ASSESSMENT OF OCCUPATIONAL NOISE EXPOSURE AMONG CONSTRUCTION WORKERS IN A SELECTED CONSTRUCTION SITE IN PUTRAJAYA, MALAYSIA

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ABSTRACT

In 2017, in Putrajaya alone have more than 30 on-going construction sites. More than 6000 man power either local or foreigner involved. To maintain as a well and fast-pace developed country, extra attention need to be given to this industry. When one talks about hazard of building construction, one always mentions about physical hazard such as work at height. Seldom we discuss on health hazards of it. One of the health hazards that present in this industry is noise. Therefore, this study is focusing on the objective which is to measure the noise level of all type of work (construction & structure, architectural and mechanical & electrical) in building construction activity, determine factor that contribute to source of noise and its control and PPE to overcome them and lastly to determine level of awareness among construction personnel towards noise hazard. To meet the objectives for this research, area noise monitoring, personal noise monitoring and survey form have been used. Result of the noise monitoring show that some activities exceed the action level of noise while result of survey show that awareness of construction personnel toward noise hazard as overall is still considered below average.

ABSTRAK

Pada tahun 2017, di Putrajaya sahaja mempunyai lebih daripada 30 tapak pembinaan yang sedang berjalan. Lebih daripada 6000 tenaga kerja sama ada tempatan atau asing yang terlibat. Bagi mengekalkan status negara maju, perhatian yang lebih perlu diberikan kepada industri ini. Apabila seseorang bercakap mengenai bahaya pembinaan bangunan, seseorang selalu menyebut tentang bahaya fizikal seperti kerja pada ketinggian. Jarang kita membincangkan mengenai bahaya kesihatan. Salah satu bahaya kesihatan yang hadir dalam industri ini adalah bunyi bising. Oleh itu, kajian ini memberi tumpuan kepada objektif yang bertujuan untuk mengukur tahap bunyi semua jenis kerja (pembinaan & struktur, seni bina dan mekanikal & elektrik) dalam aktiviti pembinaan bangunan, menentukan faktor yang menyumbang kepada sumber bunyi dan kawalannya serta PPE untuk mengatasinya dan akhirnya menentukan tahap kesedaran di kalangan kakitangan pembinaan terhadap bahaya bunyi. Untuk memenuhi objektif kajian ini, pemantauan bunyi kawasan, pemantauan bunyi peribadi dan borang tinjauan telah digunakan. Hasil pemantauan kebisingan menunjukkan bahawa beberapa aktiviti melampaui tahap tindakan kebisingan sementara hasil tinjauan menunjukkan kesedaran kakitangan pembinaan terhadap bahaya kebisingan sebagai keseluruhan masih dianggap di bawah purata.

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1.0 INTRODUCTION

1.1 Introduction

The development of construction in Malaysia has embarked on a new era towards the realization of sustainable and progressive construction. Construction industry becomes one of an important element of the Malaysian economy (Zakaria et al., 2012). In modern years, there are expected to be various large scale projects normally involved the usage of high-level automation method of construction and more complicated processes. The government had launched the Construction Industry master Plan 2006-2015 (CIMP) introduced by the Construction Industry Development Board (CIDB) with the purpose of gearing up the Malaysian construction industry towards globalisation and competitiveness. One of the main strategies known as strategic thrust 3, emphasises more on fight vigorously for the highest standard of quality, occupational safety and health and environmental practices. Construction activity becomes one of the sources of noise pollution besides road traffic and manufacturing processes. Nowadays, noise does not only pose a problem to developed countries but also affect to developing countries (Alberti, 1998). Noise level in developing countries is even greater and complex that creates serious problems compared to developed countries due to bad planning, poor construction of bulidings, lack of legislation and enforcement by governmental bodies and agencies (Burgland et al, 1999; Fuente &Hickson, 2011).

1.2 Problem Statements

In Malaysia, although we have Factories and Machinery (Noise Exposure) Regulations 1989, its implementation among contractor is still questionable. Client and local authority usually set their noise requirement solely on boundary noise monitoring only; concerning noise pollution to surrounding community. Seldom had they done the occupational noise monitoring on workers due to several factors.

Due to this phenomenon, controls and requirement to wear the appropriate personal protective equipment are based on previous practice and advice from machines' supplier only. These might be irrelevant since we do not know the exact noise level which workers exposed to.

1.3 Objectives

The objectives of the research study are as follows:

a) to measure noise level of all job trade in building construction activity.
b) to determine factors that contribute to noise exposure of building construction activity
c) to determine control and personal protective equipment required of all job trade in building construction activity.
d) To determine level of awareness among industry personnel towards noise hazard.

1.4 Research Outcome

The information provided by this research can be used to determine whether there is a noise problem, practical measure that can be adopted to control the level of noise exposure.

2.0 LITERATURE REVIEW

2.1 Noise Exposure

The causative relationship between excessive noise exposure and occupational hearing loss has been acknowledged for centuries now. In a modern world, noise is part of everyday life that usually sources either from job processes in the workplace or from leisure activities or hobbies outside work. Noise also comes from daily life activities such as air traffic, trains, industries, construction, public work and neighbourhood. These types of noises were classified as community noise, whereas noise emitted in the industrial workplace is considered as occupational noise (Burgland et al., 1999). Noise generally can be defined as unwanted sound might be unnoticed will cause some physical and psychological stress among living as well as non-living object (Singh and Joshi, 2010). There is no difference between sound and noise, physically. Sound is sensory type perception whereas noise corresponds to undesired sound. According to NIOSH (1991), noise is any kind of unwanted disturbance within a useful frequency band. Noise is definitely present in every human activity and when assessing its impact on human well-being it is usually were classified either as occupational noise (workplace) or as environmental noise which is includes noise in all other setup whether among community, residential or domestic level such as traffic, music and playgrounds.

High levels of occupational noise become a serious problem in all regions over the world. For examples, more than 30 million workers in the United States of America (USA) are exposed to hazardous noise (NIOSH, 1998). WHO (2001) stated that almost 4-5 millions of people in Germany (12-15% of workforce) are more tends to exposed to noise levels that measured as hazardous. Construction sector usually generate noise and put an over-exposed among workers. According to Whitaker et al. (2004), in the early 1980s, around 421000 construction workers were exposed to daily noise levels above 85 dBA while Lusk et al. (1999) reported the number of workers were increased approximately to 500000. In 2002 alone, about 500000 to 750000 workers had deal with daily noise level exceed 85 dBA in most trades (Neitzel and Seixas, 2005). Noise from various sources (heavy equipment) used in construction which is range between 80 to 120 dBa may resulted in the risks of over-exposure among operators (Spenser and Kolvachik, 2007).

Most construction workers loss their hearing ability after years of working in the sector. An association between noise exposure and hearing loss has been recognized with major causes of construction accidents were found strongly related to the attitude of the workers (A. R. A. Hamid et al, 2011). According to Ciobra et al. (2011), age is become one of the common causes of hearing loss among older workers known as *presbycusis*that refer to age-relating hearing loss that very common in the elderly. Noise exposure is also associated with other health effects such as an increase in diastolic blood pressure and cardiovascular disease risk (Van Dijk, 1999; Whitaker et al., 2004; Davies et al., 2005).

2.2 Noise Exposure In Workplace Worldwide

According to World Health Organization (WHO, 1997), Noise induced hearing loss (NIHL) has been recognized as a significant occupational health problem and tend to increase through the industrial world. The extent of NIHL is reflected by the identification of NIHL in the 1980's as one of the ten leading work-cognate diseases and injuries (Berger, 2000) and in 2004 it became fifteenth (15) most solemn health quandary in the world as tenacious by WHO (Smith, 2004). NIHL is become the second (2) highest cause for hearing loss in adult after *presbyacusis*and be the one most common occupational diseases among workers (Brookhouser, 1994; Rabinowitz, 2000). Internationally, the estimated prevalence of NIHL reported about 7% of the total population in Western countries and 21% in developing countries (Cocha-Barrientos et al., 2005). While the prevalence for industrial population varies based on types of industry (electrical workers, sand and gravel workers, and construction worker) that fall between 37-59.7% (McBride and Williams, 2001; Landen et al., 2004, Dement et al., 2005; Rachiotis et al, 2006).

According NIOSH (1996) and Concha-Barientos et al. (2004), the most affected workers are in manufacturing, construction, transportation, agriculture and the military sector. In 1985, WHO reported around 42 million of people are globally experience hearing impairment, and the estimation number has increased to 120 million people in 1995 (Berglund et al., 1999; Smith, 2004). The estimated number then increased as 250 million people with hearing loss due to occupational noise where three quarters were from adult-onset hearing loss, and two thirds of the hearing loss cases reported are from developing countries (WHO, 2002; Shield, 2006). In the United States (US), the general figure for the prevalence of hearing impairment is about 28 million of Americans in 1999 and of these cases approximately one third was primarily as a result of noise exposure (ACC, 2006; Shield, 2006). It was also estimated that as 30 million out of the population were tend to expose to harmful noise on their daily basis (NIOSH, 1998; Rabinowitz, 2000). Possibly one-third out of 40 million American that suffering hearing loss are partially attributed to noise (NIH, 1990; Ostri and Paving, 1991; Sataloff&Sataloff, 1993).

On a bigger scale, around 50 million people in Europe are at risk of NIHL and tinnitus (Toppila et al., 2005; Starck, 2006). In Germany, around 10.2 million of the populations are exposed to noise levels, 7.6 million in France, 7.2 million in Italy and 2 million in the Netherlands (Shields, 2006) where the highest incidence of noise induced hearing loss occurred in metal, mechanic and construction sector. ACC (2006) reported that approximately 11.4% of workers in the Czech Republic are risk of hearing problems, and the number has decreased by 40% between 2000 and 2002. In Denmark, NIHL was reported to be high in manufacturing, construction and agriculture (ACC, 2006). Exposure to noise in the workplace has been estimated for about 10% of the burden of adult hearing loss in western countries (Dobie, 2008; Nelson et al., 2005).

2.3 Noise Exposure In Developed Country

In developing countries noise is a major occupational health problem and it occurs either in formal nor informal work environmental. Common types of occupations in informal sectors are associated with high noise exposure are carpentry, building construction, textiles, metal artisans, motor vehicle repairs, corn-mills, sugar-cane crushers, farm jobs and shoe making (Amedofu& Fuente, 2008). The move of manufacturing industry to developing countries has created a lot of occupational diseases and occupational health and safety have become prominent issues (Wong, 2006; Fuente &Hickson, 2011). The hazards are from various sources such as machinery and noise generated during the job processes. According to the International Labor organization (ILO), it is estimated approximately 2 million workers are killed due to work-related accidents and diseases and 270 million occupational accidents occur each year (Kawakami, 2001).

The noise emissions in manufacturing and other industries generally have contributed to the high number of occupational diseases. Developing countries are well known as lack of effective legislation and program that dealing with noise, poor enforcement and implementation even if certain legislation existed (WHO, 1997; Gomes et al., 2002; Amedofu& Fuente, 2008). According to Fuente and Hickson (2011), in their review on NIHL in Asia, the prevalence of NIHL in Asia was high which is ranging from 18% to 89%, whereas India was recorded the highest with 89%, followed by

Pakistan with 66%. Japan has been reported to be the lowest prevalence with 18%. Most of the workplaces in Asia recorded noise levels that more than 85 dBA.

Noise in developing countries is though, complex and create a greater problems compared to well developed countries due to several factor such as bad planning, lack of awareness about NIHL, lack of legislation, poor enforcement by government or agencies and lack of competent personnel from local governments to inspect the industries (Alberti, 1998; Burgland et al., 1999; Amedofu& Fuente, 2008; Fuente &Hickson, 2011). The average noise levels in developing countries are increasing due to industrialization that is not always accompanied by protection (Concha-Barrientos et al., 2004).

2.4 Noise Exposure In Malaysia

Noise induced hearing loss is one of the most common occupational disease experienced by workers compared to other occupational diseases. It can be seen from the total number of 663 cases investigated in 2010, noise induced hearing loss made up 70.4% compared to other diseases (DOSH, 2012). The study conducted by DOSH in 1990, it was found that about 26.9% (12,3657) of the 45,974 total workers from 302 factories in Klang Valley had degree of hearing impairment of 3000 to 6000Hz and another 21.9% had a significant hearing impairment, indicates a high risk of suffering hearing loss to exposure to high occupational noise levels. Some of workplaces recorded a noise levels of more than 90 dBA that exceed the permissible exposure level (PEL) as stipulated in the Malaysian noise regulation (Factories and Machinery Regulations 1989). From the study, the highest noise levels recorded in textile industry followed by basic metal industry, chemical production, beverage industry and non-metallic production (DOSH, 1991). These findings are significant with studies which is found high noise levels recorded in manufacturing industries such as wood based industries, textile, automobile and steel industries (Franks et al., 1996; Nelson et al, 2005).

Ismail et al. (1993) conducted a research to measure the noise exposure level among quarry workers in Selangor area and found the workers were exposed two (2) to seven (7) times more than the allowed noise level. Many of workers developed hearing loss at least one or both ear due to noise exposure. Road traffic controllers in Kuala Lumpur area are at risk of having NIHL from exposure to intense noise level in their daily work routine where the noise levels were measured between 75 dBA to 85 dBA with a maximum level recorded at 108 dBA. A recent study conducted in the northern part of Malaysia has shown that noise exposure is still a problem in manufacturing industries (Mokhtar et. al., 2007) where all the locations measured have high levels of noise as high 90 dBA. Work processes such as punching, stamping in a metal company or in the boiler and air compressor recorded the noise level surpassed 80 dBA with maximum level recorded more than 95 dBA.

High noise exposure was also recorded in the agriculture sector. DOSH in 2008 reported that many farmers were exposed to occupational hazards such as pesticides, chemicals and organic fertilizers and noise through the heavy usage of modern machinery in paddy fields in Kedah and Selangor region. The noise level measured from the machines range from 89 dBA to 110 dBA, and the workers did not use any hearing protection while the job processes (Shukri, 2010). The findings from the studies shows that occupational noise is still unresolved issue that needs attention to minimize the occurrence of NIHL problem. In Malaysia alone, noise regulations have been existed since 1967 and later improved in 1989 with more specific noise regulations, but enforcement is seldom practiced especially in small and medium scale industries (Rampal, 2000; Rampal&Nizam, 2006; Rus et. al., 2008).

2.5 Noise Exposure In Construction Workplace In Malaysia

Construction activity is one of the sources of noise pollution that gave an impact towards the workers through the work processes. According to Singh and Davar (2004), a level of noise (TWA) for industrial area is recorded as 75 dBA and 70 dBA in a day and night time respectively based on ambient noise standard. Several studies were conducted to investigate the sources and effects of noise and clearly shows the construction worker will has hearing loss if they were exposed to very high noise levels for considerable lengths of time (Alice, 2002; Singh, 2004; Neitzel&Seixas, 2005; Quitana et al., 2008; Singh & Joshi, 2010). The permissible noise exposure for construction worker to receive is 90 dBA for 8 working hours; equivalent to 100% of noise exposure (FMA, 1989; OSHA, 1994).Zolfagharian (2012) have conducted a structured interview with 15 construction professionals, aimed at prioritizing the frequency and severity of environmental impacts across the residential buildings in Malaysia. Construction activities were identified as the second contributory sources of noise pollution. The findings outlined the need of effective plans to promote the awareness and knowledge of construction practitioners, and implementations of noise control strategies by construction of barriers, and application of noise protective tools.

The study of determination of noise exposure level at construction at certain workplace in Malaysia were conducted by Ishak Baba by choosing Sri GadingGading, University TunHussien Onn Malaysia (UTHM) and InstitutKemahiranBelia Negara (IKBN) Dusun Tua, Hulu Langat construction area. The result shows the maximum of noise dose (D) for Sri Gading and UTHM is approximately 43% and 28% respectively, while time weighted average noise level (TWA) for these sites is about 84 dBA and 80.8 dBA. IKBN recorded maximum of noise dose (D) and average noise level (TWA) is 88 dBA and 75.8% respectively. The result suggested the level of noise exposure at selected areas is acceptable range based on regulation (Ishak et al, 2011). He is also concluded that construction workers are advisable to wear hearing protection device when construction activities take place in order to civilize safety practice in the industry field.

Previous research according to awareness of noise pollution at construction site was conducted by Wan Amir Johari (2008) by selecting 4 construction project sites within Nusajaya, Johor area with total of 40 construction workers (10 from each sites) were evaluated. From the study, the measured nosie level were significantly found is below than permissible exposure limit (PEL) under Factory and Machinery Act (Noise Exposure) Regulation 1989 although the majority of surveyed workers perceived noise as a problem and their workplace was noisy as well. The researcher also concluded that the workers noise perception was at the average level while their awareness was at low level.

Zaron et al. (2014) were conducted a research of occupational noise exposure among road construction workers that aims to evaluate noise exposure and prevalence of hearing loss among typical road construction workers. The researcher has used personal noise dosimeter to obtain the noise exposure profile of heavy equipment operators that working on various stage; road work, trade work and pavement work with total of 73 construction workers were evaluated.The results show that in road works stage there are 6.9% workers exposed to action level ≥85 dBA and 1.4% workers exposed to noise ≥ dBA. 4.1% workers from trade work and 13.7% workers from pavement work were exposed to noise ≥85 dBA. The study also shows about 5.48% of workers from pavement work exposed to hazard level of noise with only 2.74% of worker used Hearing Protection Devices (HPD). Theprevalence of symptoms of hearing loss among workers with

45% of workers from road works, 32% from trade works and 23% from pavement stage (Zaron et al, 2014).

2.6 Noise Level Measurement

There are varieties for quantifying noise levels, the most useful of which for measuring sound as a health hazard as described de Hollander et al (2004). In general, these metrics are based on physical quantities, which are "corrected" to account for the sensitivity of people to noise. These corrections are depending on the noise frequency and characteristics (impulse, intermittent or continuous noise levels, and also the source of noise. The following measures are most relevant for assessing occupational noise levels:-

Sound pressure level. The sound pressure level (L) is a measure of the air vibrations that make up sound. Human ear can detect a wide range of sound pressure levels (from 20 μPa to 200 Pa). They are measured on a logarithmic scale with units of decibels (dB) to indicate the loudness of sound.

Sound level. The human ear is not equally sensitive to sounds at different frequencies. To account for the perceived loudness of a sound, a spectral sensitivity factor is used to weight the sound pressure level at different frequencies (A-filter). These A-weighted sound pressure levels are expressed in units of dBA.

Equivalent sound levels. When sound levels fluctuate n time, which is often the case for occupational noise, the equivalent sound level is determined over a specific time period. In this guide, the A-weighted sound level is averaged over a period of time (T) and is designated by LAeq.T. A common exposure period, T, in occupational studies and regulations is 8 h, and the parameter is designated by the symbol, LAeq.8h.

The control of noise exposure has become one of the main components in occupational health. The most appropriate exposure measurement for occupational noise is the A-weighted decibel, dBA usually averaged over an 8-hour working day. Exposure is initially measured as a continuous variable, and theoretically could be treated as such in assessing the burden of disease (Concha-Barrientos et al, 2004). However, as many surveys report exposure above and below cut-off values, rather than as a distribution. For example, the following categories are widely applied because they correspond to specific regulatory limits in developed (usually 85 dBA) and many developing (usually 90 dBA) countries for an average 8-hour day (Hessel &Sluis-Cremer, 1987; Alidrisi et al, 1990; Shaikh, 1996; Hernandez-Gaytan et al., 2000; Osibogun, Igweze&adeniran, 2000; Sriwattanatamma&Breysse, 2000; Ahmed et al., 2001):

- Minimum noise exposure: <85 dBA
- Moderately high noise exposure: 85-90 dBA
- High noise exposure: >90 dBA

As referred to NIOSH's threshold of daily allowance, the standards in occupational health regard 85dBA as the noise level will produce physical harm to workers, providing the exposure is continuous for more than eight (8) hours per day. The factories and Machinery (Noise Exposure)

Regulations 1989 by the Malaysian Government set the permissible limit of exposure as:

a) No employee shall be exposed to noise level exceeding equivalent continuous sound level of 90 dBA or exceeding the limits specified in the First Schedule or exceeding the daily noise of unity.

b) No employee shall be exposed to noise level exceeding 115 dBA at any time.

*Source: Factories and Machinery (Noise Exposure) Regulations 1989.

2.7 Review Legislative History and Legislation In Malaysia

Safety and health standards that contained references to excessive noise had been issued in the United States under the Walsh-Healey Public Contracts Act of 1936 that prescribed either a limit or acknowledged the occupational hearing loss (NIOSH, 1998). In 1969 the Department of Labor, Safety and Health Standards Department altered the Walsh-Healey Public Contracts Act of 1936, demanding the usage of hearing protection to be worn out when the average noise level surpassed 90 dBA in 8 hour period time (TWA) within 5 dB exchange rate as its permissible exposure limit (PEL) for general industry. In the United States, the occupational Safety and Health Act (Public Law 95-165) were altered a few times between years 1981 to 1983 resulted in the implementation of hearing conservation program for occupational exposure at 85 dBA or above. However, the standard does not cover all workers in all industries such as transportation, oil and gas drilling and servicing, agriculture and mining industries (NIOSH, 1998; NMCPHC, 2009).

In Malaysia, in order to minimized fatal accidents, injuries, illnesses and also hazard at the workplaces, all company and organizations have to follow the regulations in two (2) Act which is: the Factories and Machinery Act 1967 (FMA 1967), and Occupational Safety and Health Act 1994 (OSHA, 1994). The regulations that related to noise exposure issues was enacted in 1989 and known as the Factories and Machinery (Noise Exposure) Regulations 1989. Regulations, guidelines and codes of practice have been drawn to support the Acts. Usually, the OSHA Act more focuses on management issues while FMA 1967 handled the technical issues (Sirat et al., 2011). The act is enforced by the Factories and Machinery Department whereas since 1967, the Department has been promoted the safety promotional activities such as producing safety and health guidelines and posters and also giving talks and introduce the importance of safety to people in specific industries.

2.7.1 The Factories And Machinery (Noise Exposure) Regulation 1989

The factories and Machinery (Noise Exposure) Regulations 1989 was enacted on the 1st of February 1989. The regulations are applied to all industries in any occupation involving exposure to excessive noise level in the workplace. These regulations consist of 34 regulations and divided into ten (10) parts and appended into two (2) schedules. In general, the ten parts of these regulations are follow as:-

Table 2.1 The ten (10) parts of regulation drawn in The Factories and Machinery (Noise Exposure) Regulation 1989.

No.	Part	Content
1	I	Interpretation of the terms used in the regulations
2	II	Permissible exposure limit
3	III	Exposure monitoring
4	IV	Method of compliance
5	V	Hearing protection devices
6	VI	Audiometric testing program
7	VII	Employee information and training
8	VIII	Warning sign
9	IX	Record keeping
10	X	Miscellaneous

The regulations demand the obligations of employees to wear a noise dosimeter during employee exposure monitoring, wear and use the hearing protection provided properly,attend or undergo audiometric testing or any medical examination and also attend employees'information and training programs conducted by the occupier. Generally, the permissible exposure level (PEL) was set at 90 dBA for 8 hours and allowed to be changed by 5 dBA (Exchange Rate (ER)) for every doubling or halving of time. The standard also stated the maximum exposure level for continuous noise at 115 dBA and no employee shall be exposed to impulsive noise surpassed a peak sound pressure level of 140 dBA. Based on Malaysia's noise legislation, the criterion level for hearing conservation program (HCP) is 85 dBA, and once the noise level reaches 90 dBA, the noise control should be implemented.

The exchange rate (ER) is known well as "time-intensity trading rule", the "doubling rule", and the "trading relation". ER is referred to the increase in noise exposure level that can be allowed for every halving of duration, with presumably the same hazard results of hearing. Malaysia is one of the few countries in the world that still adopt the 5 dBA ER instead 3 dBA that used by other countries. The 3 dBA ER is well accepted by almost countries over the world such as Australia, Canada, New Zealand, United States, United Kingdom, China, Germany, European Union, Singapore, Japan, Sweeden and many others. A few countries such as Malaysia, Brazil, Chile, Colombia and Israel still adopt the 5 dBA ER (NIOSH, 1998; Madison, 2007; Nietzel, 2012). The 3 dBA exchange rate is known as the equal-energy rule or hypothesis due a decrease/increase of 3 dBA represents a doubling or halving of the sound energy. The principle behind the different exchange rates as defined by NIOSH (1998):-

"The premise behind the 3-dB exchange rate is that equal amounts of hearing impairment regardless of how the sound energy is distributed in time. However, the 5-dB exchange rate attempts to account for interruptions in noise exposure that commonly occur during the workday, presuming that some recovery from temporary threshold shift occurs during these interruptions and the hearing loss is not as great as it would be if the noise were continuous”

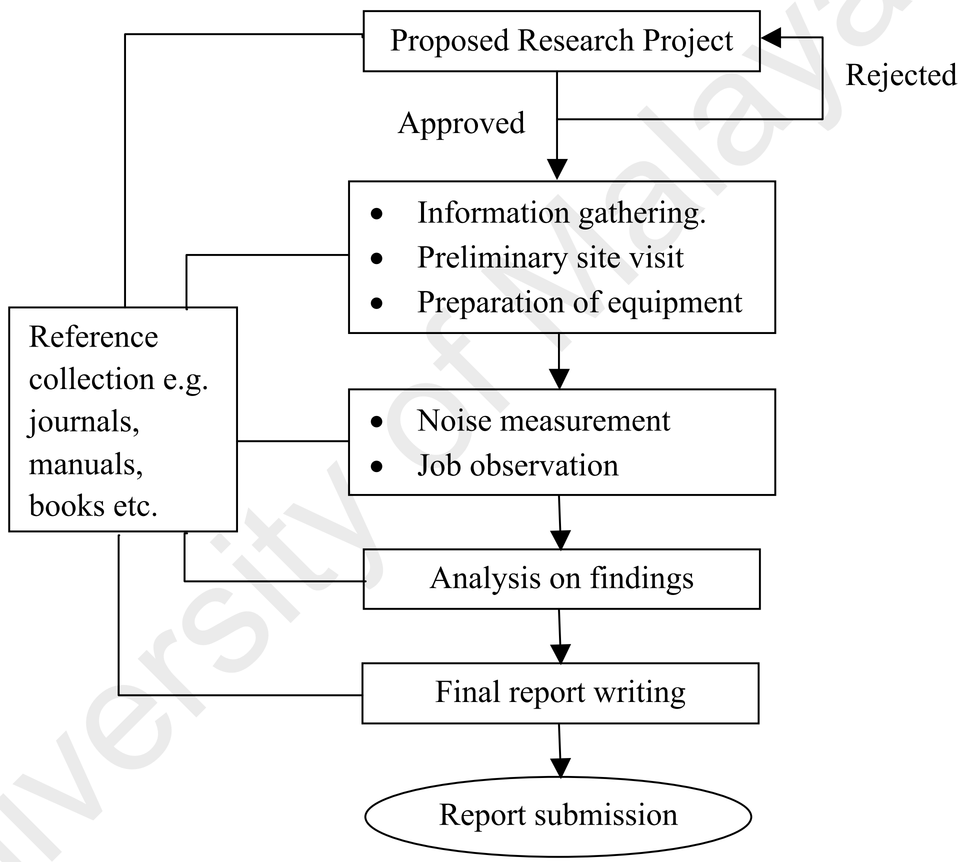
The adoption of 3 dBA ER generally gave more benefits as 5 dBArule is less protective. The used of 3 dBA ER will protected the employee where their exposure exceeds the permissible exposure level. The adoption of 3 dBA ER was supported by previous research that demonstrated the benefits where a significance difference was found when a worker’s day exposure level was calculated with the use of 3 dBA ER compared to 5 dBA ER (Seixas et al., 2005; Daniell et al., 2006). The difference between the mean exposures was 5.7 dBA higher with a 3 dBA ER to 5 dBA ER where 3 dBA ER produces a 1.5 to 3-fold increase in the percentage of over-exposed workers (Daniel et al., 2006). More workers were exposed to hazardous noise as compared when the exposure level was calculated using 5 dBA ER.

Based on trends and studies that supported the usage of the 3 dBA ER principle, it seems reasonable to Malaysia considered change the exchange rate that is currently used in the Factories and Machinery Act (Noise Exposure Regulations) 1989 from 5 dBA ER to 3 dBA ER in order to protect more workers from occupational noise. This will avoid the situation where workers continue to lose their hearing due to the inadequacy of current regulations.

3.0 METHODOLOGY

3.1 Research Project Methodology

This chapter describes methods used for this project starting from references gathering until result of noise monitoring is analyzed. The following diagram show the overall activities for this study:



Figures 3.1 Research project process flow

3.2 Gathering the Information

Information on physic of sounds, trend of noise exposure at workplace around the world and in Malaysia, review on legislative on noise in Malaysia are gathered through collections of journal, reports, books and manuals.

3.3 Preliminary Site Visit

Preliminary site visit was conducted at the selected construction site in Putrajaya to obtain sufficient information and to get better understanding on work environment and current work progress in order to determine scope of measurement and target group for the studies.

3.4 Type of Job and Group of Workers Selection

Progressively, the selected construction site was at the stage of sub structure. Task available to be studied are divided based on their job trade. Since work locations are not fixed and they are always move to different location at fast pace, noise mapping is not relevant to be conducted. Hence we measure the noise based on their type of work. Table 3.1 shown Job trade, type of job, and job description.

Job Trade	Type of Job	Job Description
Civil & Structure	Carpenter	Customize formwork made of timber and plywood using nail and hammer.
	Bar bender	Bend the iron bar (for concrete reinforcement) to suit the formwork using bar bender machine.
Architectural	Brick layer	Layering and paste cement in between of bricks. Layering of brick manually. Sometimes need to cut the brick into size using cutting machine.
	Plasterer	Rendering the concreted structure and apply plaster on the surface.
Mechanical & Electrical	Pipe laying	Laying of pipe. Sometimes need to cut the pipe into size using cutter.

Table 3.1 Job classification

Figures 3.2 Photo of workers customizing the timber formwork

Figures 3.3 Photo of electrical worker laying the pipe

3.5 Instruments

Noise Measurements were performed using the following equipment:

3.5.1 Noise Logging Dosimeter

- Model : Eg 4 Quest Technologies (3 units)
- Serial No : EHK 040003 & EHK 030040/37

3.5.2 Noise Sound Level Meter

- Model : SoundPro SP DL-1, Quest Technologies (1 unit)
- Serial No : BGG110002

3.5.3 Calibrator

- Model : QC-10 Calibrator, Quest Technologies
- Serial No : QE4040008

Noise Logging Dosimeter was calibrated with a calibrator prior and after the measurements, in accordance to the calibration procedures of the respective instruments.

3.6 Noise Measurement

Noise measurement were done continuously throughout the day work in accordance to ISO 9612 Acoustics – Guidelines for the measurement and assessment of exposure to noise in a working environment. The following measurement methodologies are carried out to measure noise level by using the instruments stated in sub-section 3.5.

3.6.1 Work Area (Job Type) Monitoring

3.6.1.1 Initial calibration of Noise Sound Level Meter (SLM).

3.6.1.2 During measurement, SLM was set at A weighting and slow response mode.

3.6.1.3 The exchange rate was set to 5 dB (A).

3.6.1.4 The microphone of the SLM was pointed towards the noise source at distance of about one (1) meter away and at height of about one (1) meter.

3.6.1.5 Type of noise exposure determined based on the differences between maximum value and minimum value. If the different is less than 3 dB(A), the noise exposure classified as Steady Continuous type. If the different is more than 3 dB(A), then the noise exposure is classified as Fluctuating type.

3.6.2 Personal Monitoring

3.6.2.1 Initial calibration of Noise Logging Dosimeter.

3.6.2.2 The meter was setting based on OSHA Hearing Conservation.

3.6.2.3 During measurement, the Noise Dosimeter was set at A Weighting and slow response mode.

3.6.2.4 The exchange rate was set at 5 dB (A).

3.6.2.5 One high-risk worker from the job type was selected for personnel exposure monitoring.

3.6.2.6 Workers personnel particular were recorded.

3.6.2.7 Noise Dosimeter was attached onto the selected worker (microphone was positioned as near to the ear of the worker as possible).

3.6.2.8 After completed monitoring, the noise dosimeter will be detached from the workers and proceed for final calibration.

3.6.2.9 Then, the noise data will be downloading to PC and results generated.

4.0 RESULT AND DISCUSSION

4.1 Overview

This chapter presents the noise measurement results and the analysis for work area monitoring, personal monitoring and surveys.

For work area monitoring, each group of workers are monitored for 3 consecutive days. After we are able to identify which group of workers are at risk (exceeding action level), 3 workers would be chosen randomly from each of those group to proceed with personal monitoring. High risk status is determined from work area monitoring results.

Then result of the personal monitoring are then cross checked with site diary to figure out which activity that give rise to the level of noise collected.

Survey forms were distributed proportionally based on ratio of workers, supervisory level and management level. The survey covers on awareness of respondents towards noise exposure and its impact on health.

4.2 Work Area Monitoring

Table 4.1 Work area monitoring result

Job Trade	Type of Job	Noise Range, dB (A)				Type of Noise
		Day 1	Day 2	Day 3	Mean	
Civil & Structure	Carpenter	78.3	76.3	81.2	78.6	Fluctuating
	Bar bender	98.6	95.4	98.2	97.8	Fluctuating
Architectural	Brick layer	94.3	95.0	94.6	94.6	Fluctuating
	Plasterer	76.2	72.0	78.6	75.6	Fluctuating
Mechanical & Electrical	Pipe laying	77.4	78.2	76.5	77.4	Fluctuating

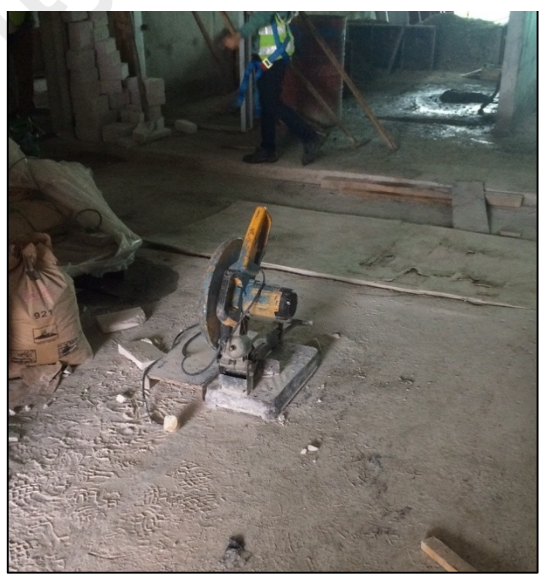
From the results shown, two types of jobs; bar bender and brick layer have noise level above action level of 85 dB(A) which are 97.8 dB(A) and 94.6 dB(A) respectively.

The work area monitoring reports then cross checked with site diary to anticipate and further to identify source of the noise.

For bar bender, noise source coming from bar bending machine used to bends the iron bar. This machine need to be operated manually. Observed two workers have been assigned to carry out this task.

Figures 4.1 Bar bending machine in the bar bending yard

As for brick layer, noise source believed to be coming from the process of cutting the brick into smaller size using angle grinder. This task only been carried out when there is the necessity to do so, not on regular basis.



Figures 4.2 Cutter machine used by brick layer

Three representatives from these two trades have been chosen to carry out the personal monitoring.

4.3 Personal Monitoring

Noise measurement of the total of 6 samples which represent bar bender and brick layer are tabulated in Table 4.2

Table 4.2 Personal monitoring results

Workers Name	Type of Job	Duration	Leq, dB(A)	Max Level, dB(A)	Peak Level, dB	Daily Dose %
Diluar Hussain	Bar bender	06:13:40	85.76	112.0	133.0	62.50
Raja Miah	Bar bender	06:08:28	86.34	96.0	126.0	61.20
Jakir Hossein	Bar bender	06:14:20	85.86	110.2	129.5	63.40
Md Dolal Miah	Brick layer	06:10:58	74.25	105.2	119.3	12.68
Jahangir	Brick layer	06:09:10	76.82	104.4	112.7	12.90
Ishmail Hussain	Brick layer	06:13:54	74.66	106.0	119.0	14.86

Based on the results, the overall equivalent noise level (Leq) measured for Mr. Diluar Hussain, Raja Miah and Jakor Hosein, workers for bar bender all slightly above the action level of 85 dB(A).

Meanwhile the overall equivalent noise level (Leq) measured for Mr. Md Dolal Miah, Jahangir and Ishmail, workers from brick layer all below the action level.

4.4 Questionnaire Survey Form

4.4.1 General Information

A total number of 100 respondents were taken for this study. Figures 4.3 show the percentage of managerial level of employee for this site. 100 survey forms were distributed proportionally to represent this ratio.

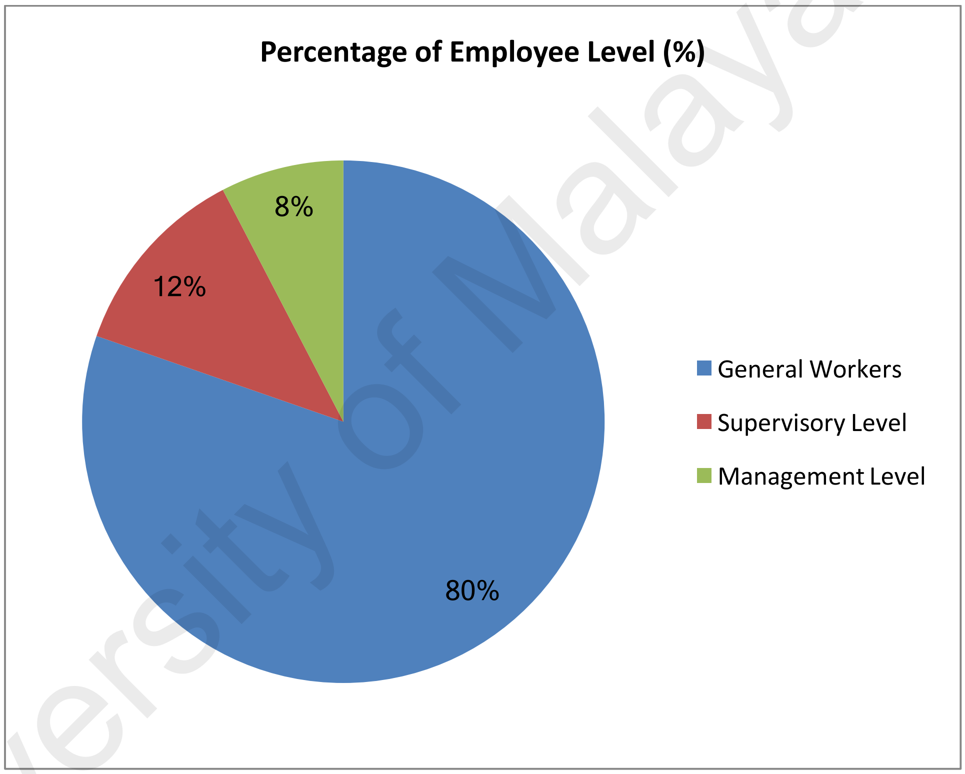


Figure 4.3 Percentage of employee level

At this point when the study was conducted, site consists of 200 workers, 30 supervisors and 19 management level. Management level consists of officer / engineer level and above. To represent the data with exact ratio, the forms distribute to 80 workers, 12 supervisors and 8 management staff. All 100 forms were successfully collected back.

Figure 4.4 show that 86% of total respondent are males while only 14% of total respondent are females while Figure 4.5 show percentage of education level.

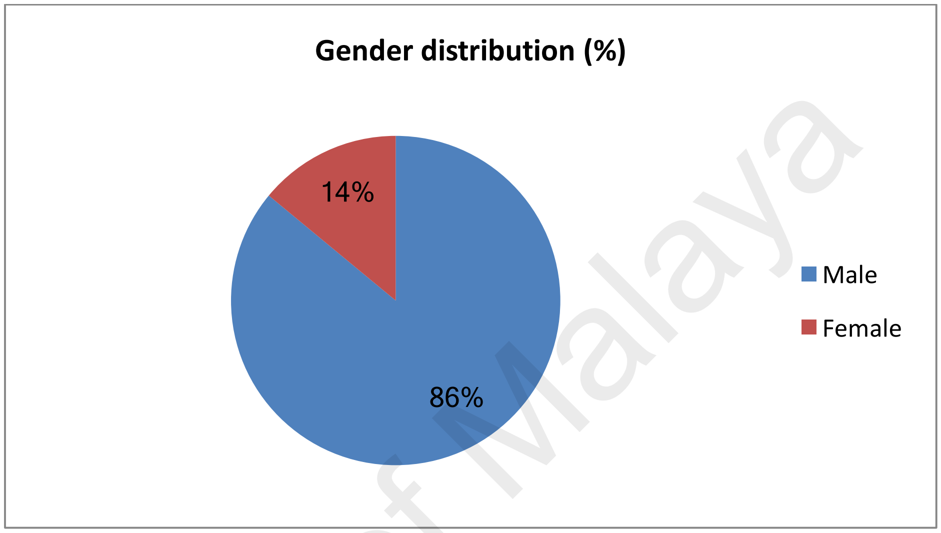


Figure 4.4 Percentage of gender studied

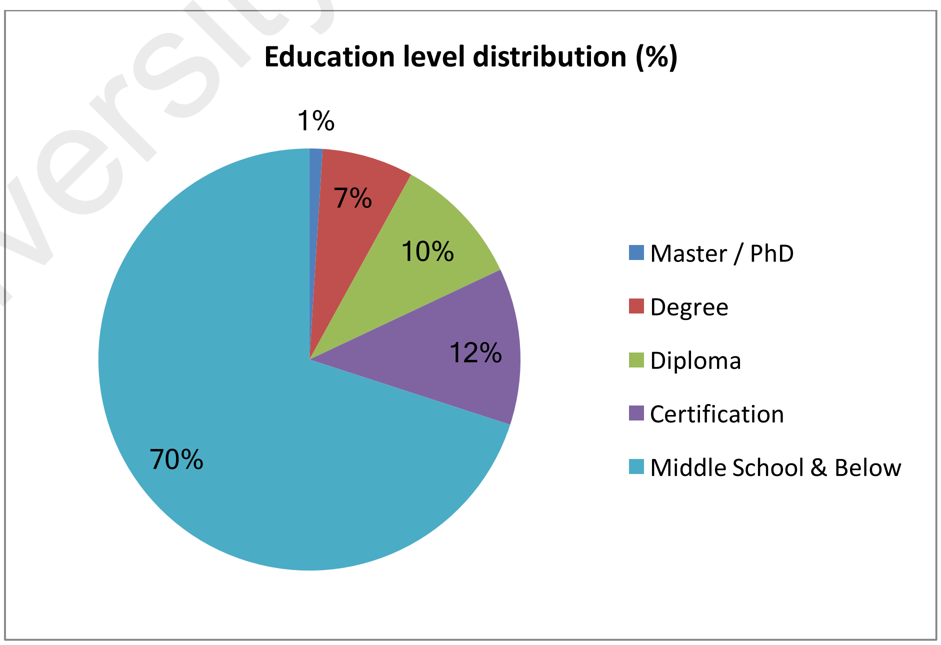


Figure 4.5 Percentage of education level

There are 21 respondents aged less than 25 years old, 35 respondents are age between 25 – 35 years old, 36 respondents are age between 36 – 46 years old and 8 respondents are above 46 years old as shown in figure 4.6.

Figure 4.6 Percentage of age of site personnel

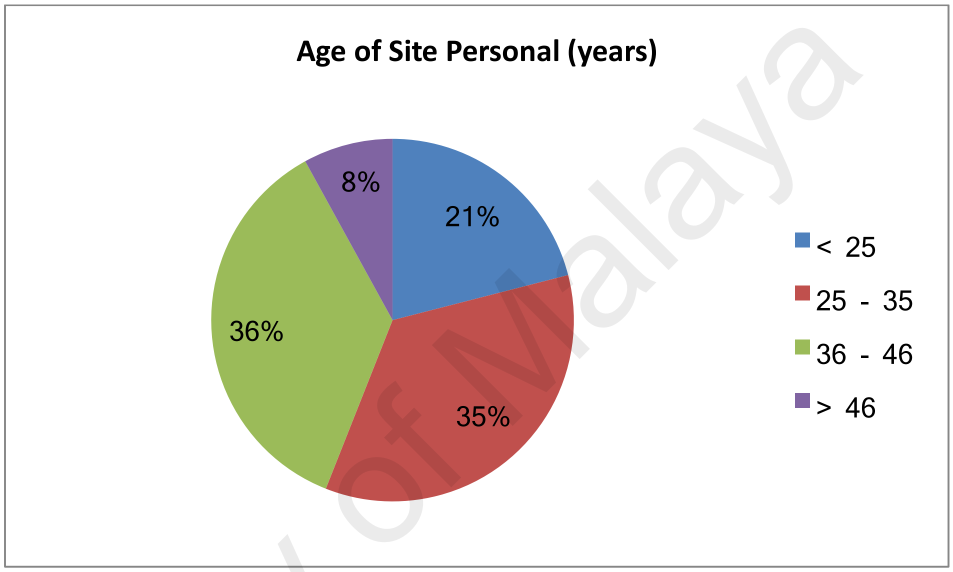


Figure 4.7 show percentage of working experience in construction industry cumulatively in years. 12% has less than 3 years of working experience. 42% has 3 – 5 years of working experience. 28% has 6 – 10 years of working experience. 18% has more than 10 years of working experience.

Figure 4.8 show percentage of nationality. 20% are Malaysian, 65% are Bangladeshi, 12% are Indonesian while other 3% are other (consist of Myanmar and Vietnam).

Figure 4.7 Percentage of working experience

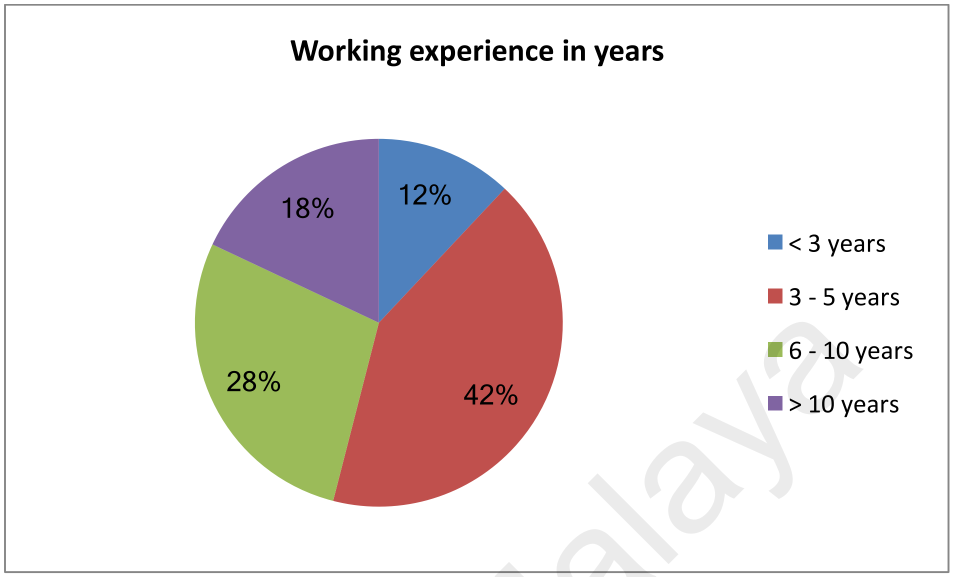
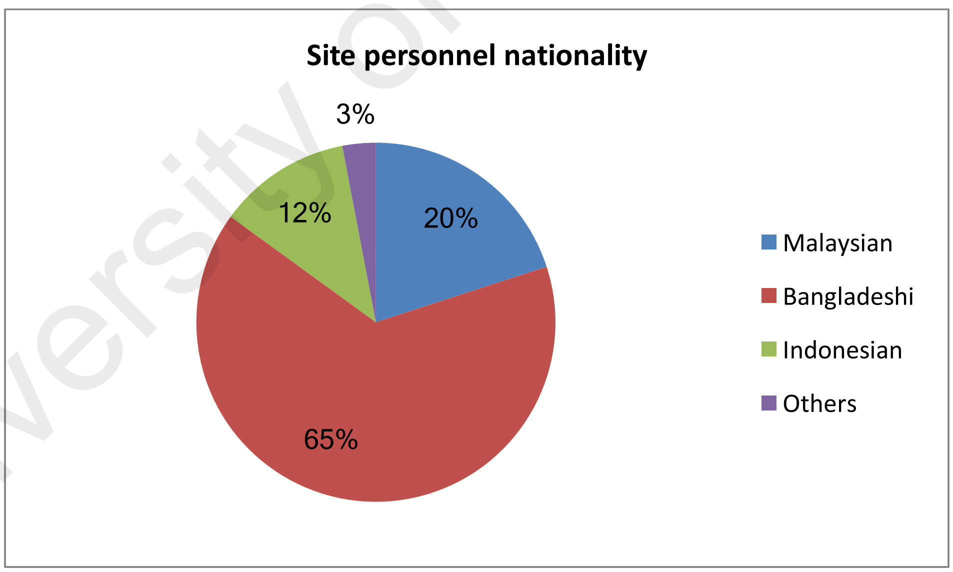


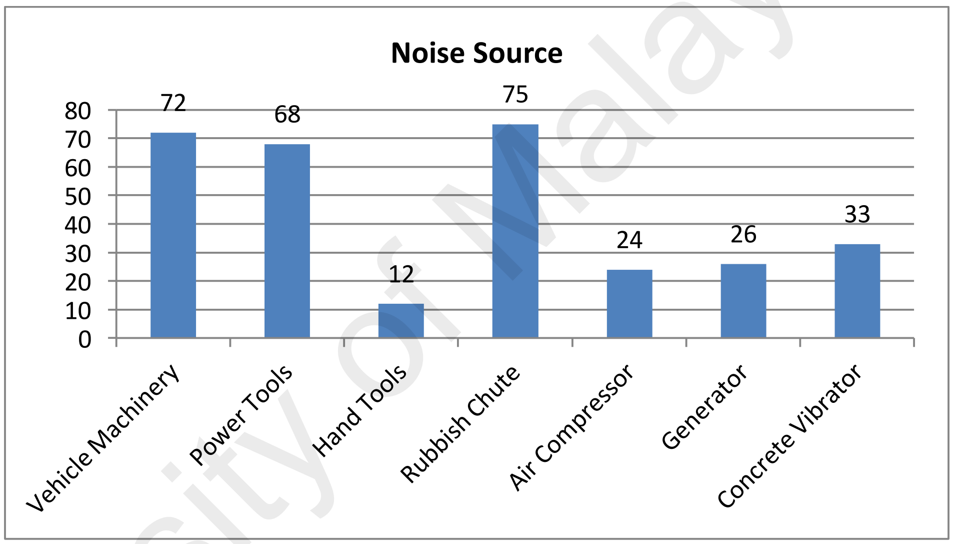
Figure 4.8 Percentage of nationality



4.4.2 Awareness on Noise Hazard at Site

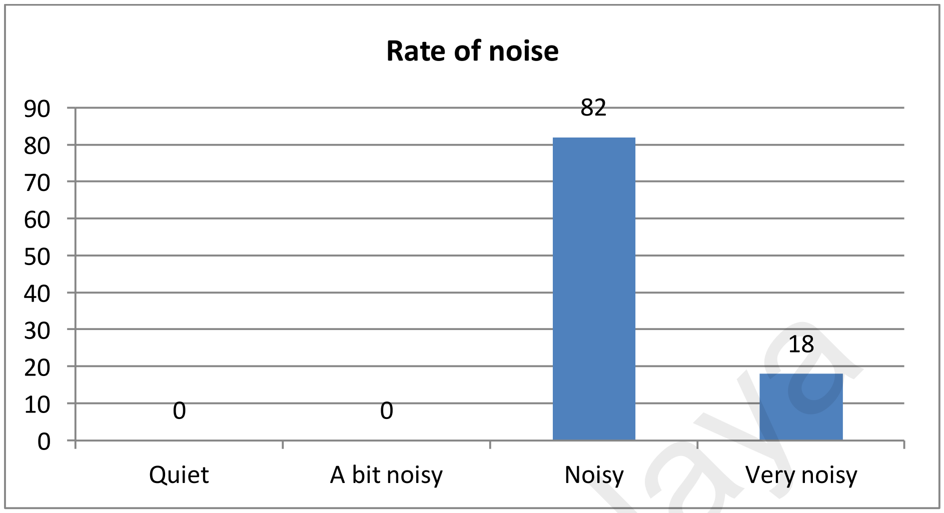
In order to find out what is the most annoying source of noise at site, respondents are allowed to select more than one option. 3 activities have been identified as major noise source; rubbish chute, vehicle machinery and power tools as shown in figure 4.9.

Figure 4.9 Source of noise at workplace



Majority of the respondent, 82 rate their workplace as noisy, 18 rate as very noisy. Neither respondents rate their workplace as quiet or a bit noisy as shown in figure 4.10.

Figure 4.10 Rate of noise at workplace



Majority of the respondents, 62 feel that noise is disturbing while 38 of the respondents are not disturbed by the noise. This is shown by figure 4.11

Figure 4.11 Noise disturbances at workplace

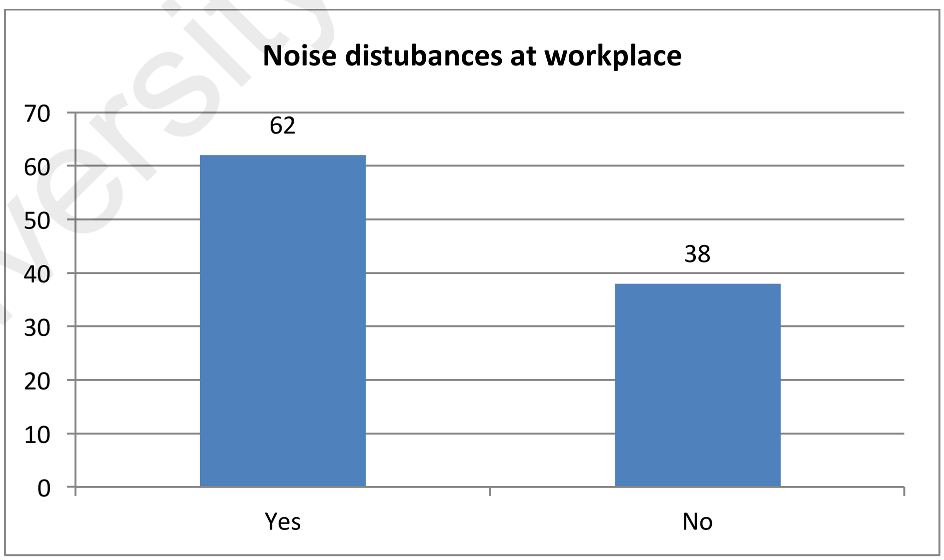


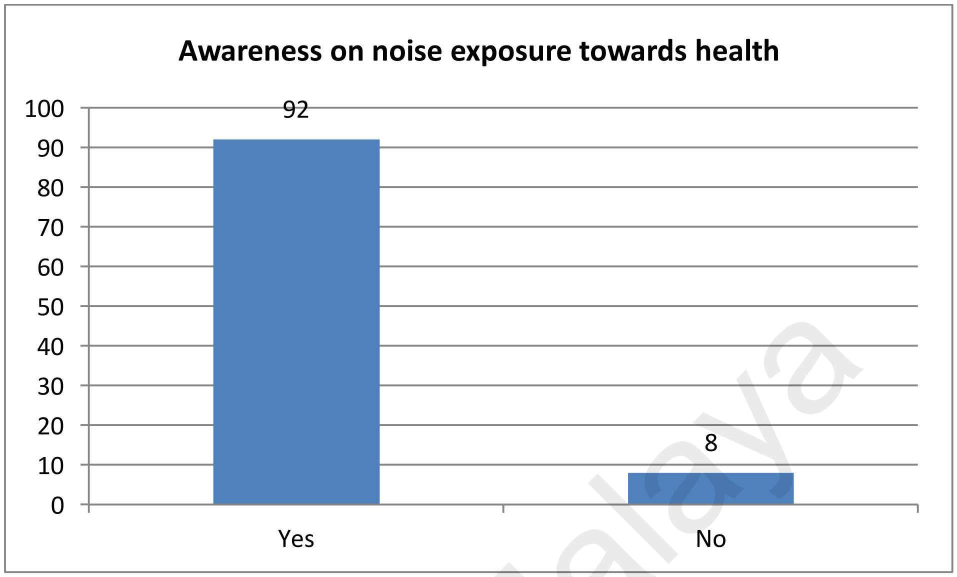
Table 4.3 shows awareness of respondent on the need to wear hearing protection when approaching noise source by year of working experience. Majority of the respondent aware on the requirement to wear hearing protective equipment but during the site observation, none spotted wearing the hearing protective equipment.

Table 4.3 Awareness on PPE usage versus year of working experience

Working Experience	Yes	No	Do not know
< 3 years	10	0	2
3 – 5 years	20	6	16
6 – 10 years	20	0	8
> 10 years	16	2	0
Total	**66**	**8**	**26**

Figure 4.12 shows awareness of respondent whether they are aware that noise exposure at workplace is a hazard to their health. Majority of the respondents (92%) aware that noise exposure is hazardous to their health.

Figure 4.12 Awareness on noise exposure toward health



4.4.3 General Discussion

Noise measurement results for area monitoring shows that workers from 2 groups of activities are exposed to the fluctuating noise and noise level of slightly above the action level. Since the working area is changing quite frequent, the level of noise varies due to the factor of barrier than present such as wall and open surrounding.

Result from the 6 unit of dosimeter shows that 100% sample exceed the action level and 67% sample exceed the Permissible Exposure Limit (PEL) of 90 dB(A). Even though sample not working on the noise source all the time, this result obtain due to the location of the noise source is too near to the sample. Workers tend to work close to each other within their group.

The results obtained from the survey indicated that most of respondent aware on noise sources in their surrounding and harm that could do to them. Most of them disregard to their working experience also aware that hearing protection is important to protect their health from noise hazard but still none seen wearing them. PPE distribution form stated that everyone was given earplug and have signature on it indicate that they have received it and understand the training given on how to use it properly. Most of them claim that they already lost the ear plug.

5.0 CONCLUSION

5.1 Conclusion

This section will discuss the conclusions resulting from the information and data that have been obtained during this study. The main information derived from the noise monitoring results and review of the literature that has been processed to be concluded in this chapter. In addition to the points made, this chapter also lay out the suggestions that can be recommended.

It can be concluded that bar bending and brick laying activities at construction site in Putrajaya have high level of noise that exceed the action level but none exceed the PEL. The factors that contribute to noise exposure is the duration of exposure during the work shift. Noise sources are coming from usage of machine and power tools. Workers for these two group of workers are required to wear hearing protection device when working near the noise sources.

Conclusion that we get from survey result also show that regardless of age and experience gained in construction activity, level of awareness toward noise hazard is still low.

5.2 Recommendations

Following are recommendations to be taken by the contractors for these group of workers of brick laying and bar bender:

1) To provide hearing protection device and to ensure they use the hearing protection to reduce the level of exposure.
2) To introduce job rotation system to minimize exposure of workers to the noise sources.
3) To institute a training program for workers. The contents should include the effect of noise on hearing, purpose of hearing protection device as well as instruction on fitting, use and care.

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