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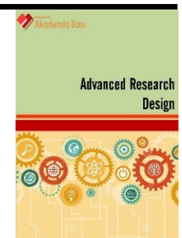

Noise measurement and awareness at construction site – A Case Study

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ABSTRACT

The construction industry is one of the major sectors in Malaysia. Apart from providing facilities, services and goods it also offers employment opportunities to local and foreign workers. In fact, the construction workers are exposed to high risk of noises being generated from various sources including excavators, bulldozers, concrete mixer and piling machines. Previous studies indicated that the piling and concrete work were recorded as the main source that contributed to the highest level of noise among others. Therefore, the aim of this study is to obtain the level of noise exposure during piling process and to determine the awareness of workers against noise pollution at the construction site. Initially, the reading of noise level was obtained at construction site by using a digital sound level meter (SLM) and noise exposure to the workers was mapped. Readings were taken from four different distances; 5, 10, 15 and 20 meters from the piling machine. Furthermore, a set of questionnaire was also distributed to assess the knowledge of regarding noise pollution at the construction site. The result showed that the mean noise level at 5 meters distance was more than 90 dB, which exceeded the recommended level. Although the level of awareness of regarding the effect of noise pollution is satisfactory but majority of workers (90%) still did not wear ear muffs during working periods. Therefore, the safety module guidelines related to noise pollution controls should be implemented to provide a safe working environment and prevent initial occupational hearing loss.

1. Introduction

Construction sector typically generates significant level of noise pollution and many cases with hearing impairments have been reported. In 1981, the Environmental Protection Agency (EPA) estimated the numbers of construction workers exposed to noise pollution ranging from a half million to 750 000 [1]. In the early 1980s, National Institute for Occupational Safety and Health (NIOSH)

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compared the numbers of workers in several trade industries which were exposed to noise levels at or above 85 dBA [2]. It was reported that the highest percentage of overexposed workers arise from concrete work followed by highway and street constructions. In Malaysia, the law and regulations which have been enforced by the Department of Occupational Safety and Health (DOSH) is Occupational Safety and Health Act 1994 (OSHA 1994). The Act stipulates that the maximum sustainable level of exposure within 8 hours is 90dBA and it equals to 100 % noise exposure directly. Exposure to noise depends on the sound level and its duration. The permissible time for safe listening decreases as sound level increases [3].

It was reported that noise exposure levels of construction workers were difficult to determine because of day-to-day variations in occupation and shift lengths, itinerant and seasonal worker off the job. However, Eaton [4] revealed that the construction worker was overexposed to very high sound levels for considerable lengths of time.

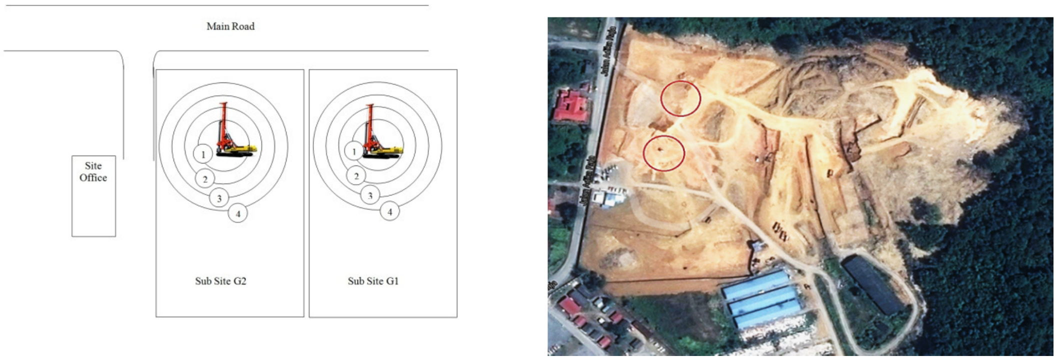
There are two main factors that generate noises at construction sites including the construction activities and from the equipment or machineries as reported by Gillcrist *et al*. [5]. The activities that usually generated noise are pavement breaking, bridge deck removal and pile driving operations [5]. Previous research reported that piling work usually produced a very loud sound either from the beat or blow by piling machine itself [6]. Furthermore, the consequence of piling driven method such as rebounding of the drop hammer and sound of the engine also created a noisy condition [7]. A study in Kempas and Skudai, Johor, Malaysia also showed that high level of noise was generated by piling machine [8]. In this study, three levels of construction stages were selected: earthworks, substructure (piling) and structural works because these stages of construction involved with machineries that produced high sound level. Noise measurements were carried out at several stations and noise predictions were calculated accordingly.

Exposure to noise at work should be assessed and controlled. Whenever possible, engineering controls should be implemented to reduce the noise level at the source. If it is not possible to reduce the noise below the control limit, then suitable hearing protection must be worn. Exposure to excessive continuous noise can lead to progressive loss of hearing [9]. Nadirah *et al*. [9] reported that excessive noise exposure can cause annoyance that can reduce human daily efficiency. Noise annoyance can cause physiological reactions that may lead to anxiety, pressure and depression. Other than that noise exposure can also cause difficulties in speech, communication and increase the risk of accidents at workplace due to inability to hear warning signals. Long-term exposure can cause permanent hearing damage. Neither surgery nor a hearing aid can help correct this type of hearing loss.

The motivation for this study was predicted due to lack of reported information regarding noise pollution at the construction sites in Malaysia. This study therefore is carried out to obtain the levels of noise exposure during piling process and to determine the knowledge of workers about noise pollution at the construction site.

2. Materials and Method

This study was conducted using two piling machines that blow the pile as shown in Figure 1(a). Figure 1(b) illustrates the site layout that was carried out at construction site in Pengkalan Hulu, Perak. The data obtain from the source of noise at the piling works were taken at three periods of time which was morning, afternoon and evening. Readings were taken from different distances which were 5, 10, 15 and 20 meters from the piling machine. In addition, five readings were recorded for each distance and the mean was calculated for data analysis.



(a) (b)

Fig. 1. (a) Schematic diagram and (b) site layout for location of both piling machines in Pengkalan Hulu Perak

The digital Sound Level Meter (SLM) model SL 1361 (Figure 2) was used to measure sound level in decibels (dBA). SLM was positioned at a distance of more than 5 meters from the wall to prevent sound reflection and placed at the height between 1.2 and 1.5 meters from ground level to prevent any nuisance. In addition, SLM was also placed at 3 different positions from the source of the noise in respective range. For each data collected, noise measurements were conducted at each of the selected locations for 15 minutes. Weather conditions were also taken into account during the measurements.

Fig. 2. Photo of Sound Level Meters (SLM)

2.1 Sampling Size

The questionnaire was prepared and pretested, and then administered to 50 respondents. However, only 44 of the respondents returned back the survey forms. Convenient sampling was used to include workers at the construction site. From 44 respondents, 14 of them were working in administration. The questionnaire elicits the information on demographic data and knowledge about the hazard of noise pollution and also the control measures at the construction site.

The survey form was designed by using the Likert's scale containing a set of position numbers between one and five. The relative importance index was calculated using

$$I = (\sum \mu)/(A \times N) \quad (1)$$

where, μ = rate scale given by respondent, A = the highest rate according to the Likert's scale and N = total of respondent [10].

The data was analyzed using IBM statistic packages for social science (SPSS) version 15.0. The capabilities of SPSS were calculated following descriptive and scale analysis. 100 sets of questionnaires being evaluated. Prior to that, Cronbach's Alpha analysis was used to verify the internal consistency of coefficient reliability of a questionnaire [11] for analyses of the split-half reliability coefficient. In this study, the Cronbach's Alpha value was 0.765.

3. Results and Discussion

3.1 Noise Level Measurement

Table 1 shows the data collected on the site at four different areas in the morning, afternoon and evening. As shown in the Table 1, both piling works gave the peak readings at the distance of 5 meters from the machines. The reading was highest in the morning, suggestive of active works on construction site at this time. These readings exceeded the allowable limit as mentioned by the World Health Organization (WHO). According to WHO, workers who were exposed to the noise exceeding 85 dB should wear hearing protection devices (HPD) if daily working hour is more than 8 hours per day.

Table 1
Noise reading from piling machine A and B

Distance (m)	Time	Piling Machine A			Piling Machine B		
		Max (dBA)	Min (dBA)	Avg (dBA)	Max (dBA)	Min (dBA)	Avg (dBA)
5	Morning	97.1	80.5	90.6	102.4	79.8	94
	Afternoon	100.2	81.2	92	99.7	82.7	93.4
	Evening	102.9	79.2	93.8	101.3	80.2	92.4
10	Morning	95.9	76.3	86.1	97.5	78.7	89.5
	Afternoon	97.8	78.4	90	96.1	80.9	90.6
	Evening	95.4	77.5	86.5	95.9	80.1	90.6
15	Morning	93.4	76	87.2	90.6	82.5	87.9
	Afternoon	93.8	77.3	83	92.4	80.2	87.4
	Evening	94.2	75.5	84.9	91.3	78.4	86.5

Figure 3 shows the noise level measured at different distances from piling machine A. The noise measurement was repeated for five times and the average reading was plotted. Area 1 which was at 5 meters from piling machine offered the highest level of noise. Furthermore, the distribution of the average level of noise decreased with the increased distance from piling machine. However the average noise level still exceeds 85 dBA even at the farthest distances which was 20 meters from the piling machine.

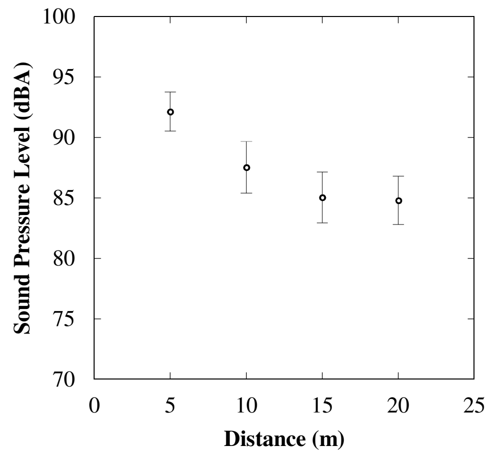


Fig. 3. Sound level at different distance for piling machine A

Figure 4 shows the comparison between noise level exposures from the two piling machines. As can be observed, the noise level from piling machine B was slightly higher than the piling machine A. In addition, noise level decreased with the increased distance from the sources.

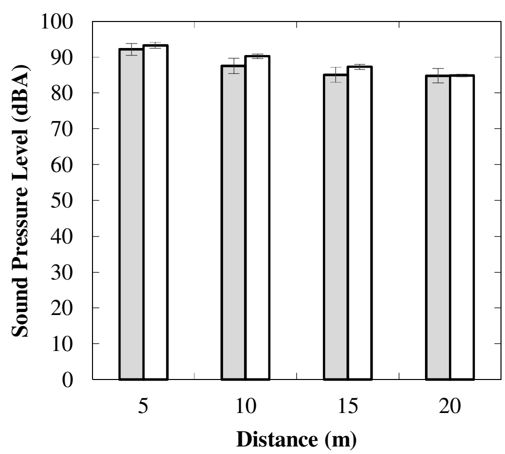


Fig. 4. Comparisons of average level of sound between piling A and B

3.2 Sociodemographic Data

Figure 5(a) reveals the demographic data of the respondents. Figure 5(a) shows that majority of workers were foreigners (86 %) and the rest were locals with most of them worked in administration. Figure 5(b) shows that 45.5% of the respondents were between 36 to 45 years of age while 9.1% were above 56 years old. As it can be seen from the Figure 5(c), 47.7% of respondents have basic primary education, 38.6% with secondary level of education, 11.4% had degree from university and only one respondent had no basic education. Figure 5(d) shows that most of the workers in construction site is not exposed to formal education, however more than 92% respondents has at least 5 years of working experience. Furthermore, more than half (52.3%) of the worker has worked in construction site for more than 10 years and only 2 workers with less than 5 years of experience.

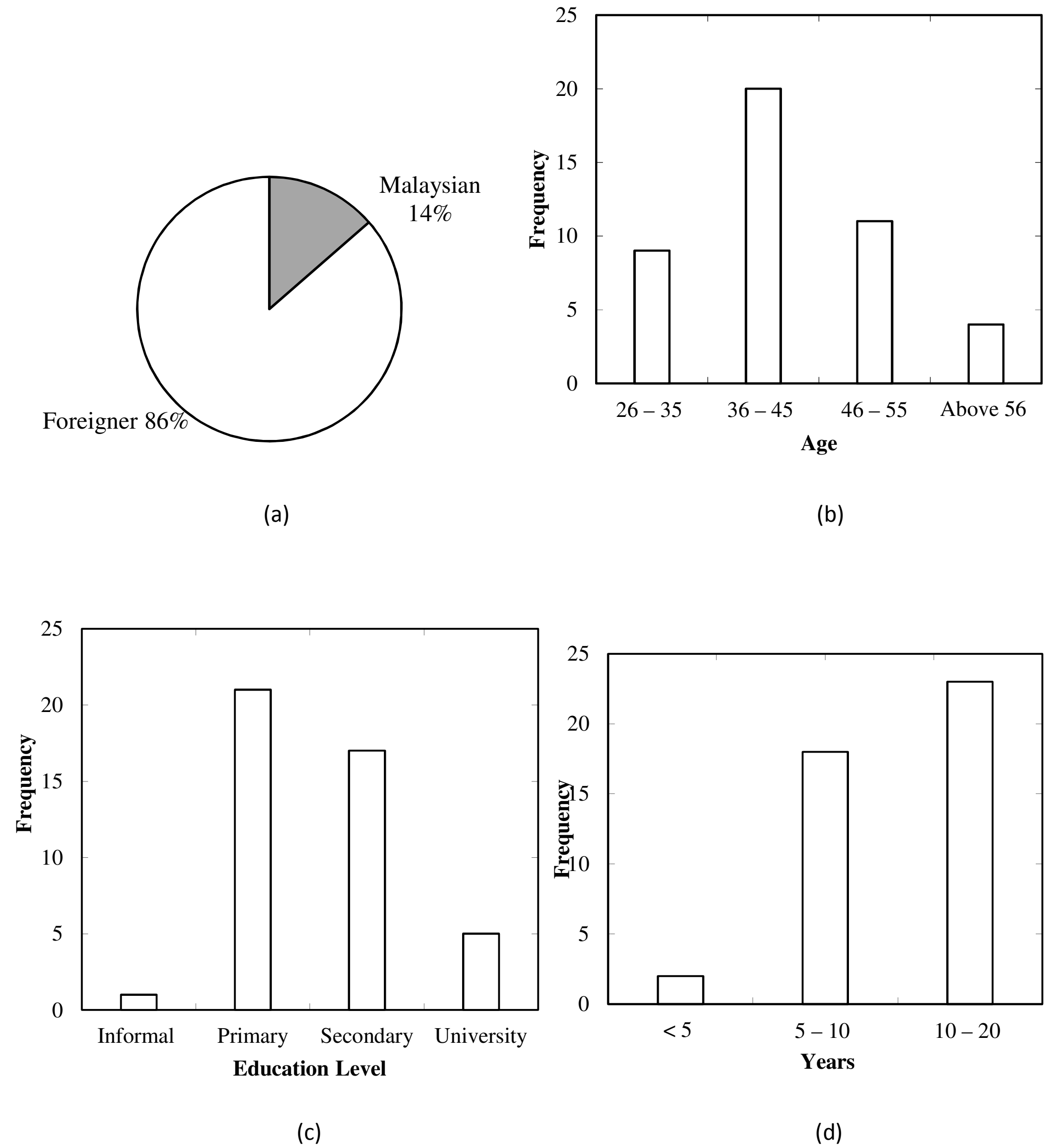


Fig. 5. Demographic studies on (a) Nationality, (b) age, (c) education level and (d) working experience of the workers

3.3 Knowledge on the Effect of Noise Pollution

A total of 36 respondents (81.8%) realized that their work place produce loud noise. Nearly half of the workers (45.5%) claimed that the loud noise is heard for more than 3 hours per day as shown in Figure 6. Although most of them agreed that the safety briefing was given to them, yet 90% of the respondents did not get any HPD during working hours. Furthermore, 77.3% agreed to use the HPD if the equipment provided for them.

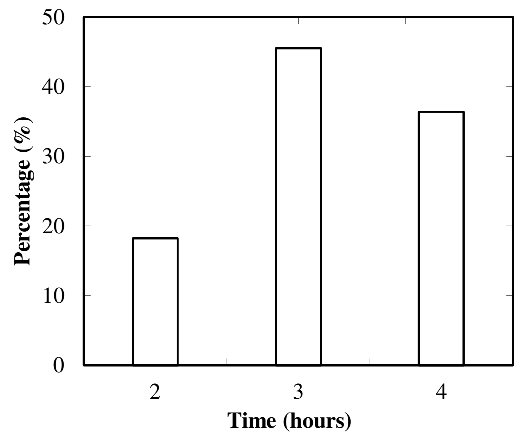


Fig. 6. Percentage of respondents against hours of exposure

As mentioned earlier, most of the construction workers had a low education level. However, they were fully aware of the harmful effects of noise pollution. Most of them agreed that noise pollution can reduce worker's daily productivity. Prolonged exposure to loud noise will cause hearing impairment, indicating that they have to use HPD to prevent hearing loss. Regular audiometric test for detecting hearing loss was also suggested by the workers. These findings emphasized that the respondents were aware of the harmful effect of noise to their health.

The respondents were asked regarding their knowledge about the control measures at the construction site. Again, most of them proposed that noise pollution control was the responsibility of the employees as well as the employer. They also suggested that the employer should organize a workshop or training session of occupational safety and health for the staff and enforcement of laws related to noise pollution. Surprisingly, one of the comments given by the respondents was that, the noise pollution in the construction site is not as critical as noise produced by manufacturing industry. This contrasts with the previous study as reported by Neizel [12]. In addition, noise pollution level can be reduced by using a flexible noise barrier (mobile barrier) or a buffer material such as the wood plate and the employer should provide personal protective equipment (PPE).

4. Conclusion

The results show that the noise level decreases with the increase in distance from the source of noise. It was also found that the level of noise was over 85 dBA even at the farthest distance which is 20 meters from piling machines. Therefore, this study has shown that workers at the construction site are exposed to noise levels above the maximum allowable limits. The exceeded level of noises should be reduced promptly to ensure the safety and health of workers. In addition, the results from the questionnaire also show that the awareness regarding noise pollution at the construction site is at a satisfactory level. However, there was lack of access to hearing protective devices despite daily exposure to loud noise. These could be due to complacent or ignorant attitude of the workers and employer regarding the harmful effect of the noise pollution. Therefore, the employer must adopt a culture of safe working environment by implementing preventive measures for reduction of noise at the construction site beginning with providing HPD and other PPE to employees.

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