SCHOOL OF MATERIALS AND MINERAL RESOURCES ENGINEERING

UNIVERSITI SAINS MALAYSIA

ASSESSMENT OF QUARRY ENVIRONMENTAL MODELING SOFTWARE VERSION2.0 (QEMS V2.0) FOR ESTIMATION OF NOISE AT CRUSHER BOUNDARY

BY

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DECLARATION

I hereby declare that I have conducted, completed the research work and written the dissertation entitled “Assessment of Quarry Environmental Modeling Software Version 2.0 (Qems V2.0) for Estimation of Noise at Crusher Boundary”. I also declare it has not been previously submitted for the award of any degree or diploma or other professional qualification, to this or any other examining body or university.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
DOE	Department of Environment Malaysia
JMG	Minerals and Geoscieces Department Malaysia
KMO	Kaiser-Meyer-Olkin
MBI	Ipoh Municipal Council
MRA	Multiple Regression Analysis
MSA	Measure of Sampling Adequacy
NIHL	Noise-induced hearing lost
NIOSH	National Institute Safety and Health
OSHA	Occupational Safety and Health Acts
PC	Principal Component
PCA	Principal Component Analysis
QEMs	Quarry Environment Modeling Software
SPSS	Statistical Package for Social Sciences
VIF	Variance Inflation Factor
WHO	World Health Organization

PENILAIAN PERANGKAT LUNAK MODEL PERINGKATKAN PERKHIDMATAN VERSI 2.0 (QEMS V2.0) UNTUK PERTIMBANGAN BUNYI DI SEMPADAN MESIN PENGHANCUR

(SIMPANG PULAI, PERAK)

ABSTRAK

Pelepasan bunyi adalah salah satu masalah utama yang dihadapi oleh kuari-kuari di seluruh dunia akibat daripada kesan kesihatan yang berpotensi terhadap masyarakat sekitar. Keadaan yang lebih teruk apabila pelepasan bunyi bising yang berada dalam lingkungan yang berbahaya iaitu 85dB, yang telah terbukti bahawa ia menyebabkan kesan kesihatan menjadi lebih teruk. Kesan kesihatan yang teruk ini seperti gangguan emosi, gangguan pendengaran dan juga hilang pendengaran. Dalam operasi kuari, penghancur biasa menghasilkan pelepasan bunyi yang berlebihan. Walau bagaimanapun, Jabatan Alam Sekitar (JAS) Malaysia telah menetapkan peraturan bunyi untuk mengawal fenomena ini. Selain itu, semua kuari di Malaysia telah mengamalkan pemantauan bunyi sebagai keperluan oleh peraturan. Berdasarkan kajian ini di Simpang Pulai, Perak, kertas bertulis ini adalah idea untuk membangunkan model ramalan baru untuk meramalkan pelepasan bunyi di sempadan penghancur. Model ini akan disahkan oleh perisian lain iaitu Versi QEMs 2. Semua data yang dikumpul dianalisis menggunakan pakej perisian IBM SPSS 13.0. Hasil analisa pada model baru telah dibuat dan menunjukkan R^2 adalah 0.139 yang menunjukkan bahawa pembolehubah meteorologi tidak banyak mempengaruhi bunyi bising. Manakala perbandingan kedua-dua model dengan tahap hingar sebenar menunjukkan QEM mempunyai nilai R^2 adalah 0.627 yang lebih baik daripada model ramalan baru.

ASSESSMENT OF QUARRY ENVIRONMENTAL MODELING SOFTWARE VERSION2.0 (QEMS V2.0) FOR ESTIMATION OF NOISE AT CRUSHER BOUNDARY

(SIMPANG PULAI, PERAK)

ABSTRACT

Noise emission is one of the main problems faced by quarries throughout the world due to the health effects towards surrounding societies. The worst case when the emissions of noise that fall into the hazardous range which is above 85dB, which have been shown to cause more severe health effect. The severe health effect can be in emotional disturbance, hearing impairment and also hearing loss. In quarry operation, commonly crusher produced an excessive noise emission. However, the Department of Environment (DOE) Malaysia has established the regulation of noise to control this phenomenon. Furthermore, all quarries in Malaysia have been practice noise monitoring as the requirement by regulations. Based on this study in Simpang Pulai, Perak, this written paper was the idea of develop a new prediction model to predict the sound emission at crusher boundary. This model will be verified by another software namely QEMs Version 2. All the data collected were analyzed using IBM SPSS 13.0 software package. The results of the analysis on new model has been made and showed the R^2 is 0.139 which indicates that meteorological variables do not heavily effects on the noise. While the comparison on both models with actual noise level resulted the QEMs had value of R^2 is 0.627 which is better than new prediction model.

CHAPTER 1 INTRODUCTION

1.1 Background

Nowadays, human is exposed toward noise at all the time. Noise will give a bad impact toward environmental society. In environmental circumstance, noise can be defined as undesired annoying sound that may be hazardous to hearing. In daily life our environment was polluted by noise. There are many sources of noise that produced by our daily activities. Generally, it can be generated by heavy traffic, building construction, industrial activities and others. For industrial activities, noise has been produced by technologies or machines that used with a vary level of noise. As an illustration, in quarrying and mining industries the noise is produced by blasting activities, transportation and machines that used for processing purpose like crusher, milling, jigs, shaking table, compressor and others.

Quarrying and mining field is one of the largest industries in the world. Thus, a lot of noise has been produced by their operation. In Malaysia, usually the location of quarry site is near to the public region such as highways, recreation parks, residential areas and others. Therefore, the disturbance of noise that generated by this quarry activities might give a trouble toward the environmental society if they receive excessive level of noise in a long period of time.

In order to avoid this problem of environmental society, noise monitoring should be conducted. The purpose of noise monitoring is to ensure that the noise level that produced is acceptable with the standard. The other objective of this monitoring is to determine the noisy area. Furthermore, noise monitoring also helps to identify if there is any decay in machinery that may lead to the formation of excessive noise. There are many types of equipment that suitable to measure the noise level such as noise dosimeter, sound level meter (SLM), integrating sound level meter (ISLM) and others. All of these equipment able to measure any kind of sound or noise that been produced. Technically, there are some factors should be taken in conducting this monitoring such as cost, time, people in charged and else. For example, to conduct a noise monitoring the equipment should be suitable and calibrate first. Thus, its take more cost to buy the equipment and longer time to calibrate it.

On the other hand, there is software that eases to estimate the average of noise level at quarry boundary without do a noise monitoring. This software is known as Quarry Environmental Modeling Software Version 2.0 (QEMs V2.0). This software was created by Jabatan Mineral dan Geosains (JMG). This model is used a specific formulae and their calculation to estimate the noise level that generated by quarry activities at quarry boundary. However, this model is limited use. It only able to estimate the noise level that produced by crusher and traffic in quarry. It is because they were considered that crusher and traffic in quarry is the major noise producer in daily quarry activities. Hence, this software able to estimate the level of noise in quarry with less cost and save time.

This study is to validate a new model and compared with QEMs V2.0 which estimates the level of noise at quarry boundary. An innovative of noise assessment approach via multivariate statistical analysis has been used to establish the relationship between data of noise level at crusher and meteorological parameters quantitatively and also development of new model to compared with existing estimation of crusher noise by QEMs V2.0.

1.2 Problem statement

The problem related in this assessment of noise is how well the Quarry Environmental Modeling software work on the estimation of noise that generated by crusher in quarry. The noise monitoring and meteorological survey are done continuously in the same quarry site. The meteorological parameters that include are wind speed, wind direction, humidity, pressure, solar radiation and rain. This monitoring and survey is to observe how the meteorological parameters affect the noise level in quarry.

Other than that, the collected data were analyzed by observing the correlation between noise levels produced and meteorological parameters. The method that been used is the multivariate statistical analysis which able to generate formulae and calculation in order to estimate the noise level in the quarry. The result of this multivariate statistical analysis will compare with another result that produced by QEMs. Thus, this assessment is to prove either the existing model able to work properly or not. If not, some correction should be done in this model.

1.3 Objectives

The objectives of the assessment are:

i. To study the existing model for estimation of crusher noise level by using Quarry Environmental Modeling software Version 2 (QEMs V2.0).

ii. To observe the relationship between the noise level from crushing activity and meteorological conditions at selected crusher boundary.

iii. To construct a new model for noise from crushing activities at crusher boundary.

iv. To validate a new model and QEMs V2.0 for estimation for crusher noise at crusher at crusher boundary with actual noise level.

1.4 Scope of Work

This research is involved in a detailed assessment that carried out at Simpang Pulai, Perak. The data has been collected only in one quarry which is Cabaran Granite Quarry Sdn Bhd from 2nd April to 20th April 2018. This research has been used a multivariate statistical analysis to quantify empirically, specifically: (1) the relationship between noise level that generated by the crusher and meteorological conditions and (2) create a new model and compared it with QEMs V2.0 estimation for crusher noise at quarry boundary. The main statistical techniques that involved were principal component analysis (PCA) and multiple regression analysis (MRA).

PCA is used to determine the significant sources of noise produced from crushing activities. It goals to: (1) compress the dimensionality of data set that contain a large number of correlated variables; (2) point out as much as possible the significant information from data set; and (3) transforming and simplify the present set of variables to a new set of variables (Jolliffe 2002). Besides, the objective of multi regression analysis is to predict the value of the dependent variable in the future. These both methods were used to validate the estimation of noise at crusher boundary by QEMs.

The noise monitoring has been done by using calibrated KIMO DB 200 Sound Level Meter (SLM). This SLM was place at crusher and crusher boundary. This data of noise monitoring are used as a dependent variable. Meanwhile, the data of meteorological were used as independent variables. Meteorological survey was done by using HOBO weather station. The meteorological factors that involved in this research were (1) humidity; (2) pressure; (3) rain; (4) temperature; (5) wind direction and (6) wind speed. The statistical analysis conducted in this research by using IBM SPSS Statistics 13.0 software package.

1.5 Thesis Outline

This thesis contains five main chapters:

Chapter 1 is introducing the research project comprising the overview of research background, problem statement, objectives and scope of work.

Chapter 2 contains the literature review on noise due to its definition, classification, sources, standardization, problem and also effects. Besides, the information suitable instrument that been used during collection data and the statistical methods employed in the development of new noise model also include in this chapter.

Chapter 3 cover the explanation of the overall experiment work at site. The methodology was summarized in the chart with the process taken.

Chapter 4 presents and discusses the results from statistical analysis which include unilabiate, bivariate and multivariate profiling, factor analysis and model validation.

Chapter 5 explains the summarization or conclusion for the overall research work. Recommendations for future study are also provided.

CHAPTER 2 LITERATURE REVIEW

2.1 Noise

2.1.1 Definition

Generally, sound is important components that represent an environment, and it associates absolutely with people's sense of hearing. Sound is a thing that can be heard which is the energy wave vibration emitted in form of vibration (Kang, 2007). It also consider as mechanical vibrations that transmitted through the air or another medium (as air and water) until it reach a person's or animal's ear. The mechanic vibration in sound is described by relationship between pressure (Pascal, Pa) and frequency or pitch (Hertz, Hz) (Muhammad Anees, Qasim et al. 2017). When, sound amplitude express in Pascal, Pa, the results can be in a very large number (Katalin 2018). Thus, the measurement unit of sound is described in decibels, dB become easier. Sound can be classified to a various sound sources and type that can be recognized as positive and negative (Brown et al., 2011).

The conversion unit of sound from Pascal, Pa to decibels, dB is expressed as:

$$SPL = 10\log\left(\frac{p^2}{p_{ref}^2}\right)\ dB$$

Where;

SPL = Sound Pressure Level in decibels (dB)

p = sound pressure fluctuation (atmospheric pressure)

p_{ref} = threshold of hearing which is 20 micropascals ($2\text{x}10^{-5}$ Pa)

Besides, noise is mentioned as unpleasant sound which implies a negative emotion (Jennings & Cain, 2013). The sound is specifically one that loud or irritating or that causes annoyance. This unpleasant sound may interrupt or obstruct with our activities such as having a communications or dealing with mental tasks (Moudon, 2009). Noise also classifies as a by-product of any activity that has been affect the person hearing capability (Basu, 2010). Noise is represent in decibels, dB. There is a noise descriptors used to indicate statistical noise quantities with a logical and efficient way of classifying measures. An example is given below:

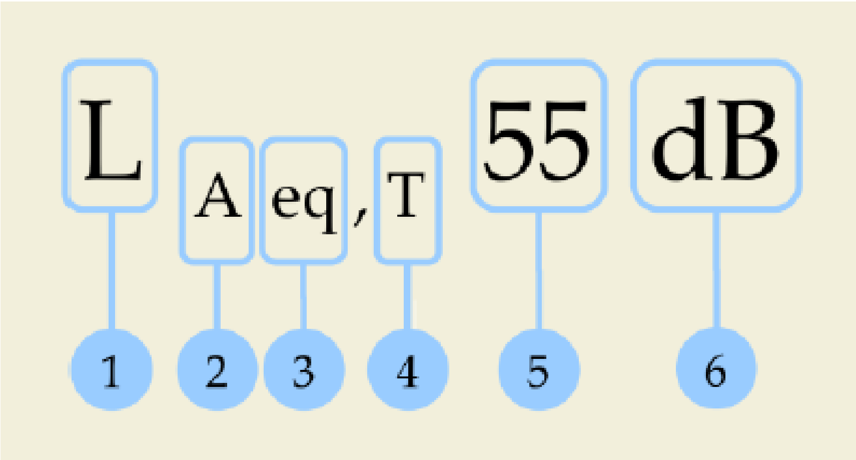

Figure 2.1 The example of noise descriptor

The Figure 2.1 is comprised as follows:

The first part (L) is a quantity of sound pressure level. There are other quantities that commonly used such as sound power (LW) and sound intensity (LI).

i. The second part (A) is described the result is used A-weighting filter. This is one of the frequencies weighting filter which used to modify the mechanism in which the equipment measures the noise generated. The other frequencies weighting are C and Z.
ii. Next part (eq) show the value is in term of equivalent noise level, this is synonym with an average noise level. It also can be in numerical value which means that the noise level exceeded the n percent of the measurement. For example, the value of $L_{A75,}$ 55dB indicates that A-weighted sound level exceeded 55dB for 75% of the period survey.
iii. The forth part (T) stands for the duration of survey. It can be in minutes or hours.
iv. After that, part (55) show the value of noise level produced. This is typically represented in whole number or to one decimal place.
v. The final part (dB) indicates that the units of noise level which is decibels.

The purpose of variety within noise descriptor is to measure a noise level with suitable purpose and condition. The most popular are ambient noise level, background noise level, maximum sound level and road traffic noise. Thus, the selection of noise descriptor part is important in which to get a good result.

The environment producing noises naturally, but over the time, they are being toned down by human involvements with more different sound (Pijanowski et al., 2011). Environmental sounds vary with location, space and time (Raimbault & Dubois, 2005; Botteldooren et al., 2006). Noise can be harmful and dangerous to our daily life. It may lead us to hearing damage, even worst disease of nervous system, digestive system and cardiovascular system. It also can be directly or indirectly affect our performance, especially at work place (Singh & Davar, 2004).

However, noise pollution is described as the environmental trouble caused by noise that resulting a dissatisfy feeling for living in vicinity. Nowadays, our surrounding environment always is being polluted by noise. This noise pollution probably can be produce from many sources such as the sound from an airplanes, dog barking, television, traffic and else. The formation of noise pollution has three main factors. It’s including noise source, propagation way and recipient.

2.1.2 Noise control criterion

The design of engineering should be rely on a good practice into the public domain, especially a noise pollution. Since 1974 the noise environment has been strengthened due to political desire (Kevin 1994). Noise levels above 85 dB are classified as hazardous for people and are found especially among construction, manufacturing, mining workers, usually in developing countries. However, according to the Occupational Safety and Health Act (OSHA) 1970, it recommends the exposure limit of noise is 90 dBA with a 5-dBA exchange rate within 8 hour per day. This effort to ensure the workers saves from noise hazardous.

In quarry activity, if the production of the day is high the longer time needed in crushing activity. So, the workers may expose to noise hazardous for a longer time. This exposure need to avoid because of the long-term side effect toward workers. The limits shown in Table 1 are described by a formula for estimation of noise dose is express as:

$$D = \frac{C}{T} \times 100\%$$

Where;

D = noise dose in percent

C = actual time of exposures (hours)

T = noise exposures limit (hours)

There is another equation which deals with the exposure of two or more different noise levels, the total of ratio these different noise levels is compute to get the noise dose. This estimation is express as:

$$D = \left(\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ ... \frac{C_n}{T_n}\right) \times 100\%$$

According to the OSHA 1970 standard, there are Limits for Allowable Noise Exposure as shown in the Table 1.

Table 1: The Limits for Allowable Noise Exposure

Table 2.1 The limits for allowable noise exposure

Noise Level (dBA)	Time (hours)
85	16.00
87	12.13
90	8.00
92	6.07
95	4.00
100	2.00
102	1.52
104	1.15
105	1.00
110	0.50
115	0.25

2.2 Noise measuring instruments

2.2.1 Introduction

In the practice of occupational hygiene, there are many type of noise measuring systems are widely used due to the advanced of technologies. These vary of noise measuring systems are depending on the: (1) aim of the study; (2) the sound properties and (3) the extent of information that related with sound. The various elements that commonly used in a measuring system include the: (1) microphone act as transducer; (2) frequency weighting; (3) calibrated attenuator and electronic amplifier for gain control; (4) data storage facilities; and (5) display. But, the measuring system also can be performing without one or two elements.

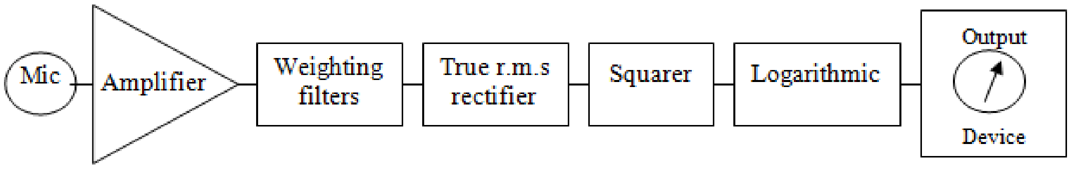

Figure 2.2 General block diagram of measuring instrument

Figure 2.2 show general block diagram of measuring instrument (Berger 2003). Sound pressure captured by the microphone to transducer it to a voltage signal. So, the conversion sound pressure to voltage is obviously affected the accuracy of the result of measurement. Then, amplifier used to make sure the microphone signal achieves an appropriate level. After that, the waveform will undergo the derivation of root-mean-square (RMS) voltage. Next element is squarer which consider as special case because of the linearity between power and square of the sound pressure. Lastly, the recent output which is square rms voltage will derives by logarithm. The result is express as R_{RMS}^2.

2.2.2 Microphones

Microphone is the interface between the measuring system and acoustic field. The function of microphone is to convert the sound signal to an electrical signal (Katalin 2018). The electrical signal produced can be resolved by the measuring equipment. There are 3 types of microphone that commonly used in measuring equipment, which are: (1) piezoelectric; (2) condenser and (3) electrets.

The name of piezoelectric microphone is due to the piezoelectric crystal that attached with the microphone membrane. It able to produces an electric current then yielded to mechanical tension. The microphone membrane was used to capture the vibration in the air that resulted from the sound waves produced. Then, the piezoelectric crystal will response and convert the vibration into an electric signal. This type of microphone is mechanically robust, stable and not easily influenced by climate change of region, especially temperature (Katalin 2018).

Meanwhile, condenser microphone mostly used by SLM. The microphone membrane is constructed parallel to a capacitor that polarized by a voltage source with high impendence amplifier (Wu, Chen et al. 2009). The membrane also attached with condenser. The mechanism is when the sound waves provoke in microphone membrane or diaphragm, the diaphragm will moves back and forth direct to the solid metal plate. Then, the capacitor will response to the rhythm of the sound and produce a electric current. Therefore, the sound wave can be converted into electric signal for measurement of sound. There are some advantages of condenser microphone which are has high sensitivity, flat frequency response, and low noise level (Wu, Chen et al. 2009). There are a few factor could be boosted the sensitivity of sensitivity of condenser microphone which includes the diaphragm size, bias voltage and air gap (Wu, Chen et al. 2009). Specifically, the sensitivity of condenser can be express as:

$$S_o = \frac{A}{k_m \, \sigma} \frac{V_b}{d} \frac{C_s}{C_s + C_p}$$

Where;

S_o = sensitivity of condenser microphone

A = area of diaphragm

k_m = equivalent spring constant

σ = membrane intrinsic stress

V_b = polarization voltage

d = distance between diaphragm and the plate

C_s = sensing capacitance

C_p = parasitic capacitance

The last type is dynamic microphone. This microphone consists of membrane that attached to a movable coil which centered in a magnetic field of a permanent electrostatic charge. Sound wave is triggered by the mechanical fluctuation of the membrane. At this moment, variations of current in the coil were produced via electromagnetic induction due to the movement of coil towards the magnetic field. This microphone has a limitation in frequency response because of the membrane does not respond to all frequencies. However, dynamic microphone able to works in moist condition.

2.2.3 Sound level meter

In the various industries today, Sound-Level Meter (SLM) is device that widely used in the measurement of sound. The availability of this device can be the simplest equipments built with one frequency weighting. It also can be fitted with various frequencies weighting according the advancement of technology today. Furthermore, SLM has a digital storage data with different capacity depends on the manufacturing. The Figure show the typical block diagram of sound-level meters.

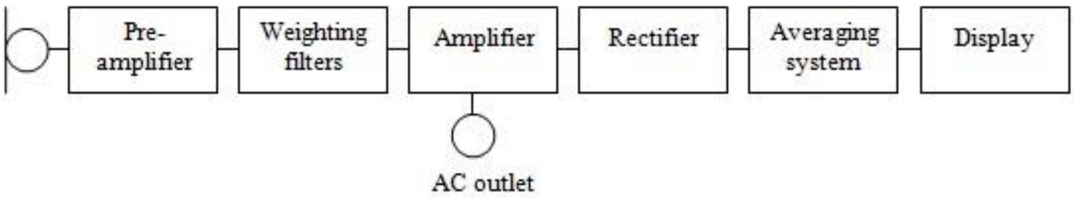

Figure 2.3 Block diagram of sound-level meter

The IEC Publication 651 and BS 5969 categorize SLM due to the level of accuracy. Table 2.2shows the various types and intended discipline of application. As the number of these various types is increase, it will reduce the measurement precision that indirectly affected the manufacturing costs.

Table 2.2 The various type and intended discipline of application

Type	Intended discipline of application	Absoulute accuracy (at refrence f requency) in refrence direction at the refrence sound level (dB)
0	Laboratory reference standards	±0.4
1	Laboratory use and field use where the acoustical environment can be closely specified or controlled	±0.7
2	General field work	±1.0
3	Noise monitoring	±1.5

There are some sound level meters able to measure peak level with certain time constant and equipped with circuit that possible to hold the instantaneous level. The sound level meter also offer the possibility to measure the fast or slow exponential averaging sound pressure. This SLM also known as integrating sound-level meters. The measurement is expressed as $L_{eq,T}$ (the equivalent level). In this case, Type 0 and 1 instrument are suitable for this measurement as vary of sound level over a very wide range and contain very short impulse or burst (Boyes 2009). Integrating sound-level meters also allow a value which known as sound energy level (SEL).

The value of L_{eq} with certain period of time is express as:

$$L_{eq} = 10 \log \frac{1}{T} \int_0^T \frac{[p(t)]^2}{p_0^2} dt$$

Where;

L_{eq} = equivalent continuous sound level

T = the measurement duration

$p(t)$= instantaneous value of the sound pressure (usually A-weighted)

p_0 = the reference rms sound pressure of 20µPa

2.2.4 Dosimeter

Dosimeter is device designed to measure the maximum daily noise dose by percentage in order to comply with OSHA's regulations. This device is provide a multipurpose use of data including; (1) noise dose and equivalent Time-Weighted Average (TWA); (2) any present or future compensation and (3) detailed histogram of the person's noise exposure such as the percentile distribution of sound level (Berger 2003). Figure 2.4 shows the schematic of noise dosimeter.

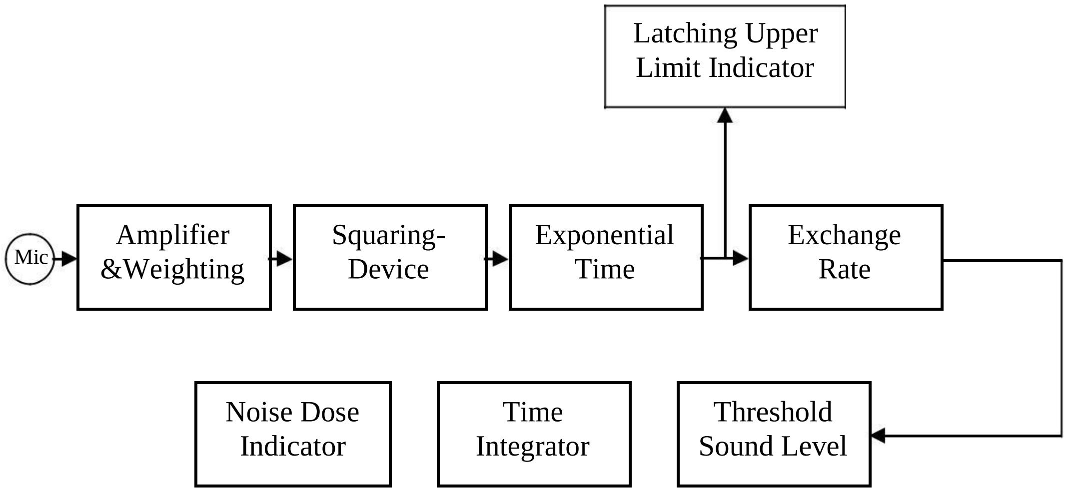

Figure 2.4 Block diagram for noise dosimeter

Dosimeter is used A-weighting network which can be received per day. The exponential time-weighting is must install in dosimeter to incorporating with the slow-response characteristic. Latching upper limit indicator function to detect and provide warning that excessive sound pressure levels that produced (Raichel 2006).

2.2.5 Band Octave Analyzer

Octave band analyzer is sound measurement device which includes a bank of sequential octave band filters. The principle is quiet simple which this device is measure the sound level in each band during the measurement of the spectrum. The spectra is generating by a tedious operation. The result usually expressed on a scale graph where the abscissa (horizontal) is represent the octave band center frequency (Hz) and the ordinate (vertical axis) represent the sound levels (dB). Figure show the block diagram for a serial octave band analyzer.

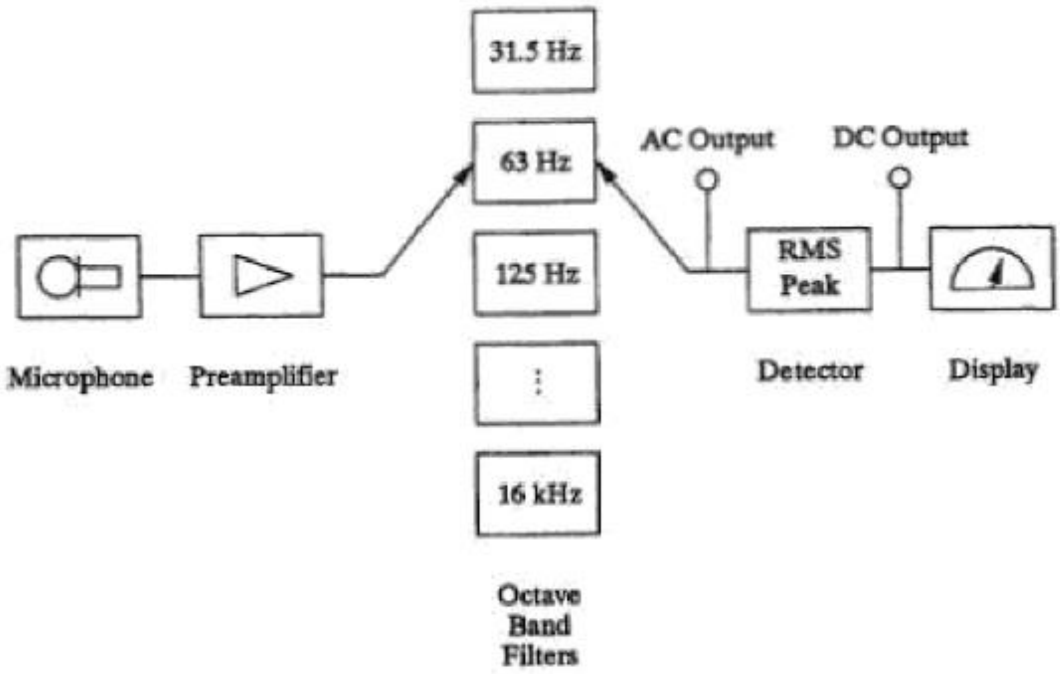

Figure 2.5 The block diagram for the octave band analyzer

2.3 Human health effect from noise

2.3.1 Mechanism of human hearing system

Generally, human ear system is receives sound energy by converting sound wave into mechanical vibration and then hydraulic energy. The sound waves is receive by the outer ear and travel through a narrow channel which known as ear canal. Ear canal leads the wave to hit the eardrum. Then, eardrum is vibrates and transfer the mechanical vibration to three tiny bones of ear which is malleus, incus and stapes. If the excessive sound wave hit the eardrum, the producing of high vibration may lead the eardum become damage or weaken. These bones function to convert the vibration signals into neural signal in the cochlea of the inner ear. Lastly, the neural signal is convert it into electrical signal and send it to the brain via auditory nerve for stimulation process. Figure 2.6 shows the basic part of human's ear.

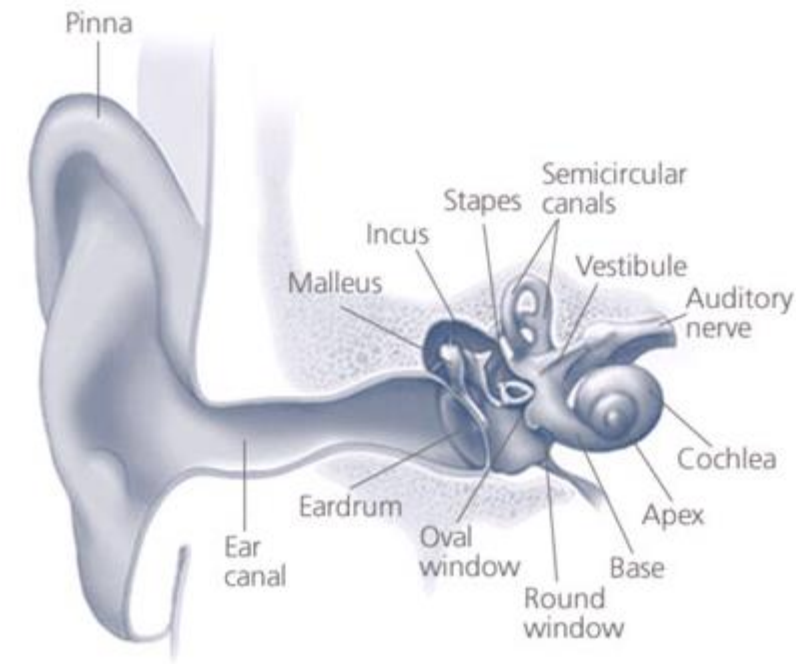

Figure 2.6 The basic part of human's ear

2.3.2 Noise-induced hearing loss, NIHL

Noise-induced hearing loss is the illness that deals with human ear. Instant high level of sound causes the hearing loss is rarely happen. The factors that taken in hearing loss arising are noise level, noise exposure period, age and physical condition of workers. The delicate structure of the inner ear become damage or weaken because of the repeated noise at 4,0000 Hz and above (Kim, Cho et al. 2011). Once hearing is impaired, there is no cure but prevention of excessive is the best way to avoid NIHL (Kim, Cho et al. 2011).

NIHL is measured by make a comparison between the thresholds of hearing with a specified standard of normal hearing. This measurement is reported in units of decibel hearing loss (dBHL). The consequences of NIHL in workplace are lost productivity, social isolation, and impaired communication. between workers, increase injuries from impaired communication and expenses workers ' compensation and hearing aid. There are some occupation sector that associated with high risk for NIHL which is agriculture, construction, manufacturing, mining, military and transportation.

NIHL is one of the most popular health issues in national health statistic. Recent studies point out besides noise; there are other factors that related lead to NIHL which are organic solvents, heavy metals, smoking, high blood pressure and hyperlipidemia . During 2001 to 2009, there are 80% of the workers in manufacturing sector claimed insurance compensation for NIHL (Kim, Cho et al. 2011). Unfortunately, in 2014 NIHL has been the most popular occupational health issue among Malaysian workers (W.Y, A.R et al. 2017). Hearing loss has been become one of the highly occurred & most severe disease in human population (Mathers 2000). According to the new estimates of World Health Organization (WHO), more than 250 million people around the world are affected by hearing loss in year 2000 and increased to 360 million people in 2012 (WHO 2012).

2.3.3 Physiological Impact

It is a fact that high exposure to noise has confirmed health hazard and risk. Annoyance is the term that strongly related with noise. Previous study has highlighted that annoyance can cause a physical and mental health problems (Park, Lee et al. 2018). The examples of physical and mental health issues are migraine, depression and high blood pressure (Park, Lee et al. 2018). Noise might result a serious psychological effects.

The parameters that associated with physiological are responsive to various emotional states including anger, frustration, startle, threat, and unpleasantness. According to the recent study, the main problem in workers of textiles industries is the noise frustration among the workers (Regecova and Kellerova, 1995). Therefore, there is criteria that used to study the impact of noise exposure rather than hearing damage criteria (Muhammad Anees, Qasim et al. 2017).

Another study included 1,542 children which their age is 3-7 years old that exposed to the area at 60 dB. The study resulted that the children had a higher heart rate and greater mean diastolic and stolic blood pressure compare to quiet areas (Ristovska and Lekaviciute, 2013). Exposure to high intensity of noise is showed problems towards mental and physical (Zannin & Bunn, 2014).

2.4 Environmental Noise Modeling

Physics-based noise modeling is a principle that obtained by carrying out a direct evaluation of the carrier distribution function through the Monte Carlo technique (Bonani and Ghione 2013). Monte Carlo technique is to obtain numerical results via computational algorithms that rely on repeated random sampling (Aslett, Nagapetyan et al. 2017). Monte Carlo technique is widely used in any sector that deals with modeling and simulation.

According to the past research, statistical models were developed with 14,235 noise level measured, which analyzed the relationships between equivalent noise level, traffic speed, traffic volume, road roughness and percentage of heavy vehicles such as lorry and truck (Abo-Q and Alhiary 2007). There was also another developed noise model which able to predict the ground noise radiated from an in-flight helicopter by taking the factor of atmosphere absorption on noise into account (Wang, Xu et al. 2018). Last but not least, SPreAD-GIS toolbox was established to estimate the noise propagation patterns for one-third octave frequency bands around a point source (Proto, Grigolato et al. 2016) .

Develop any environmental noise modeling approach to the in term of complexity in chosen element to described and analyzed. However to choose the element, the key information to all predictive studies is the systematic representation of the noise sources to be investigated and physical environment through which noise will travel the receivers. Table 2.3 shows the requirement for specifying a environment noise modeling.

Table 2.3 Requirement of the specification of environmental noise modeling

Stage	Minimum requirement	Other addition information
The noise source to be investigated	Number of sources, sound level produced by each source, directional characteristic of each source, height and distance of source and frequency characteristic of each source.	Time variations of emissions, any information that have the best correlate with condition.
The physical environment through which noise will transmit to the receivers	Separating distance between all relevant noise sources and receivers, the obstructing structures and the height of receivers.	The profile of ground terrain, the characteristic of the ground cover and meteorological factors.

2.5 Quarry Environmental Modeling Software Version 2.0 (QEMs V2.0)

2.5.1 Overview

Jabatan Mineral & Geosains (JMG) was developed software which is Quarry Environmental Modeling software (QEMs) to estimate the dust concentration, traffic noise and ground vibration level by the result of principle component analysis (PCA) results, followed by stepwise multiple regression analysis (MRA) of reliability analysis (RA) findings from data sampled at selected quarry sites. However, there is an improvement in this model which provides a calculation to estimate the noise level at crushing activities. This new model is called as QEMs Version 2. This software will calculate the dust concentration and Quarry Particulate Pollution Index (QPPI), noise measurement in dB(A) for traffic sound and crusher noise and ground vibration (PPV) using prediction model based on generic algorithms.