International Journal of Scientific Research & Engineering Trends
Volume 8, Issue 1, Jan-Feb-2022, ISSN (Online): 2395-566X

Simulation Framework for the Prediction of Strategic Noise Monitoring and Occupational Noise Exposure at LRT3 Depot

Mohd Fazizi B. Ishak
Health, Safety and Environmental
The International Business School of Scandinavia,
Denmark

Abstract- Construction industry in Malaysia was found with severe occupational noise exposure problems due to improper noise management including control measure, noise monitoring and lack of reliable noise information at the workplace. However, producing reliable strategic noise mapping in a dynamic, complex working environment is challenging. To overcome the limitation, alternative method for estimating occupational and environmental noise exposure is required. This research applies to LRT3 Depot as a policy of work where persons are employed in any occupation at construction sector covered under Occupational Safety and Health Act 1994 (Act 514). This research proposes on strategic noise mapping in order to provide important information in the simulation framework of the noise exposure using Sound Level Meter (SLM-25) at construction site researchers have to developed area. The preliminary noise measurement will be carrying out in LRT3 project. Hence, to control and mitigate the environmental and occupational noise risk, this research is proposing of calculation of the workers' and the environment noise exposure during the working hours. Based on the measured data, the individual noise level of each source will be identifying. Then, a probability-based model will be developed to predict the sound exposure level with typical factory schedules. Noise mapping using geometrical acoustical simulation will be utilized to calculate noise exposure levels for more extensive areas instead of a few specific locations. Three case studies will be conducted to obtain the noise exposure levels in another construction site to assess the framework developed. A framework will be proposed base on the result obtain to identify the workers' and environment noise exposure levels and determine the noise risk zone in construction industry. This research provides manual and instruction to manage the generation of noise at construction site.

Keywords- noise, exposure etc.

I. INTRODUCTION

The construction activities inevitably generate high levels of noise to on-site workers and residents near the construction sites, in which frequently affected their health including physical and psychological diseases (Ballesteros et al., 2010).

ISO 9612:2009 (ISO, 2009) provides three occupational noise exposure measurement methods which are:

- Task-based measurement (TBM), which is suitable when works can be divided into well-defined tasks easily;
- Job-based measurement (JBM), which is used when typical work patterns are complicated to be split into tasks; and
- Full- day measurement (FDM), which measures the continuous sound pressure level over a working day.

The selection of the measurement method depends on characteristics and complexity of jobs managed by workers. Some previous studies have compared these measurement strategies in ISO 9612:2009 in terms of accuracy (Arezes et al., 2012; Tao et al., 2016).

However, the results in these studies indicate that three measurement strategies show a good agreement when work areas for tasks are fixed and work patterns can be predicted easily.

Thus, the results cannot be applied to a situation with mobile jobs or unpredictable work patterns. To overcome these limitations, researchers have developed alternative methods for estimating occupational noise exposure.

In recent years, many methods have been used to predict noise levels in the workplace, such as the discrete-event simulation method (37), artificial neural networks (Hamoda, 2008), regression analysis (Manatakis & Skarlatos, 2002), the probabilistic approach (Haron et al., 2008) and the simple prediction chart technique (Haron et al., 2012).

International Journal of Scientific Research & Engineering Trends
Volume 8, Issue 1, Jan-Feb-2022, ISSN (Online): 2395-566X

These are the fundamental noise prediction methods that can be used as a managerial tool in the construction process.

The stochastic approach is the most reliably used to predict environmental noise by considering the randomness and complexity of the working environment (Haron & Oldham, 2004). However, none of these methods has been applied to modular construction activities and/or facilities yet. Therefore, the aim of this research is to simulate framework for the prediction of strategic noise monitoring and occupational noise exposure at LRT3 Depot using probability-based model.

1. Scope of Work:
This research applies to LRT3 Depot as a policy of work where persons are employed in any occupation at construction sector covered under Occupational Safety and Health Act 1994 (Act 514). These propose research is focus on proposing a framework to predict noise exposure levels of the workers at LRT3 Depot using the probability-based-model using Sound Level Meter (SLM-25) and Octave Filter. The preliminary noise measurement will be carrying out at LRT3 Depot in Johan Setia, Klang, and Selangor.

Based on the measured data, the individual noise level of each source will be identifying. Then, a probability-based model will be developed to predict the sound exposure level with typical factory schedules. Noise mapping using geometrical acoustical simulation will be utilized to calculate noise exposure levels for more extensive areas instead of a few specific locations.

2. Objective:
The objective of this research is to provide guideline with effective implementation for compliance to the Occupational Safety and Health (Noise Exposure) Regulations 2019 and to comply with all statutory requirements to assess compliance of the noise levels monitoring in accordance with the DOE‘s Guidelines in order to avoid or minimize adverse noise impacts on sensitive receptors form on-going construction activities through appropriate management measure.

3. Hypothesis:
- Awareness level and implementation of noise control among project team are low.
- There is significant relationship between strategic noise monitoring and occupational noise exposure.

4. Problem Statement:
The researcher conducts this research after doing self-assessment on health workers condition. Based on random interview with workers at site area, most of the information regarding their health condition is frequently having headache and some of them have hearing problem. The researcher finally decided to observe the noise risk zone; potential workers expose to the noise and analyze noise exposure limits by developing an effective framework.

Based on recently data from Social Security Organization (SOCSO), the most occupational diseases reported are occupational noise related hearing disorders (ONRHD). Even though the figures might due to an increase of awareness among employees or employers to report cases of diseases, but it also indicates that the cases of occupational diseases are fluctuated.

The effect of ONRHD is irreversible, cumulative and permanent. Therefore, the Department of Occupational Safety and Health (DOSH) have amend the noise exposure limit and imposed a more practical standard to control the exposure of excessive noise to the employees at the place of work, together with more structured and workable arrangements through the Regulations.

II. LITERATURE REVIEW

Based on research by Alice H. Suter, 2002, over than one and half million construction workers detected are exposed to potentially hazardous levels of noise, yet federal and state Occupational Safety and Health Administration (OSHA) programs provide little incentive to protect them against noise-induced hearing loss. Construction noise regulations lack the specificity of general industry noise regulations. American College of Occupational and Environmental Medicine, 2017 stated that about 42% of respondents reported hazardous occupational noise exposure; 10 years or more was associated with hearing loss regardless of age, sex or education. Absent DPOAEs, tinnitus, and the Wilson audiometric notch were significantly more prevalent in hazardous workplace noise-exposed workers than in no exposed. When mandatory, 80% reported wearing hearing protection.

Based on research from Neitzel RL, Heikkinen MS, Williams CC, Viet SM and Dellarco M, Three devices were tested: a sound level meter (SLM), a dosimeter, and a smart device with a noise measurement application installed. The SLMs and dosimeters yielded similar A-weighted average noise levels. Levels measured by the smart devices often differed substantially (showing both positive and negative bias, depending on the metric) from those measured via SLM and dosimeter, and demonstrated attenuation in some frequency bands in spectral analysis compared to SLM results.

Virtually all measurements exceeded the Environmental Protection Agency's 45 dBA day-night limit for indoor residential exposures. To determine the noise environmental quality (NEQ) for a locality on the basis of noise impact parameters, value function curves developed for each individual noise impact parameters identified.

International Journal of Scientific Research & Engineering Trends
Volume 8, Issue 1, Jan-Feb-2022, ISSN (Online): 2395-566X

The noise environmental quality (NEQ) value ranges from 0 to 1 with 0 representing a very poor NEQ and 1 an excellent NEQ respectively. The value function curves show the dose effect/ dose response relationship between noise doses and the effect of these doses on the exposed persons or their response to the doses (A. K. Gorai & A. K. Pal 2009).

III. METHODOLOGY

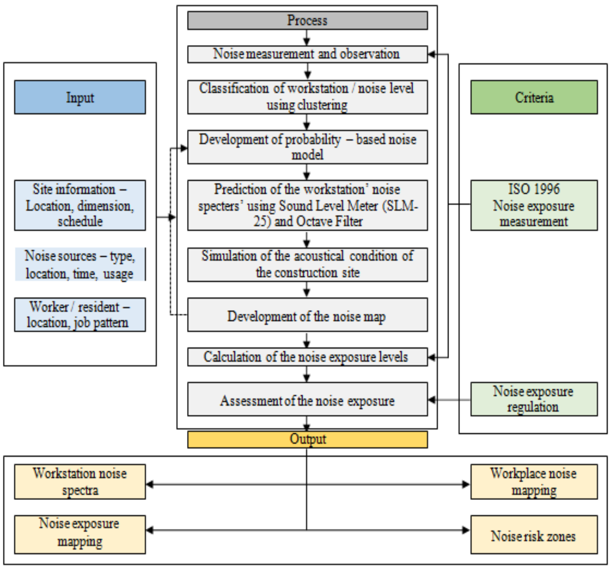

Fig 1. Methodology Framework.

IV. ANALYSIS

1.Noise Levels Measurement

The result shown noise levels recorded at point N1, N2, N3 and N4 from 6th to 9th September 2021 for a period of 8-hours are tabulated as follows Table 11. Certificate of Analysis (COA) shown in Table 13, Table 14, Table 15 and Table 16.

Table 1. Monitoring Station for Noise Level Measurement.

Stations	Description
N1	Nearest working receptors (TNMB) at the northernboundary of the project site. (2.975355, 101.460643)
N2	Nearest working receptors (HLMB) at the southernboundary of the project site. (2.975179, 101.460750)
N3	Nearest residential receptors at the eastern boundary ofthe project site. (2.975254, 101.460804)
N4	Nearest industrial receptors at the eastern boundary ofthe project site. (2.975319, 101.460700)

Measurements of noise levels recorded at location N1, N2, N3 and N4 are summarized in the Table 12 below:

Table 2. Measurement of Noise Levels.

MonitoringLocation	Average of noise levels as LAeq, dBA		(Baseline Data) forAverage of noise levels as LAeq, dBA		Noise Limit of LAeq (dBA) EIA Approval Condition No.13	
	Day time	Night Time	Day time	Night Time	Day time	Night Time
N1	63.0	-	55.0	-	65	55
N2	62.6	-	55.0	-		
N3	50.9	-	65.0	-		
N4	54.4	-	70.0	-		

2. Noise Mapping:

Noise Levels dB(A)

	49.1 – 80.5
	30.8 – 99.0
	30.8 – 83.4
	30.8 – 86.9

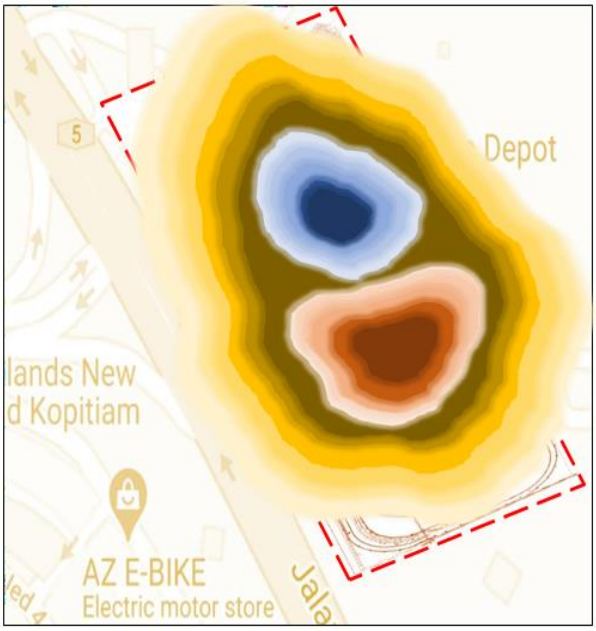

Fig 2. Noise Mapping.

Notes:
2.1. Recommended noise level For Noise Sensitive Areas, Low Density Residential, Commercial (Shops Lot), Worship Areas, The Planning Guidelines for Environmental Noise Limits and Control, Department of Environment, Malaysia, 2007; Annex A: Schedule of Permissible Sound Levels –Schedule 1.

The recommended maximum permissible sound levels (LAeq) as stated in COA No.25 are:
- Daytime (7.00 am to 10.00 pm): 65dBA
- Night time (10.00 pm – 7.00 am): 55dBA

2.2 Noise sources:
- Daytime: - Construction activity, vehicle movement and commercial activity
- Night time: - Public activity, commercial activity and vehicle movement

From summarized noise monitoring analysis results shows that the LAeq during daytime at all location point monitoring were below the respective Maximum Permissible Sound Level of 65dBA (daytime) and 55dBA (night time). All points were compiled the DOE limit.

V. RESULT AND DISCUSSION

1. Management and Mitigation Measure:

Table 3. Management and Mitigation Measure.

Plant	Typical StandardLAeq (dB)	Sound Reduction of Plant		
		Source ofNoise	Mitigation Measures	A Weighted sound reduction
Earth movingplant: Bulldozer , crane, dump truck Dumper, excavator, loader	72 to 92	Engine	a. Fit more efficient exhaustsound reduction equipment. b. Manufacturer's enclosurepanels should be kept closed.	5 to 10
Compressorsand generators	82	Engine Compressoror generator body shell	a. Fit more efficient soundreduction equipment. b. Acoustically dampenmetal casing. Manufacturer's	Up to 10
		Total machine	. Erect acoustic screen between compressor or generator and noise-sensitive area when possible, line of sight between top of machineand reception point should be obscured. Enclose compressor orgenerator in ventilatedacoustic enclosure.	Up to 20
Pumps	75	Engine pulsing	Use machine inside acoustic enclosure with allowance for engine cooling	Up to 20
Materials handling	80	Impact on material	Do not drop materials from excessive heights.Screen dropping zones, especially on conveyor	Up to 15

2. Noise Monitoring Recommended Limits Level:

For the management of construction noise level during the construction phase, the relevant criteria related to the noise level shall be refer to Schedule 1 and 6 as stipulated in Table 8 and Table 9.

Table 4. Schedule 1 – Maximum Permissible Sound Levels (LAeq) by Receiving Land Use for Planning and New Development.

Receiving Land Use Categories	Day time 7.00am – 10.00pm	Night Time 10.00pm – 7.00am
Noise Sensitive Areas, Low Density Residential, Institution (School, Hospital), Workshop Areas	55dBA	50dBA
Suburban Residential (Medium Density) Areas, Public Spaces,Parks, Recreational Areas	65dBA	55dBA
Urban Residential (High Density) Areas, Designated Mixes Development Areas (Residential – Commercial)	65dBA	55dBA
Commercial Business Zones	65dBA	60dBA
Industrial Zones	70dBA	65dBA

Table 5. Schedule 6 – Maximum Permissible Levels (Percentile LN and Lmax) of Construction, Maintenance and Demolition Work by Receiving Land Use.

Receiving Land Use	Noise Parameter	Day time 7.00am – 7.00pm	Evening 7.00pm – 10.00pm	Night Time 10.00pm – 7.00am
Residential	L90	-	-	-
	L10	75dBA	70dBA	70dBA
	Lmax	90dBA	85dBA	85dBA
	LAeq	-	-	*Note 1
Commercial	L90	-	-	-
	L10	80dBA	80dBA	75dBA
Industrial	L10	80dBA	80dBA	80dBA

VI. CONCLUSION

While construction activities are most affected by both noise hazards, noise in particular is a hazard in many workplaces and occupational noise-induced hearing loss has been classified as priority diseases in workplaces. Identification of noise hazards in the workplace is fairly simple, however, awareness of individual hearing deficit may be delayed due to the cumulative nature of noise exposure and the complicating impact of leisure noise and age-related hearing loss. Although regulations and guidance for noise hazards that emphasise the importance of control at source have existed in Malaysia for many years, hearing protectors are reported to be the predominant control measure. Thus, in many workplaces, there is a need for change in the approach to control of noise hazards.

Despite different health impacts, noise hazards have similar sources with vibration, behave similarly and from a prevention and engineering perspective, the controls are similar. The site team has a role in identifying, assessing and controlling noise hazards and particularly in implementing a noise management program as part of an Environment Management System. Specialist expertise may be required to conduct noise surveys and to advise on development of control strategies. This research can be used by the contractor in order to comply with legal and other requirements includes DEIA Conditions of Approval, ISO14001, Particular Specification and requirements stated in this research in performing the construction activities.

The conclusion of this research shall establish, display, formally communicated and deploy a written Environmental Policy showing the commitment towards environment. It shall be made understood to all levels of the organization. The Environmental Management System compatible with ISO14001 and policy shall adopt and reflect the relevant contents of DOE Requirements. All aspects of the research for duration of the sampling shall be included in the research. Prior to and during the execution of the research, the management of sampling population shall comply with the Environmental Quality Act 1974 (Act 127 & Subsidiary Legislation) and other related environmental legislation and associated guidelines including, but not limited to;

REFERENCES

[1] Alice H. Suter (2002). Construction Noise: Exposure, Effects, and the Potential for Remediation; A Review and Analysis American College of Occupational and Environmental Medicine, 2017.
[2] Arezes, P.M., Bernardo, C.A., Mateus, O.A. (2012). Measurement strategies for occupational noise exposure assessment: a comparison research in different industrial environments. Int. J. Ind. Ergon. 42, 172e177.
[3] Ballesteros, M.J., Fernandez, M.D., Quintana, S., Ballesteros, J.A., Gonzalez, I. (2010). Noise emission evolution on construction sites. Measurement for controlling and assessing its impact on the people and on the environment. Build. Environ. 45,711e717.
[4] DOE, The Planning Guidelines for Environmental Noise Limits and Control (Ministry of Natural Resources and Environment Malaysia, 2007).
[5] FMA, Factories and Machinery (Noise Exposure) Regulation 1989 (Laws of Malaysia, P.U. (A) 1/89, 1989).
[6] Hamoda MF (2008) Modeling of construction noise for environmental impact assessment. Journal of Construction in Developing Countries 13(1): 79–89.
[7] Haron Z, Yahya K, Zakaria R, Oldham D (2008). A probabilistic approach for modeling of noise from construction site for sustainable environment. Malaysian Journal of Civil Engineering 20 (1): 58–72.
[8] Health impacts of construction noise on workers: A quantitative assessment model based on exposure measurement (Xiaodong Lia, Ziyang Songa, Tao Wangb, Yu Zhenga, Xin Ning, Journal of Cleaner Production Volume 135, 1 November 2016, Pages 721-731.
[9] Juan Miguel, Barrigon Morillasa, David Montes, Gonzaleza Guillermo, Rey Gozalob (2016). A review of the measurement procedure of the ISO 1996 standard. Relationship with the European Noise Directive. Science of the Total Environment. Volume 565, 15 September 2016, Pages 595-606.
[10] K. Gorai & A. K. Pal (2009). Methodology of the community noise environmental quality assessment: A case research of Indian iron ore mining complex. Journal of Geology and Mining Research Vol. 1(10) pp. 214-223.
[11] Neitzel RL, Heikkinen MS, Williams CC, Viet SM and Dellarco M (2015). Pilot research of methods and

equipment for in-home noise level measurements 102:1-11.
[12] N.Garga, A.K. Sinhab, V. Gandhib, R., M. Bhardwajb, A.B.Akolkar (2016). A pilot study on the establishment of national ambient noise monitoring network across the major cities of India. Applied Acoustics. Volume 103, Part A, February 2016, Pages 20-29.
[13] Manatakis E, Skarlatos D (2002). A Statistical Model for Evaluation and Prediction of the Noise Exposure in a Construction Equipment Area. Applied Acoustics 63: 759–773.
[14] Strategic Noise Mapping Prediction for a Rubber Manufacturing Factory in Malaysia, Ming Han Lim, Yee Ling Lee, Foo Wei Lee and Gan Chin Heng, 2018.
[15] Tao, L., Zeng, L., Wu, K., Zhang, H., Wu, J., Zhao, Yufeng, Li, N., Zhao, Yiming (2016). Comparison of four task-based measurement indices with full-shift dosimetry in a complicated noise environment. Int. J. Ind. Ergon. 53, 149e156.
[16] Zhang H, Zhai D, Yang NY (2014). Simulation-Based Estimation of Environmental Pollutions from Construction Processes. Journal of Cleaner Production 76: 85–94.