maximum value of noise reading was 82.2 dBA, occurred when standing at the gangway. This project may help KTM Komuter Berhad to increase the comfort of passenger when riding this public transport.

Keywords: Noise, Public Transport, KTM Komuter Berhad, Evaluation

1. INTRODUCTION

Railway in Malaysia enters the new era of high speeds and high capacities for both intercity and urban systems. There are several types of train service in Malaysia, such as Monorail, MRT Sungai Buloh-Kajang, LRT, ERL Link, and KTM Komuter Berhad that can be used to avoid congested traffic during peak hours. There should be an increase in the number of passengers when rail services has expanded their journey to connect between urban and intercity area. However, a report from Land Public Transport Commission (Malaysia) in 2016 showed that the number of passengers had decreased by 8.6% [1]. Therefore, by providing comfort and non-fatigue experiences of journey, KTM Komuter Berhad hope they can convince the passengers to use the train as one of their daily important transportations and thus increase the number of ridership of this public transport.

Noise in train along the passenger journey is the one of the factors that can contribute to fatigue [2]. Noise exposure can also lead to the risk of cardiovascular disease (CVD), mental ill-health, and mortality [3]. The purpose of this study is to evaluate the noise level in a women train cabin of KTM Komuter Berhad that travels from Pulau Sebang/Tampin to KL Sentral station. The study was started from Pulau
Sebang station, the first station for the trip by KTM Komuter line located in the state of Melaka and being the hub of Melaka to Kuala Lumpur. This trip ended at KL Sentral, as it is the largest hub connecting KTM Komuter with other public transport facilities such as LRT (Light Rail Transit) and Monorail. The journey took about two hours traveling time and noise level were recorded at three areas (in the middle of the cabin, at the gangway, and near the exit door). Information of this project can provide awareness to passengers regarding noise value inside a train cabin.

This paper is organized into the following sections: Section 2 reviews related literature on noise inside train in other countries and also source and effect of noise to human health. Methods used in this project are described in Section 3, and Section 4 elaborates and discusses the results of this study. The conclusion comes together with a suggestion for future researchers are explained in Section 5.

2. NOISE IN LITERATURE

2.1 Previous studies on noise

Several studies regarding noise have been conducted by researchers under different situation or environment. Edgar [4], who did noise study on students wellness, reported that high levels of noise have direct consequences on the academic performance as well as on the physical and psychological health of the student. He added that poor acoustic conditions maximize the noise problem and worsen the study condition of the students. Table 1 listed the noise value according to World Health Organization (WHO) and the effect if human were exposed to the noise pollution. The sound of jet take off or a motorcycle that gives noise value of 120 dBA (decibel) are among the examples of noise pollution that can cause hearing damage if we hear to it for more than one minute. Noise pollution also exist at home; for example, the sound of vacuum cleaner and the ring of a phone.

| Typical Example       | dBA | Effects                             |
|-----------------------|-----|-------------------------------------|
| Respiratory           | 0-10| Audition threshold                  |
| Home conversation     | 50  | Silent                              |
| Highway traffic       | 70  | Annoying, intrusive, interference of phone |
| (15m), vacuum cleaner |     |                                     |
| Average factory, train (at 15m) | 80  | Possible hearing damage              |
| Jet take-off, motorcycle | 120 | Damage if over than 1 minute         |

Several organizations have set the appropriate auditory limit value for humans when exposed to noisy situations over a certain period as shown in Table 2. The Malaysia Occupational Safety and Health Administration (OSHA) [5] exposure limit represents a regulatory standard, permitting an exposure of 90 dBA for 8 hours a day. Whereas, WHO standards [6] showed that the exposure for 8 hours to noise at only 75 dBa is enough to cause human noise induced hearing loss.

| Duration (dBA) | WHO (dBA) | OSHA (dBA) | Duration (min 30 s) | WHO (dBA) | OSHA (dBA) |
|----------------|-----------|------------|---------------------|-----------|------------|
| 8 h            | 75        | 90         | 7 min 30 s          | 93        | -          |
Previous study regarding noise annoyance compared with vibration exposure was done by Mikael [7], in which the result of vibration velocity does influence the annoyance from noise. Some noise studies that have been carried out for the railway system is shown in Table 3. Literature reported that a high-speed train contributes 96.2 dBA with maximum speed of 360 km/h. This level of noise can possibly cause hearing damage if passengers were exposed to the noise for more than 4 minutes. According to Neitzel [8], noise exposure is a function frequency-weighted exposure level and the exposure duration.

Table 3: Previous study regarding noise value related to train

| Journal/ Author | Name of Train Company | Result      |
|-----------------|-----------------------|-------------|
| Chicago Transit Authority Train Noise Exposure [9] | Chicago Transit Train | 76.9 dBA    |
| Acoustic Comfort Indicator for the Assessment of Interior Noise in Korean High Speed Trains [10] | Korean High Speed Train | 74.4 dBA |
| The Problem of High Speed Railway Noise Prediction and Reduction [11] | High speed train in Germany, France, China and United States | 96.2 dBA |
| | | 59.4 dBA |

Noise pollution from the railway transportation can come from variety of causes. These include as the noise when the train break, the noise caused by the gangway (the link between coaches to another train coach), and the noise when the train is moving (stemming from the wheel sound from the train wheel. In a closed and heavily passenger train, the noise can come from the passengers (passenger chatting in the train) or even from the air conditioner inside the train cabin.

3. METHODOLOGY
Noise measurements within passenger trains were taken from Pulau Sebang/Tampin until KL Sentral for morning hour and from KL Sentral to Pulau Sebang/Tampin for afternoon hour. It covered 18 stations with two hours of journey travel in the morning (9-11 am) and afternoon (12-2 pm). A Sound Level Meter (TECPEL) was used to capture and measure the noise inside women cabin for KTM Komuter Berhad. Using a battery of 9 volts to operate...
the tools and it can capture the maximum and minimum level of noise. Sound Level Meter also has been calibrated prior to use to measure noise inside train cabin. Frequency-weight averages (Leq) representing the average noise exposure level over a period of time. The noise was captured every second and recorded. Researcher carried the sound Level Meter microphone on a collared shirt, 2 inches away from the researcher’s ear to provide a representative estimate of personnel noise exposure. Data retrieval was done in the middle of the cabin, near the exit door, and at the gangway as shown in Figure 1.

![Figure 1. Position of reading noise measurement inside a train. (a=at the gangway, b=at the exit door, c=at the middle of the cabin)](image)

The measurement of noise and the number of passengers inside the train cabin was monitored after the train departure from one station to another. Noise data was also taken after the next station announcement that was made by the train driver. At the same time, using stop watch, travel time from one station to another station was recorded to complete data collection for this case study. The observer avoid reading the sound tool that was close to the passenger who was chatting inside the train. The data was analyzed by using Microsoft Excel. Regression analysis and equation were used to examine the matrix relationships between noise reading, time data and place data was taken as well as the number of passengers in women cabin.

Based on the growing women population, and in line with the increase in the value of women users onboard the train, this study was conducted in a women cabin[12]. This is aimed to give women awareness on the noise value when they experienced during travel with KTM Komuter Berhad. The outcome of this study can provide information to women on which part of the train gives the highest value of noise pollution so they can avoid standing around that areas. The results of this study may also provide information to the KTM Komuter regarding the current noise value inside their commuter train, allowing them to take precautionary measures if the value obtained exceeds the predetermined standard value.

4. RESULTS AND DISCUSSION

The measurement of noise data was taken inside a women cabin for KTM Komuter Berhad near the exit door, middle of the cabin, and at the gangway. Table 4 represents the summarized data for noise reading at the three different positions that were collected over 18 stations during a train journey from Pulau Sebang/Tampin to KL Sentral and went back from KL Sentral to Pulau Sebang/Tampin.

Overall results showed that there were more passengers riding a train in the morning hours compared to the afternoon. Another result that has been discovered was the number of passenger in the morning hour was higher than afternoon hour. This was possibly due to people rushing to get to their workplaces in the morning time rather than the afternoon. The results obtained agreed with the study by Xu [13], who discovered that there was more crowded population of the passenger in the morning hour because many users use the train to go to work to avoid traffic congestion. Passenger crowd in a cabin is a contributor to noise pollution that can cause discomfort to the users [14].

|                      | Morning | Evening |
|----------------------|---------|---------|
| **Table 4.** Comparison results for noise reading inside a train cabin of KTM Komuter |         |         |
Comparison between morning and afternoon traveling time showed the highest value of noise reading was 82.2 dBA. It was recorded at the gangway position during the morning hour when the train travels from UKM (Universiti Kebangsaan Malaysia) to Kajang, as shown in Table 4. In KTM Komuter train, there are eight gangways connecting one cabin to another. According to Min Noh [2], the noise reading on the gangway were higher than the readings in the cabin. This statement supports the result obtained in this study. Meanwhile, the maximum value of noise reading for the afternoon journey was 80.3 dBA from Sg. Gadut to Rembau Station when the noise tool was placed near the train exit door with the number of passenger was 9. With the small number of passengers as states before, noise from friction of wheel to track is greater than the noise from passenger along the journey that took about 10 minutes (records of travel time have been showed in Figure 2). From Table 2, this value can possibly cause hearing damage if ones were exposed to it more than 15 minutes. The noise value was worsen by the non-smooth track condition along the path. Figure 2 shows travel time that has been successfully recorded to meet the needs of this case study. From Figure 2, the longest journey is from Pulau Sebang to Rembau station which takes 13 minutes 52 seconds, while the shortest journey is from Midvalley to Seputeh for one minute. This travel time affects the noise level in the train cabin where the passenger will rush out of the train give a high of noise value if the train journey is short because worries the train door will be closed before they can get out of the train. When compared to the longer journey, the passenger is quitter to get out of the train cabin when arriving to the destination and this affects lower noise level reading. This graph on Figure 2 can also be used by the passenger of the KTM Komuter to plan their journey to reach the destination on time.
Table 4 shows that low noise value of 58.5 dBA for an afternoon trip when the train moved from Salak Selatan to BTS (Bandar Tasik Selatan) Station. With a relatively high passenger value in a cabin, totaling to 62 people at that time, the noise value is lower although it can still be considered as annoying noise. This was probably because the six-minute journey made passengers to have their cool downtime inside the train near the exit door. Meanwhile, for morning trip, the lowest recorded value is 65 dBa from Seputeh to Midvalley Station. This value is obtained because the passengers were in hurry to get out of the train due to the very short time for one minute (as illustrated by Figure 2, a trip from Seputeh to Midvalley is the shortest journey compared to the others).

Figure 3 shows describe the fluctuated value of noise data for morning hour in KTM Komuter Berhad that travels from Pulau Sebang to KL Sentral. As can be seen, the number of passengers is increasing since the morning from Pulau Sebang Station to KL Sentral Station. For most of the passenger, their last destination is at KL Sentral Station. This is because KL Sentral serves as the interchange station within the same or different transit line or other public transport [15]. From Figure 3 too, there are 8 times when the reading reached maximum values, which were obtained from the noise is in the gangway area. The result shows that users who stand near the gangway are more vulnerable to the noise pollution compared to other places. The minimum value of noise is obtained when the noise tool placed in the middle of the cabin which gives 11 times of the minimum value of noise reading along the way in the morning journey. As a result from this study, it is expected that passengers can avoid from standing at the gangway and if possible stand or sit in the middle of the train cabin.
Figure 3. Noise reading from Pulau Sebang to KL Sentral

For the afternoon trips, noise data from KL Sentral to Pulau Sebang Station is illustrated in Figure 4. There was a decrease in the number of passengers onboard the train from KL Sentral to Pulau Sebang. The reduction in the number of passengers is because Pulau Sebang Station is the last destination for the trip from Kuala Lumpur to Melaka. For this afternoon trip, the same fluctuating trending graph was observed as in the morning journey. The maximum value of noise was found to be at the gangway (same result with morning journey) for 9 times. Meanwhile, the minimum noise value was observed at the exit door for the journey from KL Sentral to Pulau Sebang for 9 times.
The percentage of response variables can be explained by the relationship between the numbers of passengers, the location of the noise reading where the data was taken, and the time when the data was taken and analysed it into a model of predictive variable using Microsoft Excel. A linear regression line that minimizes the distance between the fitted line and all noise data points can be generated using regression analysis. \( R^2 \) is a statistical measure to show how close the noise data are to the fitted regression line. The \( R^2 \) value is always between 0% and 100%. In general, the higher the value of \( R^2 \), the better the model is. Table 4 shows the regression model on the afternoon journey for a number of passengers inside one cabin of KTM Komuter, in which 89.66% of the variance gives the highest value of \( R^2 \) in this study. Meanwhile, the lowest value of \( R^2 \) variance was in value of noise category which gave 0.7% when the tool of noise was placed near the exit door during the afternoon journey. During morning hour, a high value of \( R^2 \) (30.06%) was observed at the middle of the cabin. The more variance that was accounted for by the regression model, the closer data points would fall to the fitted regression line.

In order to understand more on the statistical relationship between one or more predictors and the response variable to predict new observation, an equation is used. For this study, a simple linear regression was performed to observe the relationship between the number of passengers in the morning and afternoon and the noise reading monitored in three different places as shown in Table 5. In relation to Figure 3 and 4, the response variable, \( y \), is the noise reading in \( L_{eq} \) and the predictor variable, \( x \), is the 18 stations that were covered in this case study. Here, the dependent variable (\( L_{eq} \) for noise value) was presumed to be in a linear relationship with the changes of the train station for morning and afternoon journey. For a negative value from all point of noise data in the morning and one data at the middle of train indicate a decreasing...
relationship between noise value $L_{eq}$ and station, in which from the beginning of the journey gave a high noise value to the final destination at KL Sentral the noise value was reduced. A positive value of noise reading when placed at the gangway and exit door position indicates an increasing relationship between train station and noise value. The afternoon session that started from KL Sentral to Pulau Sebang gives low to high value of noise reading.

Table 5. Comparison of results using regression models and equation

|                | No of passenger | Gangway | Near the exit door | Middle of the train cabin |
|----------------|-----------------|---------|-------------------|---------------------------|
| Morning hour   | R²              | 0.8966  | 0.0297            | 0.1768                    | 0.3006                    |
| (PS – KLS)     | Equation        | $y = 4.2917x + 2.8603$ | $y = 0.165x + 75.132$ | $y = 0.3238x + 76.726$ | $y = 0.291x + 73.326$ |
| Afternoon hour | R²              | 0.7148  | 0.0835            | 0.007                     | 0.2245                    |
| (KLS – PS)     | Equation        | $y = -2.833x + 55.5$ | $y = 0.2387x + 70.081$ | $y = 0.0701x + 69.263$ | $y = -0.3819x + 67.269$ |

5. CONCLUSION

Overall, the noise measurement at the gangway had the highest value of noise reading. It is hoped that the train users should avoid standing around the gangway area when riding a train if they do not want to be exposed to the noise pollution. For the train station, the highest value of noise was observed when traveling from UKM to Kajang Station. And for this study, the highest value of noise reading was found during the morning hour. This corresponds with a large number of passengers riding a train during the morning hour.

There are various ways to reduce the noise pollution that occurs when the train moving. Among other things is to use a noise absorbed foam which can be mounted around the train cabin wall or in a place that contributes the highest noise value (in this case study, it is at the gangway). The foam will absorb sound generated from the train while moving. The use of curtains and carpet can also reduce the noise reading inside a train. Besides, the existence of these carpets and curtains will create a luxurious condition in the cabin and train becomes more comfortable and attractive for public users. It is hoped that KTM Komuter Berhad will also be able to take this issue seriously to reduce the value of noise reading faced by passengers when riding these public facilities. Further measurement and analyses are being carried out to reveal the cause of noise that contributes to the uncomforted journey to passengers.

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