PSYCHOLOGICAL IMPACT OF NOISE EXPOSURE AMONG MACHINE OPERATORS AND NON-MACHINE OPERATORS IN CONSTRUCTION SITES IN PERAK, MALAYSIA

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ABSTRAK

Bunyi bising pembinaan adalah salah satu masalah pencemaran bunyi serious di mana setiap projek pembinaan pasti mempunyai masalah pendedahan bunyi bising. Di Malaysia, laporan statistik menyatakan bahawa tapak pembinaan mempunyai pendedahan yang tinggi terhadap beberapa isu terutamanya pendedahan terhadap bunyi bising di mana pendedahan kepada bunyi bising disenaraikan sebagai kedudukan 2 dengan frekuensi 134 tapak pembinaan daripada 140 tapak pembinaan. Laporan telah menunjukkan bahawa bahaya kebisingan merupakan salah satu punca utama terjadinya kemalangan dalam industri pembinaan kerana bunyi bising menjejaskan keselamatan dan kesihatan dalam kalangan pekerja pembiaan. Hal ini demikian, bunyi bising ada isu yang serious dalam kalangan industri pembangunan di Malaysia manakala impak pendengaran bunyi bising perlu dijalankan dalam kajian ini. Kajian ini menumpukan perhatian dalam mengenalpasti tahap pendedahan seseorang terhadap bunyi dan kelaziman simptom kesan kesihatan psikologi dalam kalangan pekerja pengendalian mesin dan bukan pengendalian mesin di tapak pembinaan Perak. Enam puluh satu pekerja pembinaan dipilih sebagai responden da dikategorikan kepada kumpulan pengendaian mesin dan kumpulan bukan pengendalian mesin. Semua responden telah dihendaki untuk memasang dosimeter bunyi peribadi semasa waktu kerja selama 8 jam untuk mendapatkan data mengenai tahap pendedahan bunyi bising dalam kalangan pekerja. Untuk kelaziman simptom kesan kesihatan psikologi akibat pendedahan bunyi bising, soal selidik dan sesi soal jawab dijalankan dalam kalangan pekerja pembinaan yang terpilih untuk tujuan pengumpulan data. Kajian ini mendedahkan bahawa tahap pendedahan bunyi dalam kalangan pekerja adalah tinggi di mana purata tahap pendedahan untuk kumpulan pengendalian mesin (81.81dBA) jauk lebih tinggi berbanding dengan purata tahap pendedahan bunyi bising untuk kumpulan bukan pengendalian mesin (74.71dBA) melalui analisis. Selanutnya, kelaziman simptom kesan kesihatan psikologi adalah tinggi dalam kalangan pekerja di mana 93.5% pengendali mesin dan 43.3% pengendali bukan mesin berasa ketegangan (tension) apabila bekerja dalam suasana kerja yang bising. Melalui analisis, hasil menunjukkan terdapat perbezaan yang signifikan di mana p-value kurang dari 0.05 antara pengendali mesin dan pengendali bukan mesin untuk beberapa kelaziman simptom kesan kesihatan psikologi di mana pengendali mesin mempunyai kelaziman yang lebih tinggi berbanding dengan pengendali bukan mesin. Akhir sekali, kajian menunjukkan bahawa terdapat hubungan yang signifikan dan positif antara tahap pendedahan bunyi bising dan kelaziman untuk sebahagian simptom kesan kesihatan psikoloi di mana sakit telinga (p-value=0.011), perubahan ketara dalam pendengaran (p-value=0.007), and pening (p-value=0.016) dalam kalangan pengendali mesin manakala kehilangan pendengaran secara tiba-tiba (p-value=0.047), kemarahan dan agresif (p-value=0.027), pening (p-value=0.050), tekanan (p-value=0.031) dan ketegangan (p-value=0.028) di tempat kerja yang bising untuk pengendali bukan mesin di tapak pembinaan.

ABSTRACT

Noise from the construction activities is one of the severe issue of noise pollution where there must be noise pollution produced at every construction projects. In Malaysia, previous statistical report has stated that the construction sites have high exposure of several hazards especially the noise hazard where noise hazard was ranked 2 with frequency 134 out of 140 sites. The previous reports reveal that the noise hazard is one of the main causes of the occurrence of accidents in construction industry as noise hazard affect the safety and health among the construction workers. As the noise hazard is reported as serious issue among the construction industry in Malaysia, an impact of noise exposure need to be conducted in this study. This study is mainly focus in identifying the personal noise exposure level and the prevalence of psychological health effect symptoms among the machine operators and non-machine operators on construction site in Perak. Sixty-one construction workers were selected as respondents and categorized into machine operators group and non-machine operators group. All respondents were monitored for 8 hours working time using personal noise dosimeter for the personal noise monitoring. For the prevalence of psychological health effect symptoms due to noise exposure, questionnaires and interview sessions were done among the selected construction workers. The result obtained reveals that the personal noise exposure level among the construction workers is high where the mean of personal noise exposure level for machine operators group (81.81dBA) is significantly higher compared to the mean of personal noise exposure level for non-machine operators group (74.71dBA). Besides, the prevalence of psychological health effect symptoms is high among the construction workers where 93.5% of machine operators and 43.3% of non-machine operators feel tension when working in noisy work environment. Through the independent chi-square test, results with the p-value less than 0.05 show that there was significant differences between the machine operators and non-machine operators for several prevalence of psychological health effect symptoms where machine operators has significantly higher prevalence compare to non-machine operators. Lastly, result obtained through Binary Logistic Regression, it reveals that there is significant and positive coefficient between the personal noise exposure level and the prevalence of several psychological health effect symptoms on ear pain (p-value=0.011), noticeable change in hearing (p-value=0.007), and dizziness (p-value=0.016) for machine operators and sudden hearing loss (p-value=0.047), anger and aggressiveness (p-value=0.027), dizziness (p-value=0.050), stressful (p-value=0.031) and tension (p-value=0.028) in noisy work environment for non-machine operators in construction site.

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LIST OF SYMBOLS

dBA	A-Weighted Decibels
dBHL	Decibel Hearing Level
df	Degree of Freedom
mmHg	Millimeters of Mercury as in a Blood Pressure Reading
Hz	Hertz
TWA	A Time-weighted Average

LIST OF ABBREVIATIONS

DOSH	Department of Occupational Safety and Health
NHIS	National Health Interview Survey
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute of Occupational Safety and Health
PPE	Personal Protective Equipment
PEL	Permissible Exposure Limit
REL	Recommended Exposure Limit
SOCSO	Social Security Organization
SPSS	Statistical Package for Social Science
TTS	Temporary Threshold Shift
UMP	Universiti Malaysia Pahang
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Introduction

Throughout this chapter, the general ideas about this study will be highlighted. This chapter includes background of study, conceptual framework, problem statement, objectives, research question, hypothesis, significance of study, scope of study, study ethics, and the operational definition.

1.2 Background of Study

Sound is defined as the propagation of pressure waves radiating through an elastic medium from a vibration source (Chauhan, 2015). According to NIOSH, the noise is defined as any unwarranted disturbance within a useful frequency band (Concha-Barrientos et al., 2004). Generally, noise is classified into occupational noise or environmental noise where in all human daily activities either day time or night time, noise always presents and gives impact towards human well-being.

Noise then is described as common occupational hazard in most of the workplaces especially the iron and steel industry, manufacture industry and construction industry (Gerges et al., 1992). The construction activity is categorized as one of the sources of noise pollution where the noise is unwanted sound which might be unnoticed and lead to psychological and physical health effect such as stress towards the people work or live near the construction site (Baba et al., 2011).

Nowadays, noise is one of the main pollutants around the world that could impacts the human working and living environment (Kantová, 2017). The impacts towards human such as anger and aggressiveness, headaches, tension, inadequate sleep, and several

diseases on human body system. The human has tried to protect themselves against high noise exposure level through both of materially and legislation actions.

The occupational hearing loss issue is increasing day-to-day among most of the people that exposed to noise at their workplaces. Exposure towards excessive noise for in long term, repeatedly exposure to noise and single exposure towards extremely intense noise will cause serious damage to the auditory system of human and this results in hearing loss, termed noise-induced hearing loss (NIHL) (Peter S. Roland et al., 1997). The noise-induced hearing loss (NIHL) usually slow in onset but will progress relentlessly as long as the exposure continues on the people and irreversible.

Due to the rapid industrialization and urbanization, construction industry has become more and more concern in Malaysia. The construction activities have led to several hazards especially the noise hazard where the noise hazard has become a common and serious source of environmental noise that gives harm to human's health (Liu et al., 2017).

The construction industry is described as a major element of economic force in Malaysia where it also be categorized as one of the most hazardous industry. As the construction industry normally generates noise hazard, this causes most of the construction workers to work under overexposed risk of noise (Said et al., 2014). According to the Social Security Organization (SOCSO) reports 2016, the construction industry in Malaysia had the accident cases reported that was 7338 cases, the third highest number of cases reported industry among all other industries such as trading, transportation and storage (Social Security Organization, 2016).

Moreover, the construction site is always a noisy workplace no matter what kind of precautions are taken. A regular 8 hours exposures to 85dBA noise exposure level could damage the hearing system. The higher the noise exposure level, the faster the hearing loss. As most of the equipment on construction site are above 85dBA noise exposure level such as Jackhammer with 100dBA, and hammer drill with 115dBA, the construction workers are high risk towards the Noise-Induced Hearing Loss (NIHL) or other psychological health effect (Lydia Baugh, 2016).

In this study, the mainly focus issue is to identify the personal noise exposure and the prevalence of psychological health effect symptoms among machine operators and non-machine operators on construction site in Perak, Malaysia. This is a cross sectional study by which simple random sampling method is used in choosing 31 machine operators and 30 non-machine operators from the selected construction site. A validated questionnaire about respondents' demographic information, occupational background related on noise exposure, prevalence of psychological health effect symptoms and health history is designed to identify the effects on workers' health due to noise exposure. The Statistical Package for Social Sciences (SPSS) is required to use for data entry and statistical analyses of data. The Personal Noise Dosimeter helps in identifying the personal noise exposure level among the construction workers.

1.3 Conceptual Framework

Figure 1.1 shows the conceptual framework for this study which intended to study the noise exposure in the construction industry.

The conceptual framework was then contributed the ideology towards the factors which cause the physical effect such as injury due to accident related to hearing ability and the psychological health effects such as noise-induced hearing loss, anger and aggressiveness, tinnitus, psychological stress, tension and difficulty in concentrating.

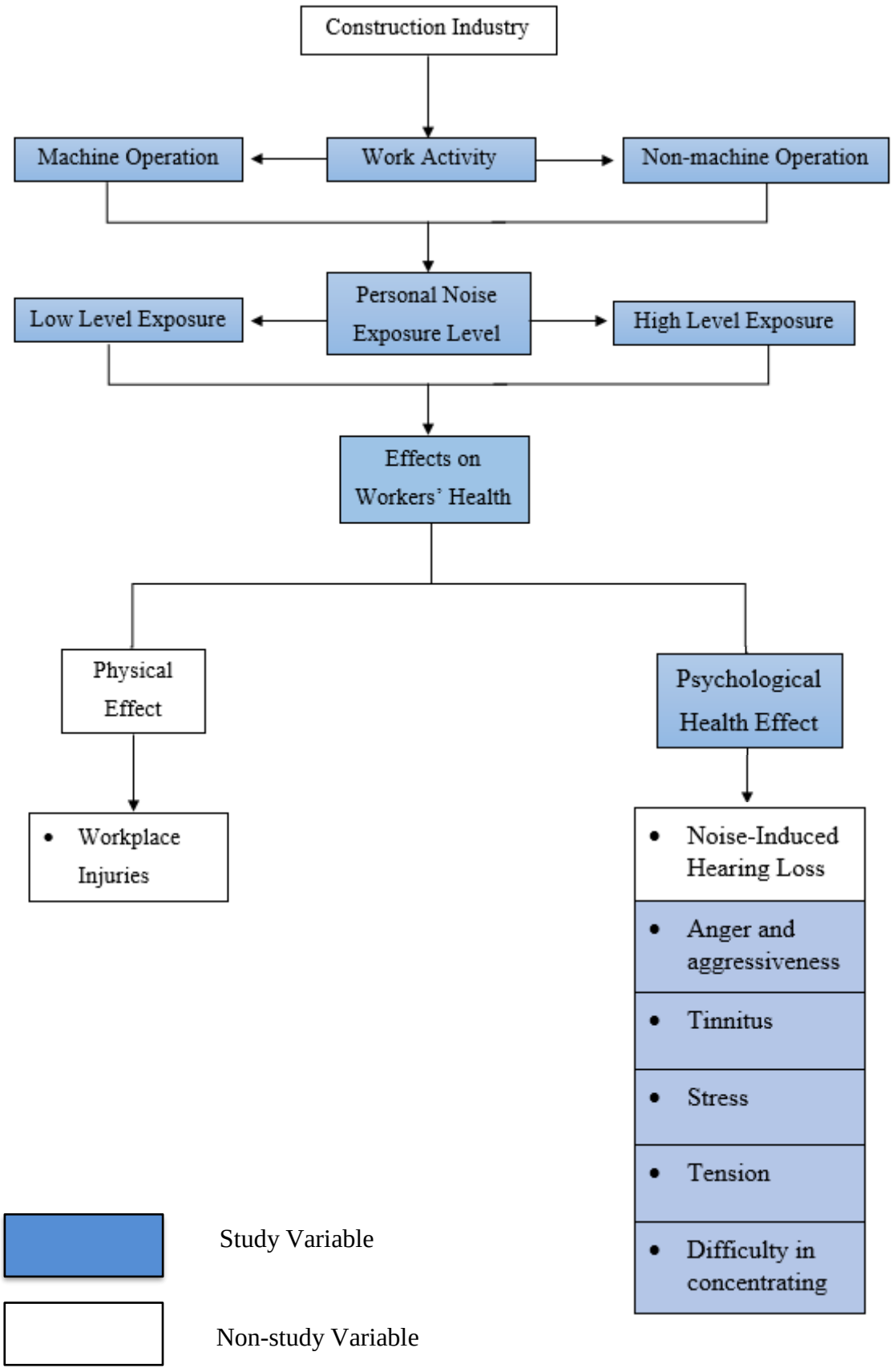

Figure 1.1 Conceptual Framework

1.4 Problem Statement

The Department of Occupational Safety and Health (DOSH) shows statistic which reported that occupational noise-related hearing disorders is the highest occurrence occupational disease among the occupational diseases such as occupational muscular disorder in Malaysia. From the statistic of occupational disease and poisoning by type of disease statistics for 1995–2009 from the DOSH, it showed that noise-induced hearing loss (NIHL) was the most commonly notified occupational disease, where in year 2016, the analysis statistic shows that the occupational noise-related hearing disorder consists of 2876 cases (Jaafar et al., 2017).

Construction noise is one of the biggest grouse of the noise pollution. For every construction project, there must be noise pollution produced at the construction site. According to the report by National Health Interview Survey (NHIS), a survey in United States stated that at least one in five, 21.4% construction workers self-reported hearing trouble in 2010 where it is nearly one-third higher than the proportion of workers with hearing trouble for all other industries, 16.3% (CPWR, 2012). Hence, the employer must be continuously monitored for noise and vibration throughout the project's duration to protect employers' safety and health at the construction site.

Based on report from "Centres for Disease Control and Prevention", the most common U.S. work-related illness is the occupational hearing loss which primarily caused by high noise exposure. The report states that the mining industry had the highest prevalence of workers with any impairment of 17%, with moderate or worse impairment of 3%, follow by the construction industry with any impairment of 16%, moderate or worse impairment 3% (Masterson et al., 2016).

Furthermore, previous studies had discovered that among all occupations in industries, construction workers are identified as one of the highest workers' compensation claim rates for noise-induced hearing loss. In report, the construction workers in many crafts exposed to noise exposure level of 85dBA and higher for long periods work shift (CPWR, 2007). The U.S. Occupational Safety and Health Administration permissible noise exposure limit is 90 dBA as a full-shift time-weighted average (TWA) where most experts agree that the hearing loss occurs with sustained exposure at or above 85dBA. On average, the construction workers used hearing personal

protection equipment (PPE) only 17% of the time when they exposed to workplace noise exposure level over 90dBA.

Moreover, the noise exposure could lead to several risks to both the safety and health of the workers as it increases the risk of accidents in the workplace. Based on previous studies, there are nearly 81% of the construction workers are exposed to high noise exposure level during the working day which could contributes to the hearing impairments and the psychological health effect symptoms (Ali, 2011). The psychological health effect symptoms indirectly contribute to the increase of the rate of accidents owing to interference with the sound signals and other non-hearing effects caused by noise such as stress, loss of attention during work and even increase of blood pressure.

The previous statistical report has stated that the number of cases on fatality and permanently disablement due to accidents at the construction sites is one of the highest as compared to other sectors in Malaysia (Hamid et al., 2003). The report has generally shown the result that the construction sites have high exposure of several hazards such as fire and noise hazards. Among the 140 construction sites that have been selected for analysis, the result has shown that the noise hazard was ranked 2 with frequency 134 out of 140 sites. This could show that the noise hazard is one of the main causes of the occurrence of accidents in construction industry in Malaysia.

As in conclusion, as the noise hazard is one of the severe issue in Malaysia especially the construction industry, without doubt that it is a need to conduct this study which is related to noise hazard in construction industry. The conducted study will be useful for further research study in the future as it could provide relevant details and information in the field of noise hazard.

1.5 Research Objectives

The aim of this study is to investigate the personal noise exposure and the prevalence of psychological health effect symptoms among machine operators and non-machine operators on construction site in Perak, Malaysia. The specific objectives are as the followings:

1.5.1 To identify and compare the personal noise exposure level between machine operators and non-machine operators in construction industry.

1.5.2 To identify and compare the prevalence of psychological health effect symptoms between the machine operators and non-machine operators

1.5.3 To determine the relationship between the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers.

1.6 Research Question

The research study is conducted to answer the following questions:

1.6.1 Which group of operators on construction industry has higher personal noise exposure level?

1.6.2 Which group of operators on construction industry has higher prevalence of health effect symptoms

1.6.3 Is there any relationship between the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers?

1.7 Research Hypothesis

The research hypotheses are listed as below:

1.7.1 The machine operators group on construction industry has significantly higher noise exposure level compared to non-machine operators.

1.7.2 Machine operators has significantly higher prevalence of health effect symptoms compare to non-machine operators

1.7.3 There is a significant relationship between the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers.

1.8 Significance of Study

The study could bring several benefits to the community especially the occupation in the construction field which include both machine-operators and non-machine operators. According to the researchers, it has been proven that the Noise-Induced Hearing Loss (NIHL) and other related health effects are highly occurred among industrial community such as the construction industry where the workers are exposed toward variable degrees of noise (Jaafar et al., 2017). The construction workers are over exposed to high noise exposure level in workplace, they will have high risk to lead to the Noise-Induced Hearing Loss (NIHL) and other health impacts such as stress, aggressive, headache and tinnitus. This study will focus on determining the personal noise exposure level and the prevalence of psychological health effect symptoms towards the construction industry workers.

Moreover, this study contributes by bring awareness towards the organization to comply with the rules that stated in Section 15 (1) – "it shall be the duty of every employer and every self-employed person to ensure, so as far as practicable, the safety, health and welfare at work of all his employees." in the Occupational Safety and Health Act (OSHA) 1994 (Government of Malaysia, 2015) . The employer shall ensure that the safety and health of the workers are being protected as far as practicable to reduce the risk of being harm towards the workers safety and health when working at the construction industries.

The significant discovery from this study will able to serve as other reference source and baseline information for future research study in the related field of noise exposure in construction industry and others too. The study helps to enhance the finding and be served as further sources and references for others to enhance the understanding regarding on noise hazard and the prevalence of psychological health effect symptoms in the industries.

1.9 Scope of Study

A cross-sectional study was carried out in this study to assess the potential risk of the noise exposure towards the construction industry workers whom work at the selected construction sites that located at Perak state in Malaysia. This study mainly focuses on the personal noise exposure level on those noise exposure group for both machine operators and non-machine operators, the prevalence of the psychological health effect symptoms and the comparison between the personal noise exposure level and the prevalence of psychological health effect symptoms among the machine operators and non-machine operators.

The construction workers that involve in both machine operation and non-machine operation will be selected in participating this study. The machine operating workers are those who operates machines such as bar tying machines, electric grinders, electro-mechanical tool Jackhammer and hammer drill. While the non-machine operating workers are those who work tasks are such brick-laying, skim-coat, formwork and mosaic laying.

The noise exposure level in this study will be measured in terms of individual on the construction workers. The measurement of personal noise exposure level will be monitored during the construction workers' work shift where they carry out their work task and the personal noise dosimeter will be used in measuring the personal noise exposure level among the workers.

The prevalence of the psychological health effect symptoms due to the noise exposure will be collected and measured in this study through the distribution of questionnaire towards the selected construction workers as respondents. This could identify the significant of impact by noise exposure to the construction workers that affect the workers' health. The psychological health effect symptoms that included in this study

such as the ear pain, tinnitus, anger and aggressiveness, sleep disturbance, stress, tension and difficulty in concentrating or decision making.

1.10 Study Ethics

In this study, the department of the construction industry that selected and located in Perak will be informed about the details of this study. The construction workers will be chosen and selected as the respondents in this study. The respondents will be given the information about this study before taking consent and participating into this study where they have the full authorities to decline and participation. All the details and information of the selected construction workers as respondents will be private, confidential and kept as secret to be used as educational purpose only. The respondents will not incur any extra cost or be given any monetary inducement in participating in this study where the incurred costs will be bear by the investigator. Moreover, the respondents reserve the right to withdraw from this study any time without any penalties. All the respondents that take part in this study will be required to sign an informed consent form and participant information sheet shown in **Appendix A** and **Appendix B**.

1.11 Operational Definition

1.11.1 Noise

Loud and unwanted sound generated from the machines and workplace activities that affect safety and health of workers in construction industry (Rong et al., 2017).

1.11.2 Machine Operation

A process where the workers works the machines either heavy or non-heavy machinery in the construction industry (Rong et al., 2017).

1.11.3 Non-machine Operation

A process where construction work tasks such as brick-laying and inspection of supervisor without use of any machines that carried out by the workers at construction site (Haron et al., 2013).

1.11.4 Personal Noise Exposure

The level of noise exposure of the workers that measures by using a personal noise dosimeter in construction industry (Fernández et al., 2009).

1.11.5 Psychological Health Effects

The psychological health effects among the construction workers is described as the mental health effect (Van Kamp et al., 2008). It is measured through the distribution of questionnaire towards respondents.

1.12 Summary

This chapter generally introduces the noise hazard in the construction industry where it gives serious impact towards the safety and health among the construction workers. Therefore, the objectives, research questions and hypotheses were set up and answered in the study towards the noise hazard in the construction industry. The conceptual framework shows the overview of the study related to noise exposure monitoring which related to personal noise exposure level and the prevalence of psychological health effect symptoms on noise exposure in the construction industry.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes the related and supporting information from different sources on previous studies. Background of noise, sources of noise on construction industry, related legislation on noise exposure, different types of effects of noise exposure and the effects of noise exposure towards the construction workers are stated in this chapter for supporting the study.

2.2 Background of Noise

Physically, both sound and noise makes no difference where sound described as sensory perception while noise corresponds to the undesired sound where it defined as any unwarranted disturbance (Kirchner et al., 2012). In every human daily activity, noise is present; while assessing its impact on human, noise usually be classified as occupational noise and environmental noise. Occupational noise is described as noise in the workplace where environmental noise is described as noise that present in daily lives.

Noise has been identified as one of the most prevailing physical hazards in the field of occupational safety and health of expeditiously developing countries where noise has been listed as one of main epidemic to cause the physiological and psychological dysfunctions after the other chronic disease globally (Shrestha et al., 2017). Noise acts as both physical and psychological impetus as the noise has proven to have association among noise-aggregated health effects.

From previous studies, the occupational noise is said to be a widespread risk factor that links to an important health outcome, hearing loss where the World Health Organization (WHO) estimated globally around 250 million workers are exposed to potentially hazardous noise levels (Concha-Barrientos et al., 2004). Most of the activities that associated with particularly high levels of noise are those in manufacturing, mining, military, agriculture and construction industries. This situation could be seen clearly in the developing countries. This indicates that these workers have the higher risk of hearing loss or other related psychological health effects due to the high level of noise. The related risk is primarily linked to the degree of noise exposure and the use of hearing protection.

Both continuous noise and impulse noise give hearing damage in highly exposure where impulse noise gives more harm compare to the continuous noise at the same level of noise exposure (Lie et al., 2016). Noise could be an efficient alarm systems around the surroundings, but once there's lots of noise within the surroundings, noise is termed into sound pollution which taken to be a secondary pollution, primary behind air and water pollution (Bhosale, 2017). Sound becomes hazardous noise once it disturbs the conventional activities such as communication, sleeping and working.

2.3 Sources of Noise in Construction Industry

Main sources of noise at the construction site is the construction machines where most of the machines produces impacts such as devices for breaking of concrete, steel bar machines, electronic grinders, electronic mosaic cutters, pile drivers, and earth moving machines that produce unwanted sound (Kantová, 2017). These mechanisms are being considered as point or linear sources of noise based on the level of movement at the construction site in the studies of noise. Several types of the construction projects are not endangered by pollution of noise where some of the projects are, but these only due to several particularly specific conditions.

Generally, the construction industry generates noise from different types of heavy machines used in the construction site on range between 80dBA until 120dBA where it puts the construction workers in the risks of over noise exposure (Said et al., 2014). Most of the construction workers that works few years in the construction industry have impact on their hearing ability. Due to the rapid industrialization and urbanization in developing

countries around the world such as China, the construction noise has led to be the common source of environmental noise (Liu et al., 2017).

2.4 Legislation Related to Noise Exposure

In Malaysia, the noise exposure at workplace is legislated under the Factories and Machinery (Noise Exposure) Regulation 1989 for the aim to protect the workers from exposure to chronic and excessive noise (Government of Malaysia, 2014). This regulation makes it mandatory for the measurement, assessment and control on noise levels and the workers' exposure to noise. Through this regulation, the workers are being protected from the excessive noise exposure where this could reduce the risk of occurrence of Noise-Induced Hearing Loss. This regulation states that "employee shall not be exposed to noise level exceeding equivalent continuous A-weighted sound pressure level of 90dBA or exceeding the limits specified in the First Schedule of exceeding the daily dose of unity" and "No employee shall be exposed to noise level exceeding 115dBA at any time." While the "85dBA is adopted as a criterion for action (action level)". Table 2.1 and Table 2.2 show the Permissible Noise Exposure listed in First Schedule of Regulation 5(1) under FMA (Noise Exposure) Regulation 1989 and conversion from noise dose per day based on the TWA (dBA). The permissible noise exposure of 90dBA for 8 hours working hours is equivalent to 100% of noise exposure towards the workers (Baba et al., 2011). It shows that the hearing loss problems will occur among the construction workers if they expose to very high noise intensity levels for considerable lengths of time.

Table 2.1 Permissible Noise Exposure listed in First Schedule of Regulation 5(1) under FMA (Noise Exposure) Regulation 1989

Noise Level (dBA) slow response)	**Duration of Exposure Permitted per day (hours-minute)**
85	16-0
86	13-56
87	12-8
88	10-34
89	9-11
90	8-0
91	6-58
92	6-4
93	5-12
94	4-36
95	4-0
96	3-29
97	3-2
98	2-50
99	2-15
100	2-0
101	1-44
102	1-31
103	1-19
104	1-9
105	1-0
106	0-52
107	0-46
108	0-40
109	0-34
110	0-30
111	0-26
112	0-23
113	0-20
114	0-17
115	0-15

Source: Government of Malaysia (2014)

Table 2.2 Conversion from Noise Dose to 8 hours TWA noise level

Percentage Noise Exposure or Dose (%)	Time Weighted Average (TWA) (dBA)
25	80
50	85
100	90
200	95
400	100
800	105

Source: Ishak et al., (2005)

According to the U.S. National Institute of Occupational Safety and Health (NIOSH), the occupational noise exposure is set with recommended exposure limit (REL), 85dBA time weighted average (TWA) (NIOSH, 1998). NIOSH also states that the exposure to 95dBA noise intensity level without any personal protective hearing equipment should not exceed 47 minutes. By comparing with the U.S. National Institute of Occupational Safety and Health (NIOSH), the United States Department of Labour, the Occupational Safety and Health Administration (U.S. OSHA) uses the 90dBA time weighted average (TWA) which is higher than NIOSH (Hanidza et. al., 2013). Exposure at or above this level is assumed as hazardous. The U.S. Occupational Safety and Health Administration (OSHA) has set the permissible exposure limit (PEL) for the construction noise intensity level to 90dBA over an eight-hour period but the Noise-Induced Hearing Loss (NIHL) usually occurs from exposure to noise intensity level at or above 85dBA (CPWR, 2012). Table 2.3 shows the permissible noise exposure limits that proposed by U.S. Occupational Safety and Health Administration.

Table 2.3 Permissible Noise Exposure by U.S. OSHA

Duration per day, hours	Noise Level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 ½	102
1	105
½	110
¼ or less	115

Source: Baba et al., (2011)

2.5 Mechanism of Hearing Damage

Sounds act as complex mixtures of the pressure variations where it travels through air in the invisible waves and when the sound waves enter ear, sound waves travel to the eardrum, lead to vibration. Figure 2.1 shows the structure of human ears. The vibration then transmits to the cochlea, causing the fluid and the sensory cells or hair cells movement within the cochlea. If the unwanted sound waves enters the ears, it lead to the high vibration to the cochlea, damage the sensory cells and gives impact to the hearing ability as shown in Figure 2.1 (Peter et al., 1997).

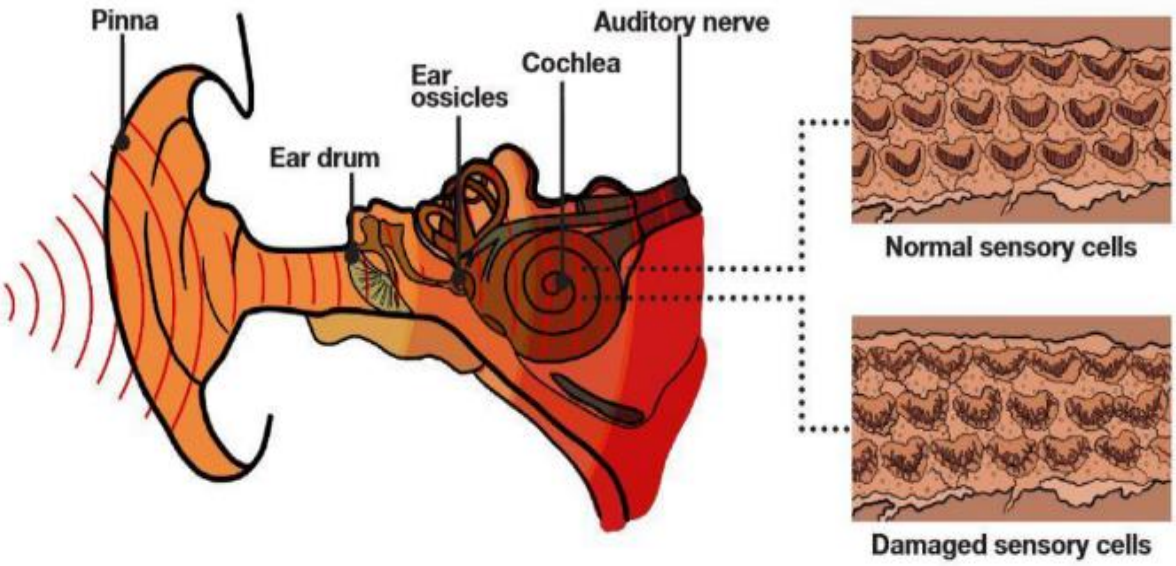

Figure 2.1 Structure of Human Ears. Peter et al. (1997)

According to previous studies, damaged of outer hair cells then raise the threshold sensitivity of the inner hair cells, this is perceived as hearing loss where a person's hearing with the outer hair cells damage, could be reduced to 50dB (Chauhan, 2015). The inner ear consists of cochlea, semi-circular canals, and vestibule where the containing the saccule and utricle which balance and equilibrium-related structures in Figure 2.2 that shows the structure of Organ of Corti. When sound waves travel to inner ear, this initiate travelling waves from oval window to a point of maximum vibration along the basilar membrane, generates shearing motions of the outer hair cells, inner hair cells and stereocilia. Traumatic noise exposure on the worker will give serious impacts on the outer hair cells and inner hair cells. The outer hair cells play the roles in vibration of the Organ of Corti which augments the sensitivity and frequency tuning of the inner ear thus damage on outer hair cells is much greater compare to the inner hair cells due to traumatic noise.

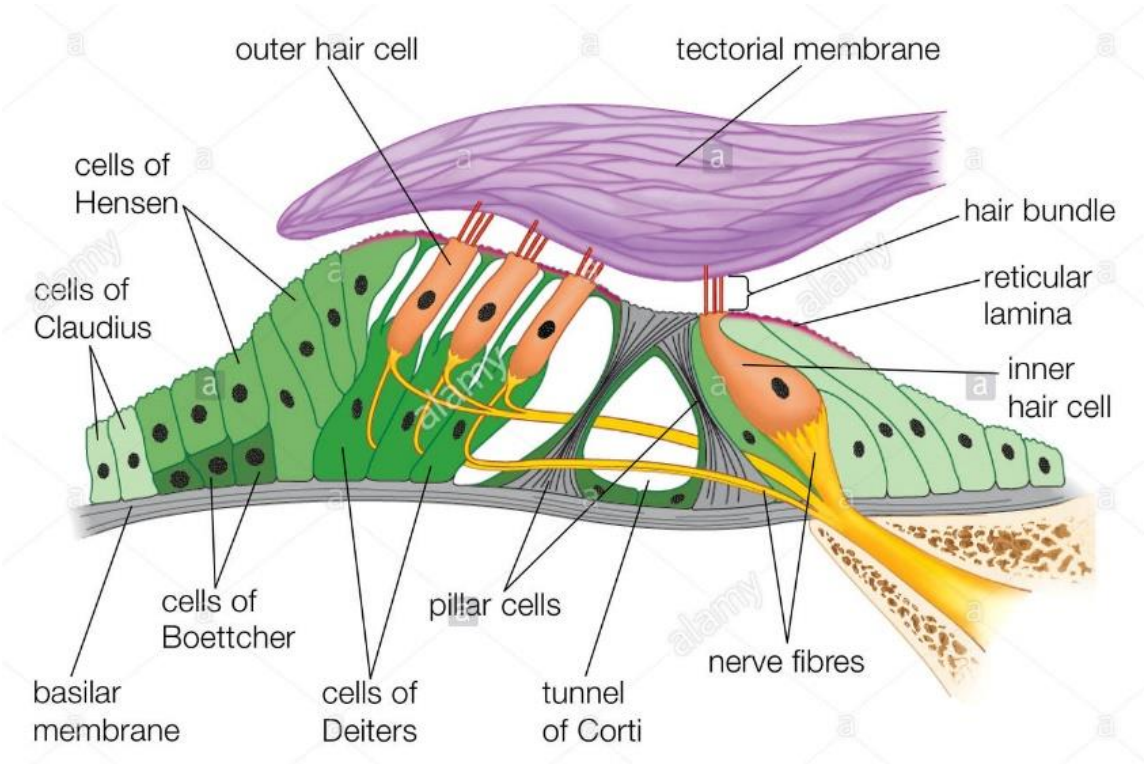

Figure 2.2 Structure of Organ of Corti of Ear. Chauhan (2015)

Both high peak impulse noise levels and short-term high sound intensity causes the acute mechanical damage on the inner ear hair cells of cochlea. This is where the noise levels higher than 135dBA while the long period of exposure to noise levels more than 85dBA also cause significant hearing loss (Verma et al., 2011). Long period of

exposure on excessive noise will damage the hair cells or sensory cells in the cochlea. The damage on few hair cells is unnoticeable firstly, but as more and more hair cells being damaged, this will lead to the loss of hearing ability where the hearing loss has occurred by the time the aware of the loss (WorkSafeNB, 2014).

2.6 Adverse Effects of Noise Exposure

From previous studies, noise is described as the major preventable cause of hearing loss and the occupational noise is defined as the most frequently studies type of noise exposure that harm human health where it categorized into auditory health effects and non-auditory health effects (Basner et al., 2014). The auditory effects include the hearing impairment, hearing loss and the Noise-Induced Hearing Loss (NIHL) due to excessive exposure of noise. The auditory effects can be caused by an exposure to an intense impulse sound or by long-term exposure with the sound pressure levels higher than 85dBA. While the non-auditory health effects include annoyance, sleep disturbance or adverse effect on quality of sleep, hypertension and the cardiovascular disease.

Previous study on noise exposure in industries had assessed the auditory effects of occupational noise towards the industrial workers that have been exposed to occupational noise levels over 90dBA between 1 and 14 years. The result obtained from previous studies reveals the presence of the noised induced hearing impairment among the selected industrial workers (Ighoroje et al., 2004). This shows that the critical noise levels of exposure and the duration of exposure triggered the process of hearing impairment and endangers the industrial workers health. Other than hearing impairment, several psychological well-being of workers also been affected due to the excessive noise exposure.

2.6.1 Effects on Daily Activities

Hearing loss lead to the rise of several problems especially in reducing the ability to detect and identify sounds and recognizing speech in daily activities as the hearing impairment is reported as the cause of communicative disability. In Australia, there is one in seven people suffer from hearing loss; 3.6 million people in 2017 (Lewkowski, 2017). These people have similar consequences of hearing loss such as dependence, stress, fatigue, poor social and reduced in cognitive function. Studies show that hearing loss lead to the poorer quality of life and leading to the increasing of prevalence of

symptoms of depression among the hearing-impaired people (Chadambuka et al., 2013). By having the communicative disability, the interaction between the hearing-impaired people with others in their surrounding will be seriously impacted.

It has been reported that the hearing loss becomes increasingly public health issue that linked to the reduced quality of life where the hearing loss gives huge impact on the quality of life due to the difficulties with communication (Ciorba et al., 2012). Difficulties in information exchange significantly impacting the daily interaction of life and the people with the hearing loss, lead to a perceived reduction of quality of life. The effects of presbycusis on the quality of life are emotional reactions such as depression and frustration, behavioural reaction such as blaming and cognitive reactions such as distracting thoughts, confusion and communication disorders. Hearing impairment consists of different types such as sensorineural and mixed hearing loss where the degree of hearing loss such in Table 2.4 shows the extent to which the threshold of a person exceeds normal hearing, and impact the communication abilities with quality of life (Chauhan, 2015).

Table 2.4 Extent to which the threshold of a person exceeds normal hearing, and impact the communication abilities with quality of life

Grade of Impairment	Audiometric ISO value	Performance
0 No Impairment	25 dBHL or less (Better ear)	No or very slight hearing problems. Able to hear whispers
1 Slight Impairment	26-40 dBHL (Better ear)	Able to hear and repeat words spoken in a normal voice at 1 meter
2 Moderate Impairment	41-60 dBHL (Better ear)	Able to hear and repeat words using a raised voice at 1 meter
3 Severe Impairment	61-80 dBHL (Better ear)	Able to hear some words when shouted into better ear
4 Profound Impairment including Deafness	81 dBHL or greater (Better ear)	Unable to hear and understand even a shouted voice.

Source: Chauhan (2015)

2.6.2 Psychological Health Effects of Noise Exposure

The psychological health effect is described as the effects on a person mentally without any physical effect such as injuries. It effects the person on their emotional and behavioural. In this subtopic, several psychological health effects due to noise exposure will be stated.

2.6.2.1 Noise-Induced Hearing Loss (NIHL)

Noise-Induced Hearing Loss (NIHL) is said to be the most frequent occupational disease reported to the Norwegian Labour Inspection Authority and the Petroleum Safety Authority where the authorities receive around 600 new reports on Noise-Induced Hearing Loss respectively, accounting for 60% among the reported work-related diseases in 2.7 million working population (Lie et al., 2016). The occupational groups in military, construction workers and others with high exposure of noise lead them to be at high risk of NIHL. Overall the NIHL is indicated as frequent diagnosis in construction industries and it has been considered as the potentially high noise exposure levels in the construction industries.

Through several studies, it has been established that the Noise-Induced Hearing Loss (NIHL) consists of two characteristics (Hong et al., 2013). First, the noise intensity and exposure duration influence the amount of hearing loss that more intensity and longer duration exposure of noise lead to severe hearing loss. Second is that the susceptibility of individual towards the Noise-Induced Hearing Loss varies extremely. As described, the Noise-Induced Hearing Loss is the damage of inner ear, therefore it does not consist of any over symptoms such as pain, and bleeding that could notice easily. The possible Noise-Induced Hearing Loss has several symptoms such as tinnitus, sounds muffled after loud noise exposure, and the feeling of ears being plugged up. In unfavourable listening situations, people with Noise-Induced Hearing Loss often face the difficulty on understanding the conversation where it has reported that over 60% of the operating engineers that operating the heavy equipment in the construction industry faced the problem in understanding conversation in the situation with loud of background noise (Hong, 2005).

Based on previous report, the burden that attributed towards occupational noise is 16% around the world where the Noise-Induced Hearing Loss is regarded as one of the

most identified occupational disorders in Europe country and amounts to the range of 7% to 21% of the hearing loss in rest of the world (Nelson et al., 2005). Workers that faced hearing loss continue to have any pre-existing hearing loss as the irreversible condition of Noise-Induced Hearing Loss. There are lots of multiple consequences and factors that contribute to the occurrence of Noise-Induced Hearing Loss where the lack of prevention is the main contributor.

According to the statistics of 2018 report in Table 2.5 from the Department of Occupational Safety and Health (DOSH), Ministry of Human Resources Malaysia, it shows that the NIHL was described as the most commonly notified occupational disease (DOSH, 2018). There are total 1775 cases were recognized and identified by DOSH as occupational noise-induced hearing disorders which includes Noise-Induced Hearing Loss, Permanent Standard Threshold Shift and the hearing impairment. These disorders are the most common occupational disease that experienced by 58% workers compared to other diseases experienced by other workers.

Table 2.5 Statistics of Occupational Disease & Poisoning by Type of Disease 2018

Type of Diseases	Number of Cases
Occupational Lung Disease (OLD)	55
Occupational Skin Disease (OSD)	22
Occupational Noise Related Hearing Disorder (HD)	**1775**
Occupational Muscular – Skeletal Disorder (OMSD)	85
Occupational Poisoning	47
Disease cause by Physical Agent	1
Disease cause by Biological Agent	13
Occupational Cancer	0
Psychosocial Problem	0
Other Types of Occupational Diseases	2
Non-Occupational Disease	1058
Total	**3058**

Source: DOSH (2018)

The measurement of Noise-Induced Hearing Loss (NIHL) is conducted through comparison between the threshold of the hearing at a specific frequency and the specified standard of normal hearing in units of decibel hearing loss (dBHL) (Kirchner et al., 2012). Threshold shift is the precursor for the main outcome of the occupational noise, the Noise-Induced Hearing Loss as it is corresponding towards the permanently increased in

the hearing threshold of hearing which rise with risk of tinnitus. The noise-induced hearing impairment occurs with the change in hearing thresholds at frequencies around 3000-6000 Hz where 4000 Hz is the largest effect towards the hearing impairment (NIOSH, 1998). The Noise-Induced Hearing Loss consists of several consequences such as social isolation, impaired communication in daily life, anxiety, and loss of productivity.

The muffle high-frequency sounds present in any level of the Noise-Induced Hearing Loss such as buzzers that lead to the difficulty recognizing and discriminating the speech consonant sounds in the situations with loud background noise with different voices in conversation. This shows that these people are more likely to face more difficulties than expected in daily communications (Suter, 2002).

2.6.2.2 Signs and Symptoms of Noise-Induced Hearing Loss

Noise-induced hearing impairment includes two common symptoms other than the loss of hearing sensitivity, that are temporary threshold shift which commonly referred as TTS and tinnitus which means ringing in the ears (Harrison, 2008). Temporary Threshold Shift (TTS) could causes the permanent changes as the exposure of noise leads the TTS to alter the delicate micromechanics of the cochlea where the reversibility of such impact might not be 100%. There are different types of tinnitus and not all the tinnitus result from the damage of cochlea. However, exposure to loud noise results in the manifestation of cochlear injury and lead to occurrence of chronic tinnitus. In this case of critical acoustic trauma, the chronic tinnitus could persist and continue to become permanent. Hearing loss, tinnitus lead to the reduction in the quality of life where the people suffer in the daily lives more than just loss of hearing (Dewey, 2017).

2.6.2.3 Cardiovascular Disease

Over the past several decades, evidence shows the increasingly of negative health effects from the noise exposure especially with chronic and excessive exposure where the long-term impacts of noise consists of different effects such as coronary artery disease and rise of the risk of heart attack (Mansoor et al., 2017). This could be the significant of health correlation particularly as the cardiovascular diseases is one of the main causes of death around the world. Expose to high levels of occupational noise could impact adversely the blood pressure both systolic and diastolic where could be shown in increase

in results of measurement of systolic and diastolic blood pressure and pulse rate of workers after exposure to the occupational noise.

Researcher states that the noise effects the human health could be categorized into four categories based on the duration and volume of noise (Jakovljević et al,. 2006). These four categories are physiological effects such as blood pressure and irregularity of heart rhythms; physical effects that consists of auditory effects, non-auditory effects, hearing loss and hearing impairment; psychological effects such as sleep disturbance and stress; and effects on the performance of work such as decreasing of productivity, misunderstanding and miscommunication.

Based on previous study, it shows that the exposure of noise influences the function of multiple organs and systems where in both laboratory setting and in real-life environments, noise exposure lead to the release of human stress hormone, catecholamines and cause the increase in cardiac output and blood pressure (Münzel et al., 2014). The study shows evidence that the incidence of increasing in arterial hypertension, and myocardial infarction are associated by the noise. Noise exposure causes the disruption of sleep structure, increase in blood pressure and stress hormone levels that may result in endothelial dysfunction and arterial hypertension. Noise could also contribute to higher prevalence of cardiovascular risk factor arterial hypertension and cardiovascular disease other than annoyance and sleep disturbance that shown in noise effect reaction scheme in Figure 2.3. The sleep disturbance comprises the mechanism on pathway from critical exposure of noise to the developing of adverse health effects among people.

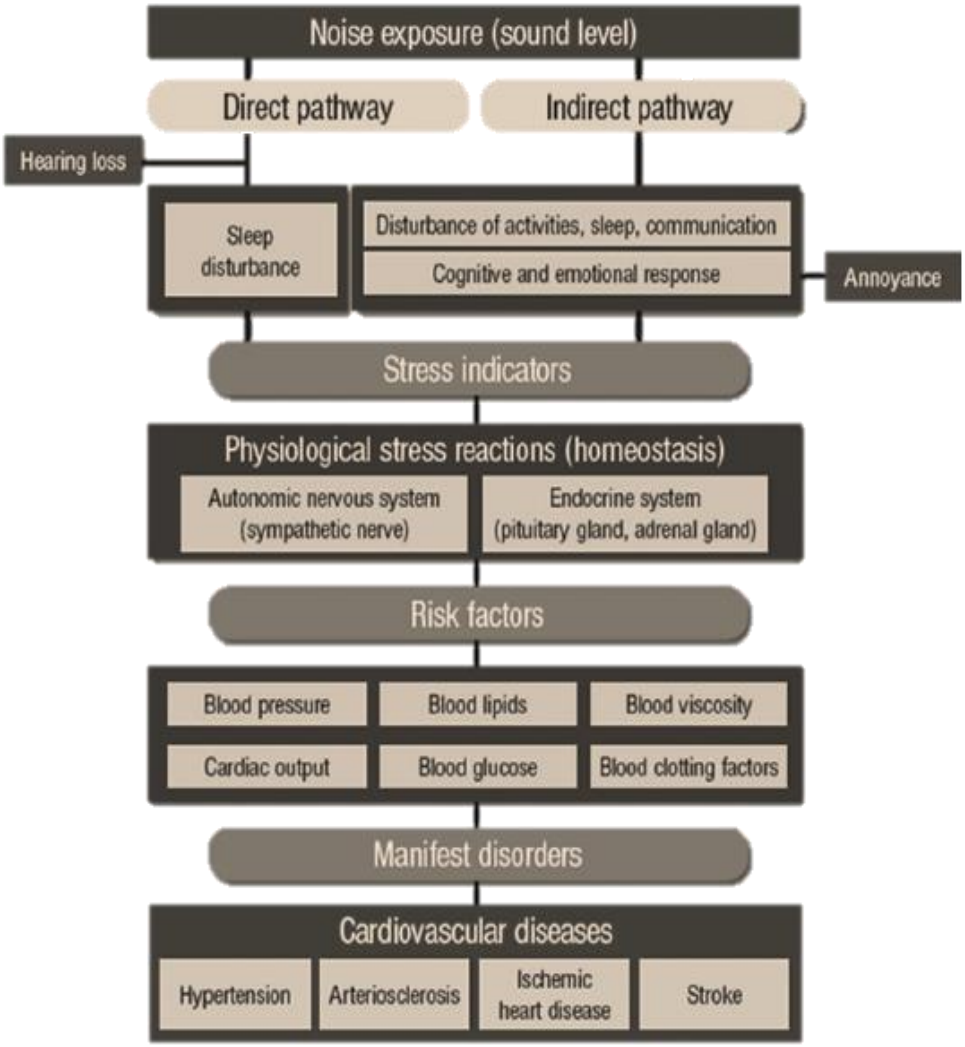

Figure 2.3 Noise Effects Reaction Scheme. Münzel et al. (2014)

A study on the workers at factory in China found the existence of significant difference of 16mmHg in sleep-time systolic blood pressure between two exposure groups as the increase the exposure of occupational noise in factory lead to the increase in systolic blood pressure (Ta Yuan et al., 2003). It shows that there is strong correlation between the occupational noise and the systolic blood pressure, and threshold levels of hearing at the different frequencies.

There is a study shows the statistically significant higher prevalence of systolic and diastolic hypertension among the construction workers who exposed with hearing impairment compare to the workers who exposed with normal hearing (Assunta et al., 2015). As the damage of cardiovascular links with the hearing loss issue, the noise could be viewed as the main cause of the damage on cardiovascular system among the workers

who exposed with excessive noise. The presence of the Noise-Induced Hearing Loss (NIHL) electrocardiographic abnormalities and the hypertension simultaneously underlined the roles of noise in these impacts on workers.

Researcher has reported that the occupational noise hazard lead to the occurrence of hypertension which is a well-known risk factor for the cardiovascular disease around the world as the excessive noise exposure associates with the high blood pressure and hypertension (De Souza et al., 2015). Workers who expose to excessive noise that higher than permissible level, 85dBA have higher rate of hypertension, mean systolic and diastolic blood pressure (Attarchi et al., 2012). This shows the exposure to excessive noise could significantly increases the blood pressure among the workers. The review of the studies published between 2000 and 2013 has shown the presence of strong positive relationship between the exposure of occupational noise and the cardiovascular outcomes (Ismaila et al., 2014).

Several studies have shown the evidence that the excessive noise problems cause the occurrence of the physical and psychological disorders such as stress, blood pressure and cardiovascular effects (Rong et al., 2017). The exposure to excessive noise rises the physiological activation that are increase in the heart rate, blood pressure, peripheral vasoconstriction and then increased in the resistance of peripheral vascular. This is supported by other researcher that reports the exposure of noise has been an indicator to both physical and psychosocial, which also associated with psychological, high blood pressure (Stansfeld et al., 2003). When people chronically exposed to continuously excessive noise at levels higher than 85dBA, they have higher blood pressure compare to those that not exposed to excessive noise.

Exposure on unwanted sounds or noise at different intensity levels lead to impact on blood pressure and heart rate, aggression, hypertension, critical stress level, hearing impairment and sleep disturbance. Exposure to noise of high intensity level of 80dBA affects the blood pressure and heart rate where rising to higher levels even after few minutes when the source of noise being cut off (LAAD, 2011). Long exposure to noise at low sound intensity level such as 50dBA also cause noise related problems such as high blood pressure, degradation of immune system and the hearing impairment.

2.6.2.4 Sleep Disturbance

There is clear evidence that exposure of excessive noise pollution negatively impacts the health by lead to the occurrence of sleep disturbance ; excessive noise exposure is viewed as significant cause of sleep disturbance (Halperin, 2014). Sleep disturbance lead to poor quality of sleep that associates with several cardiometabolic, psychiatric and social outcomes negatively among people. People who struggle with sleep disturbance due to excessive noise exposure will face several situations such as sleepiness, annoyance, mood changes and cognitive performance in daily activities

2.6.3 Physical Effects of Noise Exposure

Previous studies state that noise is one of the factors that increase the risk of accidents in the workplace which means that the exposure of noise could cause several risks of accidents and impacts the safety and health of the workers (Ali, 2011). With noise environments where noise levels higher than 80dBA, workers will suffer in communication problems and cause rise in risk of the occurrence of accidents and injuries. Moreover, the effects of Noise-Induced Hearing Loss and requirement of use of personal protective hearing equipment also indirectly contributes to the rise of rate of injuries. The association between the hearing loss and exposure of noise are being recognized and with the workers' attitude, it lead to the accidents in construction industry (Rahim et al., 2008). The impact of excessive noise exposure could not be detected and noticed immediately as the only the accumulation of excessive noise exposure causes the obvious deterioration in aspects of physical and social where the severe impact of overexposure is the hearing loss.

2.7 Effect of Noise Exposure on Construction Workers

The occupational noise exposure at work could harm workers' health especially in the construction industry. It gives adverse impact towards the construction workers on their health effects and the work performance. It has been reported that construction workers suffer on severe occupational health impact due to occupational noise exposure. Based on the previous report, there is 94% of the total severe health impact of construction workers such as formwork fixers and concreters occurred during the construction stage on superstructure (Li et al., 2016).

The most well-known auditory health effect of noise exposure at the workplace is the hearing loss problem among the workers. Therefore, excessive noise exposure is considered as dangerous hazards at the workplace. Expose to excessive noise is described as 1 of the 67 risk factors considered due to the significantly contribution for the global burden of disease (Lundälv, 2004).

According to the previous studies, the frequently reported non-auditory health effect symptoms are the stress, irritability, headache, and talking difficulties in the noisy situation where the irritability symptoms is the most frequently reported among other symptoms (Oliveira et al., 2015). The stress could happen when the demands work environment such as the noisy work environment exceeds the ability of the workers to cope with but there are multi-factors that leads to stress. This is supported by other researchers where they identified that exposure of noise causes the tinnitus, headache, dizziness and the mood disorders (Lopes et al., 2009).

According to previous study, it has been showed that noise leads to negative emotions, frustration fear and anger (Mokhtar et al., 2007). This is due to effect of noise causes temporary or permanently alterations in body reactions and interfere with the human sensory and the perceptual capabilities that degrade the workers' performance when carrying out the tasks. Generally, the construction workers are usually being forced to work under poor physical environment such as outdoor temperature, poor air quality, excessive noise exposure and working at height hazards (Ayessaki et al., 2015). All these adverse working conditions especially the excessive noise exposure result in stress among construction workers.

Moreover, the construction workers whom exposed towards excessive noise complain on difficulties in communication among other health effect symptoms such as the loss of concentration and attention during work and nervousness (Cordeiro et al., 2005). The loss of concentration and attention during work could strongly affect construction workers' performance at the workplace and even lead to the occurrence of unwanted accidents (Ayessaki et al., 2015). Especially when the construction workers are carrying out the complex and tough tasks which involving the concurrent performance, there is high probability of accident occurs if the construction workers' performance is strongly affected by the excessive noise exposure.

2.8 Summary

The literature review in the study showed that the noise exposure lead to the negative effect on health such in psychological health effects and physical effects. The study mainly focuses on the psychological health effects due to personal noise exposure towards workers' health. This will be identifying in the finding of the prevalence of health symptoms due to exposure of noise among the construction workers.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the study design and method used to conduct this study, which includes the study design, study technique, sampling design, study instrument, and data collection and analysis.

3.2 Study Design

This study is described as the cross-sectional study where the study assessed the personal noise exposure level towards the construction workers and the prevalence of health effects among the machine operators and non-machine operators in the construction industry. The study has made the comparison about the personal noise exposure level and prevalence of psychological health effect symptoms among the machine operators and non-machine operators in the construction site.

3.3 Sampling

The methods of sampling techniques and frame of sampling process of data collecting are mentioned throughout this subtopic. Sampling is one of the most important elements in the study where it ensures the effective sequences in collecting related and useful data for the study.

3.3.1 Population and Sampling

The sampling population in this study was the workers who work in construction site. The sample of this study were selected randomly and divided into two groups, the machine operators group and the non-machine operators group.

In this construction company, there are around 349 workers but only 72 workers are currently working at the study location – selected construction site. By using the Cochran's sample size calculation expressed in the equation 3.1 and equation 3.2 with assumption of level of acceptable error at 5%, the number of respondents was identified.

$$n_0 = t^2pq / d^2 \quad (3.1)$$

$$n_0 = [(1.96)^2 (0.5) (0.5)] / (0.05)^2$$

$$= 384$$

$$n_1 = n_0 / 1 + [(n_0 -1) / N] \quad (3.2)$$

$$n = 384 / 1 + [(384 - 1) \text{ population}]$$

$$n = 384 / [1 + (383 / 72)]$$

$$= 61 \text{ samples}$$

Where;

t = normal curve that cuts off area, selected alpha level of 0.025 in each tail = 1.96 for 95 percent confidence interval

d = acceptable margin of error for proportional being estimated = 0.05

p = estimated proportion of an attribute that is present in the population

q = 1 – p

n_0 = is a satisfactory approximation to the n, required return sample size according to Cochran formula = 384

n_1 = required return sample size because sample > 5% of the population

N = population of workers

Therefore, 61 of the construction workers were selected as the samples for this study. Hence, there was total 31 respondents who are the machine operators and 30 respondents that work as non-machine operators in the selected construction site.

The total number of samples selected in this study was adequate as it refers to the previous study of noise exposure among machine operators on construction sites in south Johor. This previous study had selected 56 machine operators as the sample size of the study (Haron et al., 2013). Hence, in this study, there were 61 samples where 31 respondents for the machine operators group and the 30 respondents for non-machine operators group.

3.3.2 Sampling Frame

The name list of the construction workers in selected construction industry had been provided by the Human Resource Department of the construction company where the name list is the sampling frame of study. With the use of the sampling frame technique, the entire target population will be covered. From the name list obtained, the construction workers that currently work at the selected construction site were being reviewed based on their criteria such as operate machines, and employment duration more than 3 months. For those workers whom employment period less than 3 months were being excluded from the selection as respondent in the study.

3.3.3 Sampling Method

Method of sampling that been used in this study is the simple random sampling technique. It is the basic type of sampling to select a subset of study samples from a large population. The simple random sampling is a method that ensures each member of the population has an equal chance or probability to be selected as respondents. Through this method, every construction workers in selected construction industry in Perak state had equal chance for being chosen as respondents in the study.

The advantage for using the simple random sampling method is that this method is easy and simple method for choosing respondents. It also considers as a fair way of selecting a sample from a given population since every member is given equal opportunities of being selected. Therefore, the result can be generalized to the whole population as the samples selected can be representative of the entire population and to reduce the bias issue. The construction workers who met the requirements and willingly to join the study will be recruited by using this method as the subjects for this study.

3.4 Data Collection

The study has used 2 groups of construction workers which categorized into the machine operation workers and non-machine operation workers. The random sampling technique was used to select respondents whom were the machine operators and non-machine operators in the selected construction site. Both groups of respondents – machine operators and non-machine operators has carried out personal noise exposure monitoring to identify the personal noise exposure level of the respondents with the use of the personal noise dosimeter. There were 61 respondents selected and participated in this study that consist of different age, work task, employment period and occupational background related to noise exposure. The required instruments that were used in this study are mentioned throughout this subtopic.

The data collection process was carried out in 4 different phases – walk-through observation, personal noise exposure monitoring, questionnaire, and interview session that could see clearly in Figure 3.1. Firstly, the walk-through observation on the construction site collected data which gave deeper understanding of the work and the situation of noise exposure. Monitoring of personal noise exposure was done by using the personal noise dosimeter. The set of questionnaires used was to ascertain the information of workers that related to the personal information of study population such as age, gender, and job task, the occupational background related to noise exposure, the prevalence of psychological health effect symptoms and the health history among the construction workers. Moreover, for the interview session, several questions from questionnaire were selected and asked to collect more accurate data of the respondents.

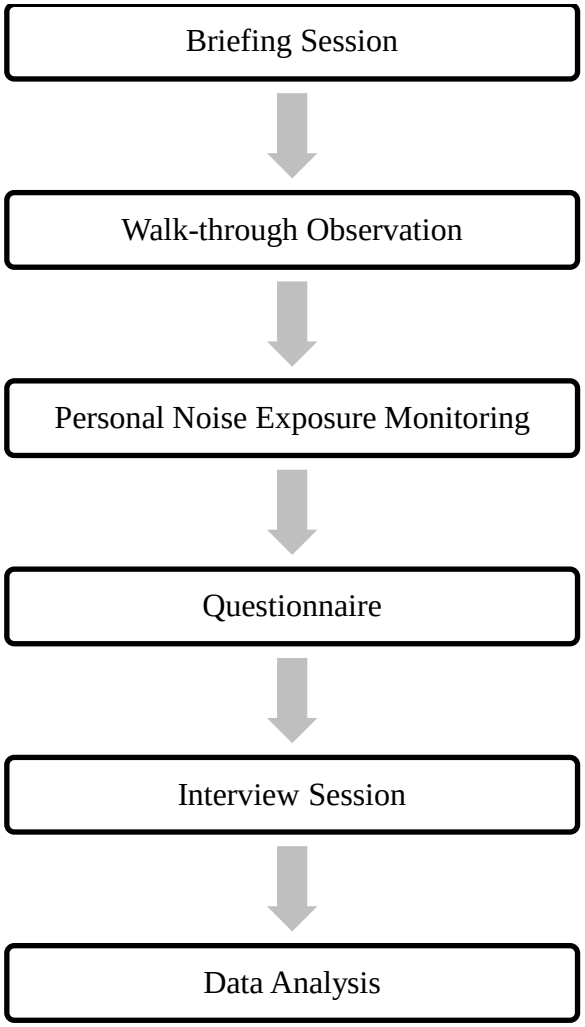

Figure 3.1 Procedure of Collecting of Data

3.4.1 Walk-through Observation

The walk-through observation was conducted with the purpose of observation on the construction site to obtain deeper understanding regarding to the safety practise and the exposure of noise among the construction workers. This observation was guided by the supervisor of the construction site to give further explanation about the noise exposure condition of the workplace and safety purpose at the construction site. The construction workers were being informed that they will under observation on their assigned routine tasks with at least one complete task. The construction workers also been observed for their safety practice against the noise exposure such as wearing of the hearing protection devices like ear muff or ear plug when they are exposed to high noise intensity. Furthermore, the workers were being observed whether they face any symptoms such as stress, annoyance, aggressiveness, tension or difficulty in concentrating after exposure to

high noise level. A noise exposure observation checklist was developed and adapted from the Noise Hazard Identification Form developed by University of Melbourne as shown in **Appendix C** (University of Melbourne, 2015). With the use of the observation checklist, the data collected through walk-through observation was useful and relevant for the study.

3.4.2 Personal Noise Monitoring

Personal noise exposure monitoring was carried out among the selected respondents by using a calibrated personal noise dosimeter (Figure 3.2). The Spark 706RC-ATEX personal noise dosimeter is an equipment which composed of a microphone that attached to a meter. Both machine operators and non-machine operators were being requested to attach the device for entire shift as stated in Figure 3.3 for 8 hours working shift including the lunch hour and time when going to washroom to collect the total noise exposure for data analysis. The meter of personal noise dosimeter was put in the workers' pocket or clipped on their belt while the microphone clipped on their collar or upper region that close to their ears.

Furthermore, the exchange rate of 5dB, 80dBA threshold levels together with 90dBA criterion level were used in this study. After monitoring for the entire shift, 8 hours, the personal noise dosimeter was being getting off and the detected noise exposure levels being recorded for further analysis. This device able to record data collected and computing the data. With the Larson Davis Blaze Software, the transfer of collected data from the personal noise dosimeter to computer was done for further analysis progress. With the software, the statistical reports on several tests such as t-test and Binary Logistic Regression were obtained. Microsoft Excel software was used in exporting the summary of the results and the statistical data from Larson Davis Blaze Software for further discussion in chapter 4 (*Spark ® ATEX Noise Dosimeters and Blaze ® Software Technical Reference Manual*, 2016). Figure 3.3 shows the flowchart of the personal noise monitoring that will be conducted in this study.

Figure 3.2 Personal Noise Dosimeter

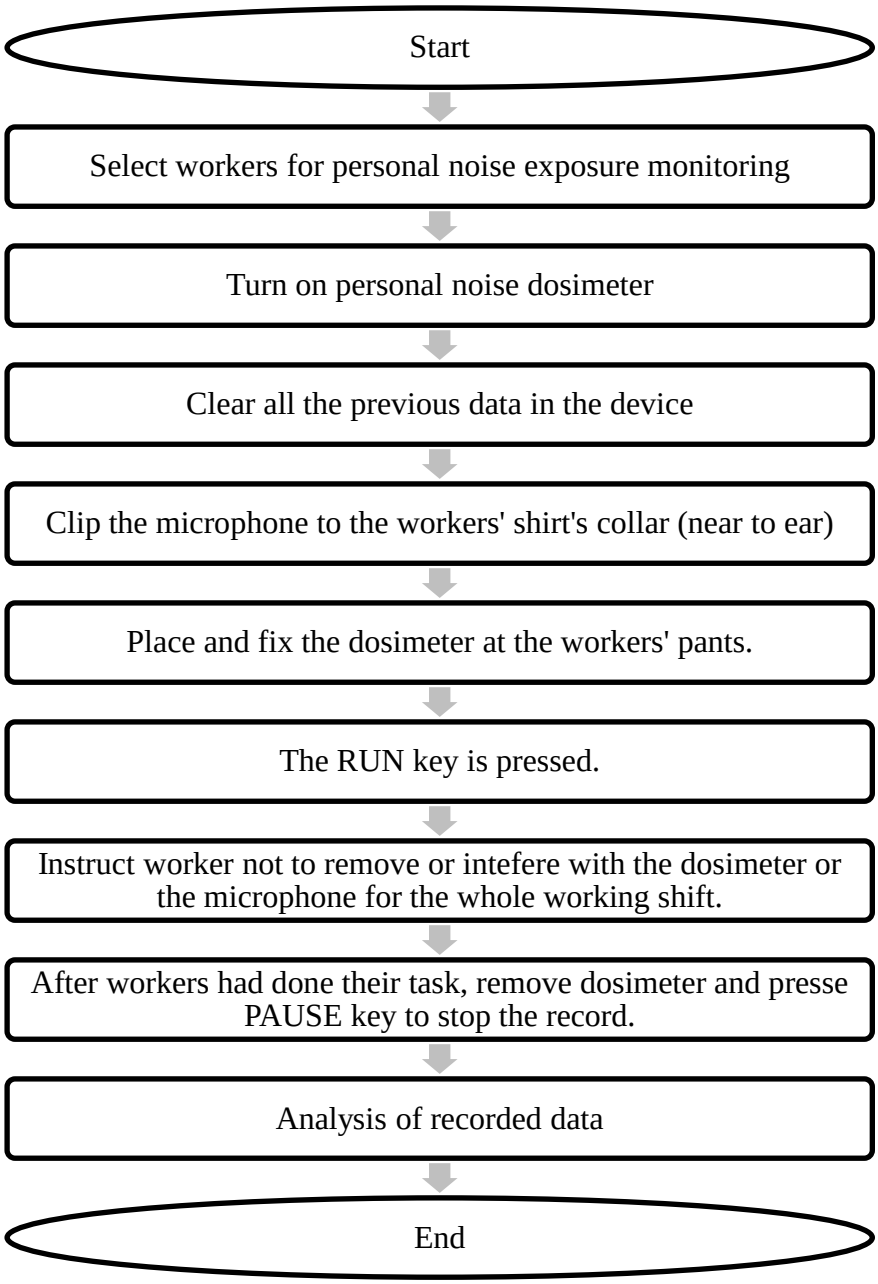

Figure 3.3 Flowchart of Personal Noise Monitoring

3.4.3 Questionnaire

The questionnaire which shown in **Appendix D** was distributed among the selected construction workers to collect more useful information and data related to noise exposure and psychological health effect symptoms due to noise exposure for this research study. Before start to answer the questionnaire, the respondents were being explained on the objective and the technique in answering the questions in this questionnaire.

There are 4 sections in the questionnaire. Section 1 is about the demographic information of the respondents such as gender, age, job task, type of machinery or equipment used and the duration of employment among the construction workers. For section 2, the questions are all about the occupational background that related to the exposure of noise among the construction workers. The information collected from this section is about the experience of workers on noise exposure and the use of hearing protection devices at the construction site. While the section 3 will be the questions related to the current conditions or symptoms regarding the psychological health effect due to noise exposure at the construction site. The respondents have been guided to ensure that they clearly understand and identified which type of the symptoms that they have experienced during work at construction site. For section 4, information about health history of the respondents has been collected for further analysis.

In the distributed questionnaire, the dichotomous questions such as Yes-No questions were asked in the questionnaire to ensure that there will be enough of data could be collected for data analysis through the Statistics Package for the Social Sciences (SPSS) Version 20.0. The questionnaire was developed and adapted from the Audiology Hearing Conservation Programme Work Relatedness: OSHA Recordable Questionnaire which designed to be simple, direct and easily understood by the respondents (AdventistHealth, n.d.).

3.4.4 Interview Session

The interview sessions were held with several selected respondents by asking the questions chosen from the questionnaire. This contributed in collecting of the more complicated and accurate data from the respondents. Through the interview session, the respondents expressed more useful and details information or data which unable to be

collected through the questionnaire. Before conducting the interview sessions, the selected respondents were being informed and explained on the purpose of this study and they are freely to speck and word each question where the data collected through the interview sessions will be fully protected and confidential. Multiple languages such as English and Bahasa Malaysia were being used throughout the interview sessions to ensure that the selected respondents fully understand the questions.

3.5 Data Analysis

Data analysis is described as a process of transferring, illustrating and evaluating the collected data in the study to discover the useful information for the support of decision-making and conclusion. The data analysis also is the process of applying of statistical or logical techniques in describing, illustrating and evaluating of the data collected. In this study, the Larson Davis Blaze Software has been used in the analysis of data collected through the personal noise monitoring while Statistical Package for Social Sciences (SPSS) Version 20.0 been used in the analysis of data which collected from the questionnaire distributed and personal noise monitoring in this study.

3.5.1 Larson Davis Blaze Software

The Larson Davis Blaze Software functions as recording and analysing the collected data from the personal noise dosimeter during the personal noise monitoring (*Spark ® ATEX Noise Dosimeters and Blaze ® Software Technical Reference Manual*, 2016). The collected data was transferred from the personal noise dosimeter to the computer, then analysed and printed out by using the software where the analysed data was used for further analysis or convert into statistical graphs for discussion in the study.

3.5.2 Statistical Package for the Social Sciences (SPSS)

Collected data has been analysed by using the SPSS software (version 20.0). This software is a windows-based program that used to perform data entry, analysis and to create the table and graphs for collected data. The SPSS is commonly used in the social sciences but also expanded to other fields including the health sciences as it is simple and efficient spreadsheet-like facility for entering data and browsing the working data files (Norusis, 2011). The inferential analysis was done by using Independent T-test to compare personal noise exposure level between machine operators and non-machine

operators. Independent Chi-square test was performed to compare the prevalence of psychological health effect symptoms on noise exposure between machine operators and non-machine operators. Lastly, the Binary Logistic Regression was performed to identify the relationship between the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers in the selected construction site.

3.6 Summary

This study was conducted at the construction site that located at Perak state. Cross-sectional study has been used in this study to assess the personal noise exposure level, the prevalence of health effect symptoms and the comparison between the machine operators and non-machine operators for both personal noise exposure level and the prevalence of health effect symptoms due to noise exposure and the relationship between personal noise exposure level and the prevalence of psychological health effect symptoms among construction workers. Walk-through observation, interview session, questionnaire and personal noise exposure monitoring were being conducted throughout this study to collect enough data for analysis. The sample size required in this study was 61 respondents where simple random sampling method been used in selecting the construction workers who fulfil inclusion criteria to participate in this study. Statistics Package for the Social Science (SPSS) Version 20.0 and Larson Davis Blaze Software will be used in entering the data and analysis of data collected.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter discusses on the findings on the personal noise monitoring and the information collected through questionnaire given to the respondents, construction workers at the construction site. During the data analysis progress, the Statistical Package for Social Science (SPSS) was used for performing several tests such as t-test, independent chi-square test and Binary Logistic Regression test on the hypotheses of the study - the personal noise exposure levels, the prevalence of psychological health effect symptoms and the relationship between personal noise exposure level and the prevalence of psychological health effect symptoms among the respondents, construction workers.

4.2 Demographic Information of Respondents

There were 61 construction workers from the selected construction site at Perak were randomly chosen for the study as respondents. The demographic information of respondents is about the gender, age, job tasks, types of machinery or equipment used and the duration of employment of the respondents.

4.2.1 Gender

According to Table 4.1, it shows that the frequency of the male construction workers is significantly higher compared to female construction workers where 58 male workers and 3 female workers were selected as respondents. The selection of more male workers compare to female workers was due to the population of the selected construction site is mostly males as most of the tasks in construction industry are heavy work that more suitable for males. The male construction workers have percentage of 95.1% of respondents while the female construction workers have 4.9% of respondents.

Table 4.1 Gender of 61 construction workers

Gender	N (%)
Male	58 (95.1)
Female	3 (4.9)

N = 61

4.2.2 Age

The age of the construction workers at the construction site were categorized into 4 categories, which are 21 to 30 years old, 31 to 40 years old, 41 to 50 years old and 51 years old and above. According to the Table 4.2 below, it shows that the highest percentage based on age range among the construction workers is 21 to 30 years old, comprises with 42.6% of the respondents, followed by age range of 31 to 40 years old, comprises with 37.7% of the respondents, then age range of 41 to 50 years old, comprises with 19.7%. The lowest percentage based on the age range among the construction workers is the 51 years old and above, comprises with 0%. The highest and second highest percentage based on age range are the 21 to 30 years old and 31 to 40 years old respondents as the construction workers among these two categories could have better work performance in the construction industry due to their work experience, health status and especially the body strength which the most important element as the construction industry mostly include the heavy work tasks.

Table 4.2 Age of 61 construction workers

Age (years old)	N (%)
21 – 30	26 (42.6)
31 – 40	23 (37.7)
41 – 50	12 (19.7)
51 and above	0 (0)

N = 61

4.2.3 Job Task

For the job task on total 61 respondents of the construction workers, they were randomly selected and categorized into two groups. Based on the Table 4.3, it shows the number of respondents for machine operators and non-machine operators group where the machine operators group, comprising with 50.8% of the respondents and the non-machine operators group, comprising with 49.2% of the respondents. The respondents

were selected evenly into these two group to ensure that there were sufficient respondents for each group for data collection in the study.

Table 4.3 Job task of 61 construction workers

Job Task	N (%)
Machine Operator	31 (50.8)
Non-machine Operator	30 (49.2)

N = 61

4.2.4 Specific Task and the Types of Machinery or Equipment Used

Table 4.4 shows the specific of tasks for 61 construction workers that were being selected. According to table, the highest percentage based on the specify of tasks among the respondents is the bar tying task, mosaic grinding task and mosaic placing task, where each of them was comprising with 8.2% of the respondents. The bar tying task and the mosaic grinding task with the highest percentage 8.2% among the respondents are the respondents from the machine operators group and commonly highly exposed to noise at the construction site. While the mosaic placing task is the task carried out by non-machine operators group whom did not use machinery during work but commonly exposed to noise at the construction site. Therefore, the bar tying task, mosaic grinding task and mosaic placing task are the most selected specify tasks among the respondents.

Table 4.4 Specific of tasks for 61 construction workers

Specify of Task	N (%)
Bar bender and cutter task	1 (1.6)
Bar bending task	2 (3.3)
Bar cutter task	2 (3.3)
Bar tying task	5 (8.2)
Cement mixing task	4 (6.6)
Cement plastering task	1 (1.6)
Concrete pump task	3 (4.9)
Drilling task	2 (3.3)
Formwork	2 (3.3)
General work housekeeping	1 (1.6)
General work task	1 (1.6)
Guard entrance	1 (1.6)
Manually cement mixing task	1 (1.6)
Manually mosaic cutting	1 (1.6)

N = 61

Table 4.4 Specific of tasks for 61 construction workers

Specify of Task	N (%)
Mixture lorry driver	1 (1.6)
Mosaic grinding task	5 (8.2)
Mosaic placing task	5 (8.2)
Operate batching plant	3 (4.9)
Operate construction tracker	1 (1.6)
Operate crawler crane	1 (1.6)
Operate passenger hoist	2 (3.3)
Pipe cutting task	2 (3.3)
Plumbing	2 (3.3)
Pump sand task	1 (1.6)
Sand pump assistant	2 (3.3)
Signal man task	2 (3.3)
Skimcoat	4 (6.6)
Steel bar bending task	1 (1.6)
Waterproof	2 (3.3)

N = 61

4.2.5 Types of Machinery or Equipment Used

Table 4.5 shows the types of machinery or equipment used by the selected construction workers. The highest percentage based on the types of machinery or equipment used is the none of any been used by the respondents, comprising with 9.8% among the respondents, followed by the hand-held mosaic grinder and steel bar wire, comprising with 8.2% among the respondents. None of any machinery or equipment been used is analysed as the highest percentage among the respondents as several non-machine operators did not use any of it especially for those whom task as mosaic placing task at the construction site. This could be seen from the Table 4.4 where the mosaic placing task is one of the highest percentage based on the specify of tasks among the respondents, comprising with 8.2% among the 61 respondents.

Table 4.5 Types of machinery or equipment used for 61 construction workers

Types of Machinery or Equipment Used	N (%)
None of use	6 (9.8)
Aluminium framework electric driller	2 (3.3)
Bar bender and cutter machine	1 (1.6)
Bar bending machine	2 (3.3)
Bar cutter machine	2 (3.3)
Batching plant machine	3 (4.9)
Concrete pump machine	3 (4.9)
Construction tracker	1 (1.6)
Crawler crane	1 (1.6)
Electrical pipe cutter machine	2 (3.3)
Hammer tools	2 (3.3)
Hand held cement mixture machine	3 (4.9)
Hand held mosaic grinder	5 (8.2)
Hand held skimcoat mixer machine	1 (1.6)
Mixture lorry	1 (1.6)
Mosaic tile cutter	1 (1.6)
Passenger hoist	2 (3.3)
Pipe wrench and hacksaw	1 (1.6)
Roller	4 (6.6)
Roller and trowel	2 (3.3)
Sand pump machine	1 (1.6)
Sand pump pipe	2 (3.3)
Shovel	1 (1.6)
Steel bar machine	1 (1.6)
Steel bar wire	5 (8.2)
Sweeper	1 (1.6)
Trowel	1 (1.6)
Walkie talkie	2 (3.3)
Water spray	1 (1.6)

N = 61

4.2.6 Duration of Employment

The duration of employment among the respondents are being categorized into 4 categories – 1 years or below, 2 to 3 years, 4 to 5 years and 6 years above. The construction workers whom work in construction industry less than 6 months were being excluded in the selection of the respondents in this study. Based on the Table 4.6, it shows that the highest duration of employment among the selected construction workers is the 2 to 3 years duration of employment, comprising with 45.9% of the respondents, followed by 4 to 5 years, comprising with 34.4% of the respondents, 1 year or below which comprises of 11.5% of the respondents and the 6 years above with the lowest percentage, 8.2% of the respondents. Majority of respondents whom worked at the construction site is around 2 to 3 years (45.9%) and 4 to 5 years (34.4%) as the construction project started in the year of 2016 and most of the workers joined and started their employment in the construction industry.

Table 4.6 Duration of employment of 61 construction workers

Duration of Employment	N (%)
1 year or below	7 (11.5)
2 to 3 years	28 (45.9)
4 to 5 years	21 (34.4)
6 years above	5 (8.2)

N = 61

4.3 Occupational Background – Exposure of Noise

The occupational background related to noise exposure was obtained through the distributed questionnaires among the construction workers.

According to Table 4.7 occupational circumstances on noise exposure, it could be seen that machine operators had higher occurrence on all circumstances related to noise exposure. From Table 4.7, it was identified that most of the construction workers where machine operators (80.6%) and non-machine operators (46.7%) were exposed on loud noise at their current job. Moreover, either machine operators (96.8%) or non-machine operators (100.0%) stated that the employer did not provide any hearing protective devices and 59 of the them did not wear on hearing protection devices when work. Furthermore, there was more than half of the respondents where 14 machine operators

and 19 non-machine operators did not agreed that hearing damaged caused by noise exposure where it is been proved by the previous researchers that the excessive noise exposure level could trigger the process of hearing impairment (Ighoroje et al., 2004).

Table 4.7 Occupational circumstances on noise exposure

Circumstances	Machine Operators		Non-Machine Operators	
	Yes N (%)	No N (%)	Yes N (%)	No N (%)
Expose on loud noise at current job	25 (80.6)	6 (19.4)	14 (46.7)	16 (53.3)
Employer provide hearing protective devices	1 (3.2)	30 (96.8)	0 (0.00)	30 (100.00)
Wearing of hearing protection devices	2 (6.5)	29 (93.5)	0 (0.00)	30 (100.00)
Opinion on hearing damaged caused by noise exposure	17 (54.8)	14 (45.2)	11 (36.7)	19 (63.3)
Difficulty in hearing	2 (6.5)	29 (93.5)	0 (0.00)	30 (100.00)

N = 61

Next, for the Table 4.8, it shows the severity of noise exposure among the construction workers. From the data analyse, it found that the severity of noise exposure among the machine operators is more severe compare to the non-machine operators. 45.2% of the machine operators stated on moderate noise exposure while 51.6% of the machine operators stated on severe noise exposure at the construction site. Meanwhile, there is 70.0% of non-machine operators stated on moderate noise exposure while only 10% of the non-machine operators stated on severe noise exposure at the construction site. Therefore, it has been identified that the machine operators were expose to more severe noise exposure compare to non-machine operators at the construction site.

Table 4.8 Severity of noise exposure among construction workers

Category	Severity of Noise Exposure		
	Mild N (%)	**Moderate N (%)**	**Severe N (%)**
Machine Operators	1 (3.2)	14 (45.2)	16 (51.6)
Non-Machine Operators	6 (20.0)	21 (70.0)	3 (10.0)

N = 61

Furthermore, for Table 4.9 period of noise exposure among construction workers, result shows that the period of machine operators expose to noise is longer compare to non-machine operators. It could be seen from the result obtained where there was 61.3% of machine operators whom exposure to noise for their whole working shift while there was only 13.3% of the non-machine operators exposed to noise for their whole working shift at the construction site. This is supported by the data obtained through the interview session with the respondent that he mentioned on most of the construction workers were exposed to moderate noise for whole working shift at the construction site. Most of machine operators were exposed to noise for their whole working shift might be due to their work tasks such as bar tying machine operators where they had to operate the machine for almost whole working shift for their work tasks.

Table 4.9 Period of noise exposure among construction workers

Category	**Period of Noise Exposure**		
	Whole working shift N (%)	Half of working shift N (%)	Less than 4 hours N (%)
Machine Operators	19 (61.3)	10 (32.3)	2 (6.5)
Non-Machine Operators	4 (13.3)	10 (33.3)	16 (53.3)

N = 61

According to data obtained as stated in Table 4.10 frequency of use of hearing protection devices, nearly 100% of the selected respondents stated that they never use on hearing protection devices at work. There were 90.3% of machine operators and 100% of non-machine operators never use the hearing protection devices at the construction site. The data analysed in Table 4.10 could be related with Table 4.7 on the occupational circumstances on noise exposure where 59 of 61 respondents did not wear hearing protection devices even when expose to noise at the construction site.

Table 4.10 Frequency of use of hearing protection devices

Category	**Frequency of Use of Hearing Protection Devices**			
	Never N (%)	Less than half of work shift N (%)	More than half of working shift N (%)	Always N (%)
Machine Operators	28 (90.3)	3 (9.7)	0 (0.0)	0 (0.0)
Non-Machine Operators	30 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)

N = 61

From data analysed in Table 4.11 noisy hobby among the construction workers, most of the construction workers did not have any noisy hobby. This was comprised by 74.2% of the machine operators and 60.0% of the non-machine operators. While the least noisy hobby that appeared among the construction workers is the frequent use of electric hand tools, comprised by 6.5% of machine operators and 3.3% of non-machine operators.

Table 4.11 Noisy hobby among construction workers

Category	**Noisy Hobby**			
	Frequent use of electric hand tools N (%)	Listen to loud music N (%)	Others N (%)	None N (%)
Machine Operators	2 (6.5)	5 (16.1)	1 (3.2)	23 (74.2)
Non-Machine Operators	1 (3.3)	11 (36.7)	0 (0.0)	18 (60.0)

N = 61

4.4 Health History

According to result obtained for health history among the respondents, most of them did not have any previous health conditions as stated in the questionnaire distributed. Based on Table 4.12, the least health condition among the construction workers are the ear problems and ear infection, comprises with 96.8% of machine operators and 100% of non-machine operators. Throughout the interview session conducted in the study, the respondent whom faced the ear problem was due to unwanted accident happened among the family members and lost right ear's hearing. While for the most prevalent health condition among the respondents is the headache, comprises with 35.5% of machine operators and 73.3% of non-machine operators. The headache condition is a commonly health issue among all the people which could occur due to variety of factors where one of the factors is noise hazard.

Table 4.12 Health history among construction workers

Conditions	Machine Operators		Non-Machine Operators	
	Yes N (%)	No N (%)	Yes N (%)	No N (%)
High blood pressure	5 (16.1)	26 (83.9)	2 (6.7)	28 (93.3)
Ear problems	1 (3.2)	30 (96.8)	0 (0.0)	30 (100.0)
Ear infection (discharge)	1 (3.2)	30 (96.8)	0 (0.0)	30 (100.0)
Dizziness (vertigo)	9 (29.0)	22 (71.0)	8 (26.7)	22 (73.3)
Headache	11 (35.5)	20 (64.5)	8 (26.7)	22 (73.3)
Sleep problem/Insomnia	4 (12.9)	27 (87.1)	1 (3.3)	29 (96.7)

N = 61

4.5 Personal Noise Monitoring

In the study, there was total 61 construction workers been selected from the construction site. The 61 construction workers were selected and categorized into 2 categories of job tasks, the machine operators group and the non-machine operators group. The personal noise monitoring was being carried out for eight hours on the selected construction workers. Figure 4.1 and Figure 4.2 show the 8hours time-weighted average (TWA) for both respondent groups – the machine operators group and the non-machine operators group.

From the analysed data obtained, it could be seen from both table and figure that the personal noise exposure levels among the construction workers is high where there was total of 88.5% construction workers were identified on their personal noise exposure level above 70dBA whereby on the 12 respondents out of 61 respondents, 10 machine operators and 2 non-machine operators had exceeded the action levels stated in Factories and Machinery (Noise Exposure) Regulations 1989 which is 85dBA. There were also 1 machine operators and 2 non-machine operators had exceeded the permissible exposure limit (PEL) stated in regulation – 90 dBA which could give harm on the safety and health of the related respondents.

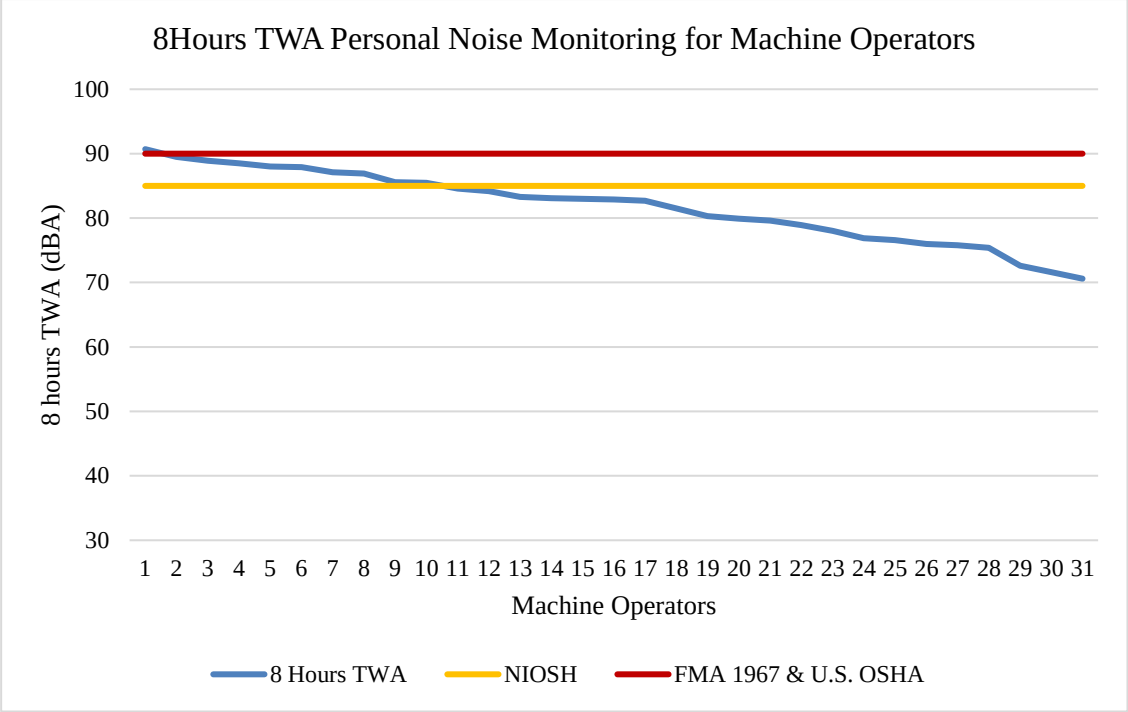

Figure 4.1 8 Hours TWA Personal Noise Monitoring for Machine Operators

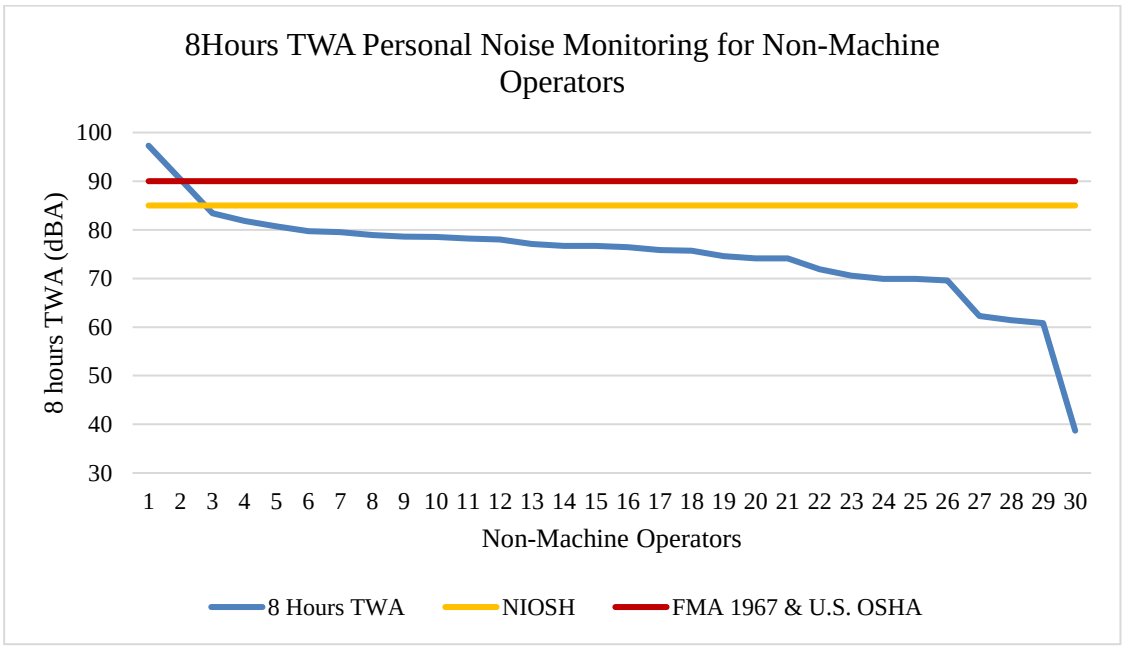

Figure 4.2 8 Hours TWA Personal Noise Monitoring for Non-Machine Operators

4.5.1 Comparison of Personal Noise Exposure Level between Machine Operators and Non-Machine Operators

Table 4.13 shows the minimum, maximum, means and standard division of results for the personal noise monitoring among the machine operators and non-machine operators on the 8hours time-weighted average (TWA). Table 4.14 shows the result of t-test on the comparison of personal noise exposure level between machine operators and non-machine operators from the Statistical Package for Social Science (SPSS). According to Table 4.14, the t-test results obtained from data analysis through SPSS shows that it is significant (t=3.411, df=59, p=0.001). Therefore, the research study hypothesis has been accepted and it is concluded that there is a significant differences of personal noise exposure level between machine operators group and non-machine operators group. Generally, the mean of personal noise exposure level for the machine operators (81.81 dBA) was significantly (p=0.001, <0.05) higher compare to the mean of personal noise exposure level for non-machine operators (74.71 dBA). This could be supported with the data collected during the interview session with the machine operators where they had mentioned that they exposed to loud noise most of the working hour compare to the non-machine operators at the construction site especially the bar tying machine operators.

Table 4.13 Minimum, Maximum, Means and Standard Deviation of Personal Noise Monitoring

Category	**Time-Weighted Average TWA (8) (dBA)**			
	Minimum	Maximum	Mean	Standard Deviation
Machine Operators	70.6	90.7	81.81	5.54
Non-Machine Operators	38.7	97.3	74.71	10.13

N=61

Table 4.14 Comparison of Personal Noise Exposure Level between Machine Operators and Non-Machine Operators

	Machine Operators n=31	**Non-Machine Operators n=30**	**T-test Statistics[2] (df)**	***P*-value**
Personal Noise Exposure Level (dBA)	81.81	74.71	3.411 (59)	***0.001**

N=61 *Independent T-Test ** Significant at p<0.05 *** Significant at p<0.001

4.6 Prevalence of Psychological Health Effect Symptoms

The data related to the prevalence of psychological health effect symptoms were being obtained through the questionnaire distributed towards the construction workers whom been selected as respondents in the selected construction site. From the data obtained, the prevalence of psychological health effect symptoms among the machine operators group and non-machine operators group were being separated and analysed through SPSS.

4.6.1 Prevalence of Psychological Health Effect Symptoms of Machine Operators

Table 4.16 and Figure 4.7 show the prevalence of psychological health effect symptoms due to noise exposure among the machine operators selected in the study. According to data analysed, the highest prevalence of the health effect symptom among the machine operators is the tension in noisy work environment, comprising with 93.5% of the respondents while the lowest prevalence of the health effect symptom is the experience of any sleep disturbance, comprising with 12.9% of the respondents. Tension in noisy work environment is the highest prevalence of health effect symptom (93.5%). Oliveira (2015) stated that the stress issue among the machine operators could rise when they unable to withstand or cope with the demand of work environment – noisy work environment. While for the lowest prevalence of the health effect symptom, sleep disturbance (12.9%) among the machine operators, this could due to although the machine operators were exposed to the noisy environment, but from the Table 4.7, most of the machine operators are not over the permissible exposure limit (PEL), but mostly near or exceed the action level which comply with legislation. Therefore, sleep disturbance health effect symptom due to noise exposure is the least among the machine operators.

Table 4.15 Prevalence of Psychological Health Effect Symptoms of Machine Operators

Symptoms of Health Effect	Yes N (%)	No N (%)
Ear pain	17 (54.8)	15 (45.2)
Sudden hearing loss	5 (16.1)	26 (83.9)
Tinnitus	24 (77.4)	7 (22.6)
Noticeable change in hearing	13 (41.9)	18 (58.1)
Anger and aggressiveness	23 (74.2)	8 (25.8)
Dizziness	11 (35.5)	20 (64.5)
Experience of any sleep disturbance	4 (12.9)	27 (87.1)
Stressful in noisy work environment	28 (90.3)	3 (9.7)
Tension in noisy work environment	29 (93.5)	2 (6.5)
Difficulty in concentrating or decision making	16 (51.6)	15 (48.4)

N=61

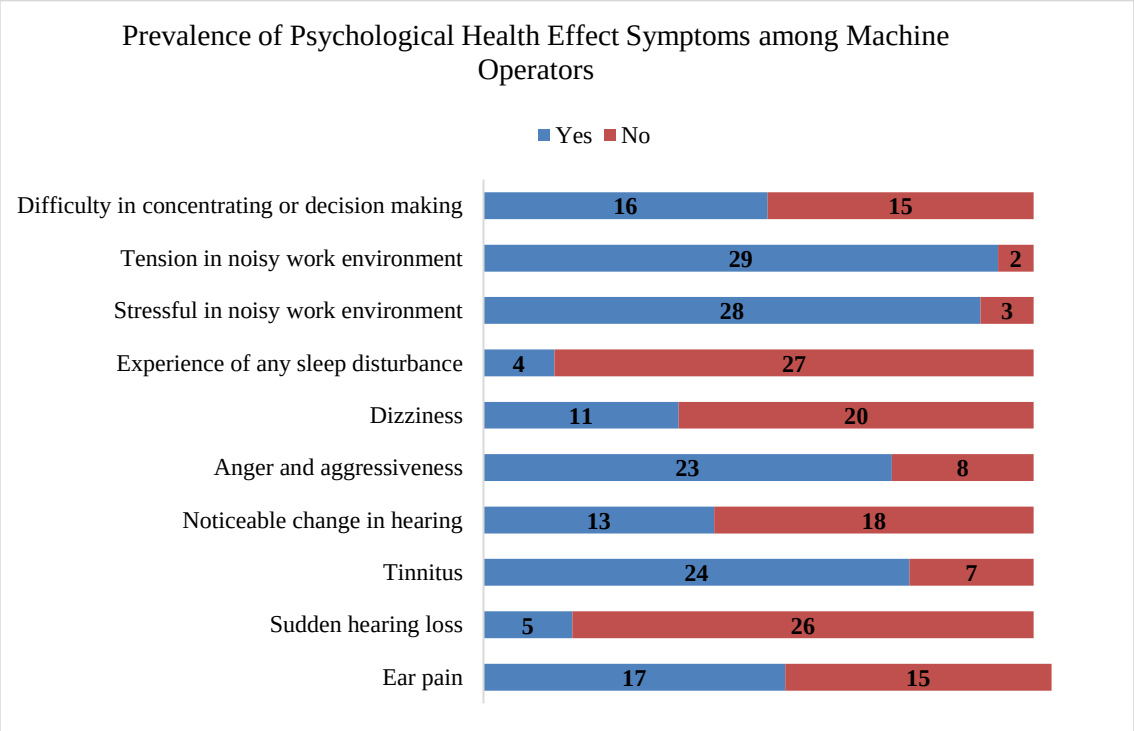

Figure 4.3 Prevalence of Psychological Health Effect Symptoms of Machine Operators

4.6.2 Prevalence of Psychological Health Effect Symptoms of Non-Machine Operators

Table 4.17 and Figure 4.8 show the prevalence of psychological health effect symptoms due to noise exposure among the non-machine operators selected in the study. According to data obtained, it shows the similar results obtained from the machine operators and the non-machine operators, where the highest prevalence of the health effect symptom among the non-machine operators due to the noise exposure is the tension in noisy work environment, comprising 43.3% of the respondents while the lowest prevalence of health effect symptom is the experience of any sleep disturbance comprising with 3.3% of the respondents. This result shows that the health effect symptom – tension in noisy work environment is the highest prevalence for both machine operators and non-machine operators at the construction site. The second highest prevalence of psychological health effect symptom among the non-machine operators is the stressful in noisy work environment. This symptom could be happened frequently among the non-machine operators might due to the workers most of the time works under noisy workplace even though the source of noise not comes from their tasks and the noisy workplace could also affect the workers work performance and become stressful in the construction site.

Table 4.16 Prevalence of Psychological Health Effect Symptoms of Non-Machine Operators

Symptoms of Health Effect	Yes N (%)	No N (%)
Ear pain	6 (20.0)	24 (80.0)
Sudden hearing loss	2 (6.7)	28 (93.3)
Tinnitus	5 (16.7)	25 (83.3)
Noticeable change in hearing	2 (6.7)	28 (93.3)
Anger and aggressiveness	10 (33.3)	20 (66.7)
Dizziness	6 (20.0)	24 (80.0)
Experience of any sleep disturbance	1 (3.3)	29 (96.7)
Stressful in noisy work environment	12 (40.0)	18 (60.0)
Tension in noisy work environment	13 (43.3)	17 (56.7)
Difficulty in concentrating or decision making	8 (26.7)	22 (73.3)

N=61

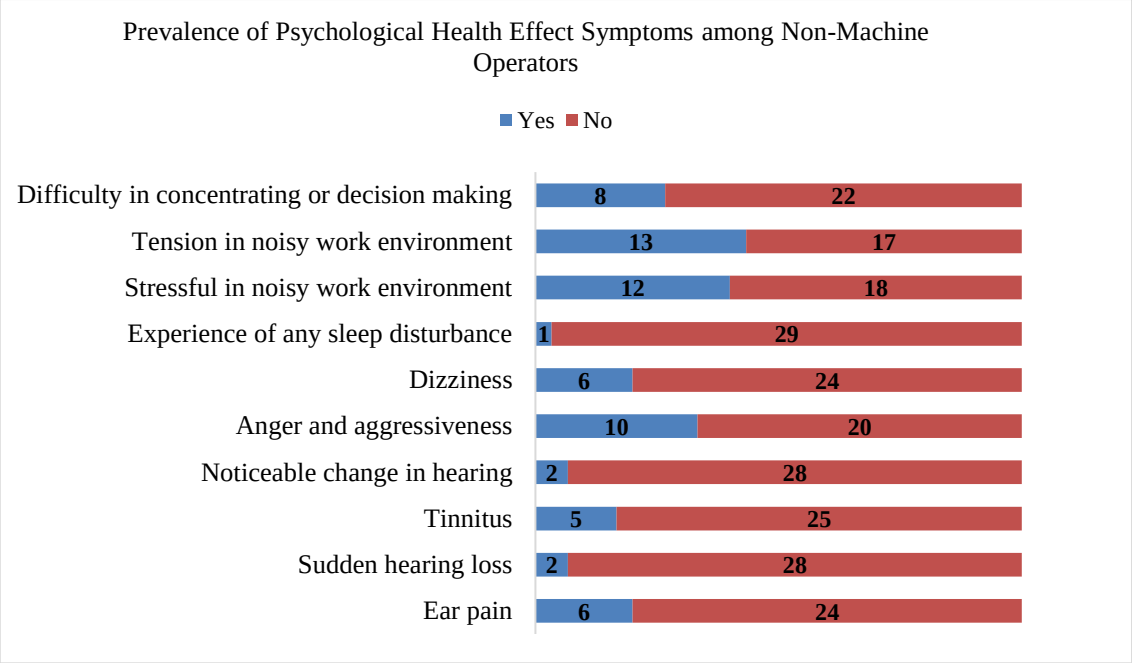

Figure 4.4 Prevalence of Psychological Health Effect Symptoms of Non-Machine Operators

4.6.3 Comparison of Prevalence of Psychological Health Effect Symptoms Between Machine Operators and Non-Machine Operators

Table 4.18 shows result of the independent chi-square test on the prevalence of psychological health effect symptoms between machine operators and non-machine operators. According to the result obtained from the independent chi-square test through SPSS, there are significantly ($p<0.05$) differences between the machine operators and non-machine operators for the prevalence of psychological health effect symptoms on ear pain ($p=0.005$), tinnitus ($p=0.000$), noticeable change in hearing ($p=0.001$), anger and aggressiveness ($p=0.001$), stressful in noisy work environment ($p=0.001$), the tension in noisy work environment ($p=0.001$) and the difficulty in concentrating or decision making ($p=0.046$)

The result obtained reveals that the machine operators group has significantly higher prevalence of all these health effect symptoms compare to non-machine operators group in the study. This could due to the machine operators group almost operates the machines for the whole working hours while the non-machine operators group might only operate the machines for half or less of the working hours or even does not use any of machines in their tasks at the construction site. According to previous studies, it has been proven that the noise exposure is associated with the psychological health effects and

could vary with source of environmental noise exposure (Hammersen et. al., 2016). The noise exposure is indirectly associated with the prevalence of psychological health effect symptoms as previous study has reported that the psychological health effect symptoms are more prevalent among the people whom are nearer to the source of noise (Van Kamp et. al., 2008). Therefore, the machine operators group more relates with the machines which could lead to excessive noise exposure compare to non-machine operators group. This lead to the issue where the prevalence of health effect symptoms among the machine operators group is significantly higher compare to non-machine operators group.

Table 4.17 Prevalence of Psychological Health Effect Symptoms Between Machine Operators and Non-Machine Operators

Symptoms of Health Effects	**Machine Operators**		**Non-Machine Operators**		**Statistics**	
	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Value[a] (x^2) (df)	*p*-value
Ear pain	17 (73.9)	14 (36.8)	6 (26.1)	24 (63.2)	7.878 (1)	**0.005***
Sudden hearing loss	5 (71.4)	26 (48.1)	2 (28.6)	28 (51.9)	1.344 (1)	0.246
Tinnitus	24 (82.8)	7 (21.9)	5 (17.2)	25 (78.1)	22.563 (1)	**0.000***
Noticeable change in hearing	13 (86.7)	18 (39.1)	2 (13.3)	28 (60.9)	10.227 (1)	**0.001***
Anger and aggressiveness	23 (69.7)	8 (28.6)	10 (30.3)	20 (71.4)	10.250 (1)	**0.001***
Dizziness	11 (64.7)	20 (45.5)	6 (35.3)	24 (54.5)	1.818 (1)	0.178
Experience of any sleep disturbance	4 (80.0)	27 (48.2)	1 (20.0)	29 (51.8)	1.856 (1)	0.173
Stressful in noisy work environment	28 (70.0)	3 (14.3)	12 (30.0)	18 (85.7)	17.102 (1)	**0.000***
Tension in noisy work environment	29 (69.0)	2 (10.5)	13 (31.0)	17 (89.5)	17.926 (1)	**0.000***
Difficulty in concentrating or decision making	16 (66.7)	15 (40.5)	8 (33.3)	22 (59.5)	3.976 (1)	**0.046***

N=61 *Independent chi-square test * Significant at $p<0.05$

4.7 Relationship between Personal Noise Exposure Level and Prevalence of Psychological Health Effect Symptoms

The variables in the study are the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers. The relationship between personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers was being analysed by performing Binary Logistic Regression through the SPSS. Table 4.19 is the result obtained for the machine operators while Table 4.20 is the result obtained for the non-machine operators.

4.7.1 Relationship between Personal Noise Exposure Level and Prevalence of Psychological Health Effect Symptoms among Machine Operators

Based on the result obtained through Binary Logistic Regression, the prevalence of ear pain, noticeable change in hearing and the dizziness health effect symptoms ($p<0.05$) showed that there is significant relationship between personal noise exposure level – 8hours time-weighted average (TWA) with these symptoms of health effects among the machine operators at the construction site. The result revealed that the tests on these health effect symptoms showed the positive coefficient and p-value less than 0.05. The positive coefficient obtained in the Binary Logistic Regression means that when one of the variable increases in its value, then the value of another variable also increases. In the study, is has been proven that when the personal noise exposure level increases, the prevalence of ear pain, noticeable change in hearing and dizziness health effect symptoms also increases among the machine operators.

For the most strength and significant relationship between the personal noise exposure level and the prevalence of health effect symptom is the noticeable change in hearing with the coefficient value of 0.312 that nearest to 1 and the p-value of 0.007. This means that the noticeable change in hearing is the most affected symptom due to excessive noise exposure among the machine operators at the construction site. Based on the data collected through interview session with the machine operators, it has been identified that several of the machine operators mentioned that they had noticed about change in hearing especially when they went back to home after work. While according to the data collected through questionnaire, there was identified that 51.6% of machine

operators stated that they exposed to severe noise exposure while 45.2% of them exposed to moderate noise exposure. As the severity of noise exposure increases, the machine operators could more easily noticed on change in hearing when they are at a quite place.

While for the least strength and significant relationship between the personal noise exposure level and the prevalence of health effect symptom is the ear pain with the coefficient value of 0.232 that nearest to 0 that means no correlation between 2 variables and the p-value of 0.011. The ear pain is the least strength and significant health effect symptom due to the personal noise exposure level on most of the machine operators at the construction site was near to the action level of 85dBA but not exceed the permissible exposure limit of 90dBA as stated in Factories and Machinery (Noise Exposure) Regulations 1989 (Government of Malaysia, 2014). Therefore, although when the personal noise exposure level increases, the prevalence of ear pain increases slightly among the machine operators. According to the

Table 4.18 Relationship between Personal Noise Exposure Level and Prevalence of Psychological Health Effect Symptoms among Machine Operators

Variable	**Personal noise exposure level (8 Hours TWA)**		
	B	df	*p*-value
Ear pain	**0.232**	**1**	**0.011**
Sudden hearing loss	0.254	1	0.072
Tinnitus	0.019	1	0.809
Noticeable change in hearing	**0.312**	**1**	**0.007**
Anger and aggressiveness	0.159	1	0.062
Dizziness	**0.248**	**1**	**0.016**
Experience of any sleep disturbance	0.449	1	0.058
Stressful in noisy work environment	0.087	1	0.436
Tension in noisy work environment	0.039	1	0.767
Difficulty in concentrating or decision making	-0.047	1	0.481

N = 31 * Binary Logistic Regression * B – Coefficient * Significant at $p<0.05$

4.7.2 Relationship between Personal Noise Exposure Level and Prevalence of Psychological Health Effect Symptoms among Non-Machine Operators

Based on Table 4.20, the result revealed that there is the significant relationship between personal noise exposure level - 8hours time-weighted average (TWA) with the prevalence of sudden hearing loss, anger and aggressiveness, dizziness, stressful in noisy work environment, tension in noisy work environment and difficulty in concentrating or decision making health effect symptoms ($p<0.05$) among the non-machine operators as tests on these health effect symptoms showed the positive correlation and p-value less than 0.05. In this study, it has been proven that as personal noise exposure level increases, the prevalence of these psychological health effect symptoms also increases among the non-machine operators.

For the most strength and significant relationship between the personal noise exposure level and the prevalence of health effect symptoms is the anger and aggressiveness with the coefficient value of 0.655 and p-value of 0.027 where the coefficient value of symptom of anger and aggressiveness is the nearest to 1 which means the perfect positive coefficient. This means that the health effect symptom of anger and aggressiveness is the most affected symptom due to excessive noise exposure where when the personal noise exposure level increases, the prevalence of anger and aggressiveness symptom among the non-machine operators increases. Previous studies reported that the people who exposed to noise pollution could lead to the increase in anger and aggressiveness (Jones et al., 1981). This is supported by previous study where it was identified that noise act as stressor that lead to unwanted expression of human such as anger (Ramirez et al., 2004).

While for the lease strength and significant relationship between the personal noise exposure level and the prevalence of health effect symptoms is the dizziness with the coefficient value of 0.248 and the p-value of 0.050 where the coefficient value is the nearest to 0. This might because of excessive noise exposure not the only cause of dizziness but dizziness also due to other factors such as the health status of the non-machine operators. According to the interview session with the non-machine operators, it has been found that the excessive noise exposure not the main source that lead to prevalence of dizziness but might also arise due to unhealthy health status such as sick.

Table 4.19 Relationship between Personal Noise Exposure Level and Prevalence of Psychological Health Effect Symptoms among Non-Machine Operators

Variable	Personal noise exposure level (8 Hours TWA)		
	B	df	*p*-value
Ear pain	0.123	1	0.095
Sudden hearing loss	**0.305**	**1**	**0.047**
Tinnitus	0.317	1	0.055
Noticeable change in hearing	0.214	1	0.057
Anger and aggressiveness	**0.655**	**1**	**0.027**
Dizziness	**0.248**	**1**	**0.050**
Experience of any sleep disturbance	4.581	1	0.993
Stressful in noisy work environment	**0.280**	**1**	**0.031**
Tension in noisy work environment	**0.277**	**1**	**0.028**
Difficulty in concentrating or decision making	0.141	1	0.071

N = 30 * Binary Logistic Regression * B – Coefficient *Significant at $p<0.05$

4.8 Summary

Throughout this chapter, it could be summarised that the personal noise exposure level for the machine operators was significantly higher compare to the personal noise exposure level for non-machine operators. Next, the health effect symptoms – tension in noisy work environment and the sleep disturbance are the highest and lowest prevalence for both machine operators and non-machine operators at construction site. Furthermore, the result shows that the machine operators have significantly higher prevalence of health effect symptoms on tinnitus, noticeable change in hearing, anger and aggressive, stressful in noisy work environment, and the tension in noisy work environment compare to the non-machine operators. Lastly, the result of the Binary Logistic Regression shows that there is significant relationship between the 8hours time-weighted average with the ear pain, noticeable change in hearing and dizziness health effect symptoms among the machine operators and sudden hearing loss, anger and aggressiveness, dizziness, stressful and tension in noisy work environment among non-machine operators at the selected construction site at Perak.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter will conclude all findings that had been obtained based on the objectives of the study. The conclusion and a few recommendations have been made in this chapter.

5.2 Conclusion

This study had been conducted to study the noise exposure among the machine operators and non-machine operators in construction industry. The respondents in the study were selected and categorized into 2 groups, machine operators group and non-machine operators group from selected construction site located at Perak. All respondents have been conducted the personal noise monitoring with the personal noise dosimeter and questionnaires been distributed and answered for purpose of identify the prevalence of psychological health effect symptoms among the construction workers due to noise exposure.

The study was set to identify and compare the personal noise exposure level towards the construction workers in the construction industry. The result of personal noise exposure levels among the construction workers was obtained through the personal noise monitoring. From the result, it has been proved that there was high personal noise exposure levels among the construction workers. There was total 88.5% of the machine operators and non-machine operators in the study were identified on personal noise exposure level above 70dBA whereby 12 respondents, 10 machine operators and 2 non-machine operators had exceeded the action levels stated in Factories and Machinery

(Noise Exposure) Regulations 1989 which is 85dBA. Meanwhile, 1 machine operators and 2 non-machine operators had exceeded the permissible exposure limit (PEL) which stated in the Factories and Machinery (Noise Exposure) Regulations 1989 that could give impacts on their safety and health. According to the result obtained through the t-test on Statistical Package for Social Science (SPSS), it showed that there is a significant differences of personal noise exposure level between the machine operators group and non-machine operators group whereby the mean of personal noise exposure level for the machine operators group (81.81dBA) was significantly higher compare to the mean of personal noise exposure level for the non-machine operators group (74.71dBA) in the study.

Furthermore, the study was aimed to determine and compare the prevalence of psychological health effect symptoms among the construction workers. Throughout the result obtained from the study, there is high prevalence of psychological health effect symptoms among the construction workers where both machine operators (93.5%) and non-machine operators (43.3%) have high prevalence on the psychological health effect tension in noisy work environment. While among the psychological health effect symptoms in the study, the lowest prevalence of psychological health effect symptoms among both machine operators (12.9%) and non-machine operators (3.3%) is the prevalence of experience of any sleep disturbance. While for comparing the prevalence of psychological health effect symptoms between the machine operators and non-machine operators in the study, it was believed that the machine operators group has significantly higher prevalence of psychological health effect symptoms compare to non-machine operators group. This had been proven through the result obtained from the independent chi-square test on the prevalence of psychological health effect symptoms between machine operators and non-machine operators. The result obtained in the study showed that there was there was significant ($p<0.005$) differences between the machine operators and non-machine operators for the prevalence of health effect symptoms. The related health effect symptoms are tinnitus, noticeable change in hearing, anger and aggressiveness, stressful in noisy work environment, and the tension in noisy work environment where the machine operators has significantly higher prevalence compare to non-machine operators.

Lastly, in determining the relationship between the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers in the study. There was been identified on the significantly relationship between the personal noise exposure level and the prevalence of psychological health effect symptoms among the construction workers. This been proven with the result obtained from the Binary Logistic Regression. Based on the result obtained, it showed that there was significant and positive correlation between personal noise exposure level on 8hours time-weighted average (TWA) and the prevalence of ear pain, noticeable change in hearing and dizziness psychological health effect symptoms among the machine operators and the prevalence of sudden hearing loss, anger and aggressiveness, dizziness, stressful and tension in noisy work environment among non-machine operators at the selected construction site

5.3 Recommendation

Throughout the findings obtained from the study, there are several recommendations be made for the purpose to minimize the risk of noise pollution at the selected construction site and for improvement on future research related to occupational noise exposure.

5.3.1 Recommendation for Selected Construction Site

Based on the Factories and Machinery (Noise Exposure) Regulations 1989, there are several recommendations could be adapted and recommended to the selected construction site to be implemented to control and protect the construction workers' safety and health from the excessive noise exposure at the construction site.

First recommendation for the employer of the selected construction site is that initial employee exposure monitoring towards the construction workers. It is stated in the Regulation 9 of Factories and Machinery (Noise Exposure) Regulations 1989 where if the selected employees shown the positive result which any of them expose to noise level at or exceed the action level -85dBA, the employer shall take concern and determine the noise exposure level on the employees that have same tasks or works at same work area.

Next, is the engineering and administrative control that stated in the Regulation 15 of Factories and Machinery (Noise Exposure) Regulations 1989. The employer shall

take action to maintain and even reduce the employees' noise exposure level below the permissible exposure level (PEL) at the construction site. This helps to ensure and protect the construction workers' safety and health at the workplace.

Furthermore, the hearing protection devices where the employer shall provide to the construction workers at the selected construction site. This is stated in Regulation 16 of Factories and Machinery (Noise Exposure) Regulations 1989. Based on the respondents, the employer did not provide any of the hearing protection devices such as ear plug when they are working at the construction site even for those machine operators such as performing the work task using the bar cutting machine that could cause excessive noise exposure.

Lastly, other than the recommendation from the Factories and Machinery (Noise Exposure) Regulations 1989, there are a few recommendations for the selected construction site. As the awareness among the construction workers related to noise exposure is low at the construction site, the employer shall provide related training, hearing protection devices and even implement the safety culture at the construction site. While when the employer has distributed hearing protection devices towards the construction workers, employer shall ensure that the construction workers understand about the importance of wearing the hearing protection devices and ensure the they wear the hearing protection devices correctly. This could help the employer to achieve the total safety culture at the construction site.

5.3.2 Recommendation for Future Research Study

There are a few recommendations could be made for the improvement on future research study related to the noise exposure monitoring. First is on the study design where the cohort study could be conducted for ensuring the relationship of cause-effect between the personal noise exposure and the prevalence of psychological health effect symptoms due to noise exposure among the construction workers. Moreover, the audiometric test could be conducted on the construction workers for the study on prevalence of the Noise Induced Hearing Loss (NIHL) due to the excessive noise exposure at the construction site.

Furthermore, construction site with large study population is recommended for the future research study to conduct the noise exposure monitoring. With the large study population, the sample size will be increased and represented the study population properly where it could help in obtaining reliable and accurate data in producing better result from the study.

5.4 Study Limitation

Without doubt that there are several unavoidable limitations throughout this study. The study was limited due to some factors such as the construction management limitation, respondent limitation and the equipment limitation.

For the construction management limitation, safety officer was revealed to review the historical noise assessment report on the construction site as reference and comparison, and not allow to take any related photos due to the confidential issue. While the respondents were mostly unable to understand and speak English or even Malay thus more time consumed in explaining to them about the study.

There had been taking 3 to 4 weeks for data collection at the construction site due to the equipment limitation such as the instrument issue where the instrument failure during the 8 hours data collection progress and the software issue where failure in transferring data from instrument to the computer for data analysis. Although it was time consuming, it allows an accurate estimate of individual noise exposure at the construction site.

In this study, the audiometric test using audiometer for diagnosis of hearing loss was not able to be applied due to a few reasons such as the equipment – audiometer is large and inconvenience to bring together to the construction site. Moreover, the respondents also unable to take the audiometric test at the Universiti Malaysia Pahang (UMP) as the study location (i.e., Seri Manjung, Perak) is too far from UMP.

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APPENDIX A – CONSENT FORM

CONSENT FORM

I have read the "Participant Information Sheet", in language that is understandable to me.

The content and meaning of this information has been fully explained to me.

I have had time and opportunity to ask question that I have about this study and this for, and all my questions have been answered. I had read, or have been read to me, all pages of this consent form. I voluntarily consent and offer to take part in this study. By signing this consent form, I certify that all the information that I have given, including my personal information are true and correct.

I understand that I will receive a copy of this signed consent form.

Name of participant	IC Number
Signature of participant	Date
Name of witness	IC number
Signature of witness	Date
Name of person explaining consent	IC number
Signature of person explaining consent	Date

APPENDIX B – PARTICIPANT INFORMATION SHEET

PARTICIPANT INFORMATION SHEET

Impact of noise exposure among machine operators and non-machine operators on construction sites in Perak, Malaysia: A comparative study

Dear Sir/Madam,

This letter is to inquire whether you would be willing to participate in a study on "Impact of noise exposure among machine operators and non-machine operators on construction sites in Perak, Malaysia: A comparative study."

This study is will be conducted to assess personal noise exposure level and the prevalence of health effect symptoms between the machine operators and non-machine operators. This study will use a questionnaire in gaining the useful information.

You may stop your involvement at any time during the if you wish. Confidentiality of your involvement in the study will be guaranteed and to completed questionnaire will not be used as data. The data that have been collected will be analysed and published in academic field. If you are willing to participate in this study, please sign the consent form and return it to the researcher.

Thank you for considering this request to participate in this research.

Your sincerely,

Kee Heng Yik (Researcher)

Ms. Nur Syafiqah Binti Fauzan (Supervisor)

Faculty of Technology Engineering

Universiti Malaysia Pahang,

APPENDIX C – WALK-THROUGH OBSERVATION CHECKLIST

WALK-THROUGH OBSERVATION

NOISE EXPOSURE OBSERVATION CHECKLIST

Date :

Time :

Location :

No	Checklist	Answer
1	The noise exposure level at workplace seem to be above 85 dB(A)	☐ Yes ☐ No
2	Workers expose to noise most of the time at workplace.	☐ Yes ☐ No
3	Most of the workers experienced explosion or blast on ear at workplace.	☐ Yes ☐ No
4	Workers have to raise their voice to be heard at workplace	☐ Yes ☐ No
5	Workers have difficulty in communicating among each other due to noise environment.	☐ Yes ☐ No
6	Workers look like stress when carrying out given tasks	☐ Yes ☐ No
7	Presence of signage which indicates the wearing of hearing protection devices	☐ Yes ☐ No
8	The organization provides hearing protection to the construction workers	☐ Yes ☐ No
9	The workers wear hearing protection devices at workplace.	☐ Yes ☐ No
10	The hearing protection devices affect workers' work performance.	☐ Yes ☐ No

Additional information:

_____

_____

_____

APPENDIX D - QUESTIONNAIRE

Universiti Malaysia Pahang

Impact of Noise Exposure Among Machine Operators and Non-Machine Operators on Construction Sites in Perak, Malaysia: A Comparative Study.

Questionnaire

Dear Respondent,

I am a final year undergraduate student of Bachelor of Occupational Safety and Health with Honor, Universiti Malaysia Pahang. The purpose of this survey is to conduct a research study in investigating the impact of noise exposure level and prevalence of health effect symptoms due to noise exposure among the machine operators and non-machine operators in construction industry. Please answer all questions to the best of your experience. There are no wrong responses to any of these statements. All responses are collected for academic research purpose and will be kept strictly confidential.

Thank you for your participation.

Instructions:

1) There are FOUR (4) sections in this questionnaire. Please answer ALL questions in ALL sections.
2) Completion of this form will take you less than 10 minutes.
3) The contents of this questionnaire will be kept strictly confidential.

Voluntary Nature of the Study

Participation in this research study is entirely voluntary. Even if you decide to participate now, you may change your mind and stop at any time. There is no foreseeable risk of harm or discomfort in answering this questionnaire. This is an anonymous questionnaire; as such, it is not able to trace response back to any individual participant. All information collected is treated as strictly confidential and will be used for the purpose of this study only.

I have been informed about the purpose of the study and I give my consent to participate in this survey.

YES ☐ NO ☐

Section 1: Demographic Information

Please tick (✓) or fill in your answer.

1. Gender :

   ☐ Male

   ☐ Female

2. Age :

   ☐ 21 to 30 years

   ☐ 31 to 40 years

   ☐ 41 to 50 years

   ☐ 51 years and above

3. Job Task :

   ☐ Machine Operator

   ☐ Non-Machine Operator

   _____ (please specify the task)

4. Type of machinery or equipment used

   _____ (please specify)

5. Duration of Employment :

   ☐ 1 year or below

   ☐ 2 to 3 years

   ☐ 4 to 5 years

   ☐ 6 years above

Section 2: Occupational Background – Exposure of Noise

This section is seeking your experience regarding the exposure of noise at the construction site. Please answer the following questions based on your experience.

By considering your experience of noise exposure when working at the construction site, answer the following questions:

1. Are you exposed to loud noise at your current job?

   ☐ Yes ☐ No

2. If yes, please describe the source(s) of that noise:

   _____

3. How bad is the noise normally?

   ☐ Mild ☐ Moderate ☐ Severe

4. How long you exposed to the noise at workplace?

   ☐ Whole working shift

   ☐ Half of the working shift

   ☐ Less than 4 hours (half working shift)

5. Did employer provide hearing protection devices to the workers?

   ☐ Yes ☐ No

   If yes: _____

6. Do you wear hearing protection devices?

   ☐ Yes ☐ No

   If no, why?

   ☐ Not beneficial

   ☐ Uncomfortable

   ☐ Difficult for communication

   ☐ Pose a danger in my job

7. How often do you use the hearing protection device at working when it is noisy?

   ☐ Never

   ☐ Less than half of my work shift

   ☐ More than half of my work shift

   ☐ Always

8. Do you have noisy hobby?

   ☐ Frequent use of electrical hand tools, such as saws and drills

   ☐ Listen to loud music

   ☐ Others/Lain-lain: _____

   ☐ None

9. Do you think hearing damaged is caused by exposure to noise at workplace?

   ☐ Yes ☐ No

10. Do you have the difficulty in hearing?

    ☐ Yes ☐ No

    If yes/, please explain*:* _____

Section 3: Current Health Conditions Due to Noise Exposure

This section is seeking your current conditions regarding the health effects due to noise exposure at construction site and your health history. Respondents are asked to indicate the extent to which they had experienced with each condition and health history. Please tick YES/NO per line to indicate the extent to which you have experienced with the following conditions currently.

Considering your <u>current working conditions at workplace</u> due to exposure of noise, have you experienced the following conditions?

No	Conditions	Answer
1	Ear pain	☐ Yes ☐ No
2	Sudden hearing loss	☐ Yes ☐ No
3	Ringing sound (tinnitus)	☐ Yes ☐ No
4	Noticeable change in hearing or ability in understanding words everyday	☐ Yes ☐ No
5	Anger and aggressiveness	☐ Yes ☐ No
6	Dizziness	☐ Yes ☐ No
7	Experience of any sleep alteration or disturbance	☐ Yes ☐ No
8	Hard to relax or stressful in the noisy working environment	☐ Yes ☐ No
9	Being pressure or tension when working in noisy environment.	☐ Yes ☐ No
10	Difficulty in concentrating or decision making.	☐ Yes ☐ No

Section 4: Health History

This section is seeking your health history. Respondents are asked to indicate the extent to which they had experienced with each condition on their health history. Please tick YES/NO per line to indicate the extent to which you have experienced with the following conditions.

Considering your health history, have you ever experienced the following conditions?

No	Health History	Answer
1	High blood pressure	☐ Yes ☐ No
2	Ear problems	☐ Yes ☐ No
3	Ear infections (discharge)	☐ Yes ☐ No
4	Dizziness (vertigo)	☐ Yes ☐ No
5	Headache	☐ Yes ☐ No
6	Sleep Problem/Insomnia	☐ Yes ☐ No

The End
- Thank you for your time and participation –

APPENDIX E – GANTT CHART (FYP 1)

NO	TASK	FEB 2018		MAR 2018				APR 2018				MAY 2018			
		W 3	W 4	W 1	W 2	W 3	W 4	W 1	W 2	W 3	W 4	W 1	W 2	W 3	W 4
1	FYP 1 Briefing														
2	Finding of Suitable Project Title														
3	Project Title Confirmation														
4	Consultation with Supervisor														
5	Drafting Chapter 1														
6	Drafting Chapter 2														
7	Drafting Chapter 3														
8	Hand in on Requisition Form														
9	Finalise of Proposal Draft														
10	Find related Construction Company														
11	Submit FYP 1 Proposal														
12	FYP 1 Oral Presentation														

APPENDIX F – GANTT CHART (FYP 2)

NO	TASK	JUL 2018	AUG 2018	SEPT 2018		OCT 2018				NOV 2018				DEC 2018			
				W 3	W 4	W 1	W 2	W 3	W 4	W 1	W 2	W 3	W 4	W 1	W 2	W 3	W 4
1	Data Sampling																
2	FYP 2 Briefing																
3	Consultation with Supervisor																
4	Review of Literature Review																
5	Data Analysis																
6	Report Writing																
7	Submit FYP 2 Report																
8	FYP 2 Oral Presentation																
9	FYP Poster Presentation																

APPENDIX G – STUDY LOCATION

Overview of 35 Storey Apartment Construction Site

(Source: Google Map)

(Source: Google Map)

Location of research study

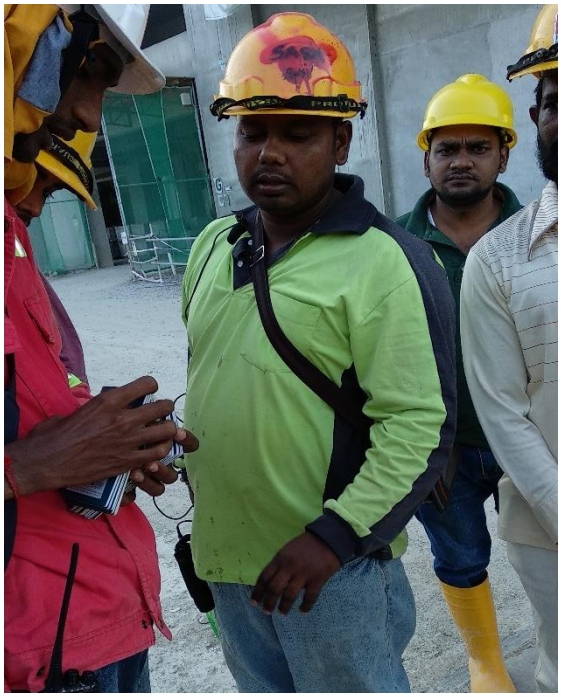
State	Coordinate on Map
Perak	4.21577,100.6731024

APPENDIX H – RELATED PHOTO

Interview session with respondent

Guiding respondent on personal noise dosimeter

Safety officer construction site



Selected respondents in meeting