ENVIRONMENTAL NOISE EXPOSURE AT KERNEL CRUSH POINT

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DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE MASTER OF SAFETY, HEALTH AND ENVIRONMENTAL ENGINEERING

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ENVIRONMENTAL NOISE EXPOSURE AT KERNEL CRUSH POINT

ABSTRACT

In nearly every industry on the globe, noise pollution is a major problem. This article is a study of noise exposure at Kernel Crush Point's production area. The study's major goal is to determine noise exposure, compare noise levels to regulatory requirements, and compare current and previous noise levels (2016 and 2019). The methodologies utilized in this study were the Statistical Package for the Social Sciences (SPSS) Version 23.0. According to the findings, there was an excessive amount of noise present, which was usually over the action level as compared to the legal standard. There was no correlation between noise levels and machine line. There was a substantial variation in noise levels between recent and previous years (2016 and 2019). The proposal should be based on the hierarchy of control, which has been approved by many health and safety organizations. The five major components of the hierarchy of control are elimination, substitution, engineering control, administrative control, and personal protective equipment. Management should offer improved personal protective equipment (PPE) with a greater noise reduction rating (NRR) to reduce sound exposure in the workplace.

Keywords: Noise pollution, regulatory requirement, legal standard

ENVIRONMENTAL NOISE EXPOSURE AT KERNEL CRUSH POINT

ABSTRAK

Di hampir setiap industri di dunia, pencemaran bunyi adalah masalah utama. Artikel ini adalah kajian mengenai pendedahan bunyi di kawasan pengeluaran Kernel Crush Point. Matlamat utama kajian ini adalah untuk menentukan pendedahan bunyi, membandingkan tahap kebisingan dengan keperluan peraturan, dan membandingkan tahap kebisingan semasa dan sebelumnya (2016 dan 2019). Metodologi yang digunakan dalam kajian ini adalah Statistical Package for the Social Sciences (SPSS) Versi 23.0. Menurut penemuan itu, ada kebisingan yang berlebihan, yang biasanya melebihi tahap tindakan dibandingkan dengan standar hukum. Tidak ada hubungan antara tahap kebisingan dan saluran mesin. Terdapat perbezaan yang ketara dalam tahap kebisingan antara tahun-tahun terakhir dan sebelumnya (2016 dan 2019). Cadangan itu harus berdasarkan pada hierarki kawalan, yang telah disetujui oleh banyak organisasi kesihatan dan keselamatan. Lima komponen utama hierarki kawalan adalah penghapusan, penggantian, kawalan kejuruteraan, kawalan pentadbiran, dan peralatan pelindung diri. Pengurusan harus menawarkan peralatan pelindung diri (PPE) yang lebih baik dengan penilaian pengurangan kebisingan (NRR) yang lebih tinggi untuk mengurangkan pendedahan bunyi di tempat kerja.

Kata kunci: Pencemaran bunyi, keperluan peraturan, standard undang-undang

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Safety and health in the workplace is a hot topic that has to be addressed. This is because it enables us to sustain lives in which Occupational Safety and Health is linked to lifestyle concerns. Occupational safety and health is formally known as the protection of administrative center environments, and it is closely linked to the protection, fitness, and welfare of people and employees There are many goals for optimizing occupational safety and fitness at the administrative center, particularly to create a safe and healthy running environment for the respective people, including people and personnel, to enjoy a comfortable working environment as well as a higher level of self-confidence in terms of safety and fitness. One of the Occupational Safety and Health issues is noise. (Rabinowitz, et.al, 2011)

Sound is a vibration that may be transmitted via any material, however when many vibrations are mixed, sound becomes noise. Sound ensures transparency, while noise is less so, and the information may not be received by the brain. Sound is defined as vibrations conveyed to the ears, and the frequency of sound is controlled through fast variations. If there is fast fluctuation, the frequency of sound will ultimately increase. The number of pressure shifts each second, or a fluctuation in pressure per second, is referred to as frequency. Hertz is the unit of measurement for frequency (Hz). (William, et.al, 2012)

The ear is an essential organ that detects both the frequency and the volume of sound. The ‘A' notation, on the other hand, comes into play since it denotes the noise levels that have been filtered using the A-weighting network. This network commonly mimics the frequency response characteristics of the human ear, which is owing to the fact that the human ear is highly sensitive to frequency, therefore the frequency is measured in a way that the human ear can readily adjust. (Rabinowitz, et.al, 2011)

The outer ear, middle ear, and inner ear all pass sound via the ear. After travelling through the ear canal, sound goes to the eardrum for the first time.. The eardrum is sometimes referred to as the tympanic membrane. The malleus, incus, and stapes are the ossicles through which the tympanic membrane passes. The vibration is subsequently transmitted to the cochlea, which has a snail-like structure.

The vibrations will be altered by a number of microscopic hair cells. Vibrational changes will ultimately turn into electrical impulses, which the brain will receive via the auditory nerve. The human brain decides what sound the individual is hearing after getting the electrical signal. (Fig. 1.1.) Throughout the exterior, middle, and inner ear, sound energy is transformed to mechanical energy, which is subsequently turned to electrochemical energy.. (Shuai, et.al, 2013)

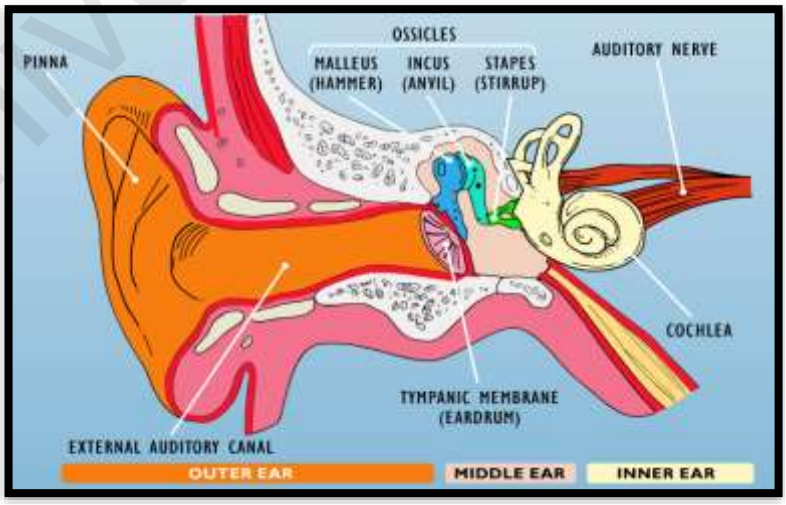

Figure 1.1: Ears structure. (Shuai, et.al, 2013)

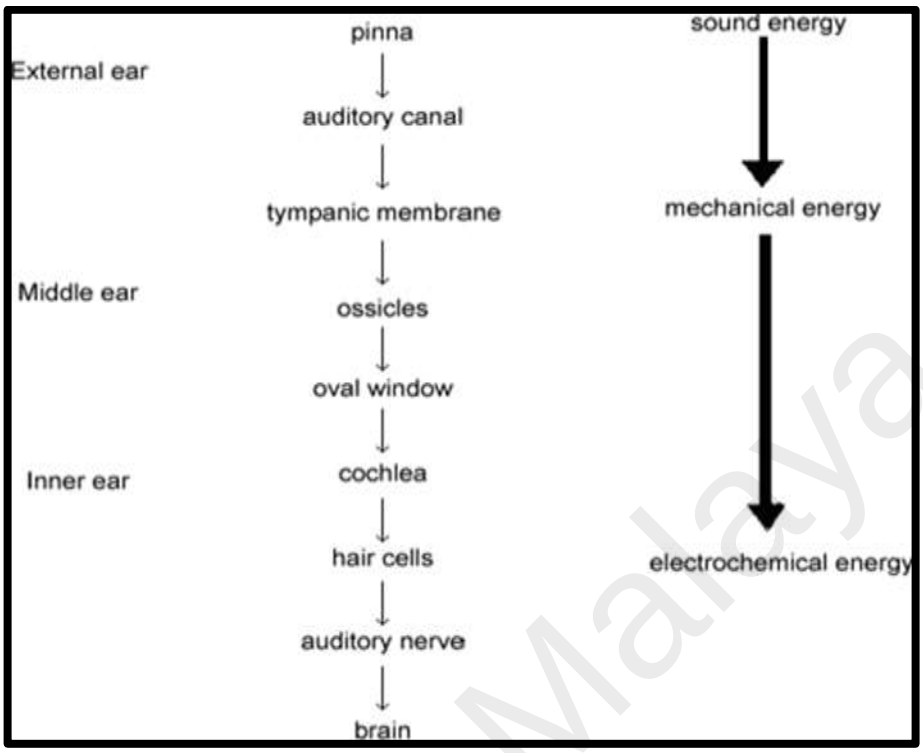

Figure 1.2: The pathway of sound travel. (Shuai, et.al, 2013)

Noise is defined as excessive sound that is measured in decibels (dB). Alexander Graham Bell's decibels (dB) were named after him. The sound level notation as well as the sound level pressure are measured in decibels (dB). Physical, psychological, and physiological variables can all have an impact on a person. These elements can influence listeners to have good hearing without harming them, and they may assist lower sound pressure levels at the listener's position, hearing sharpness, and acclimation to constant sounds as well as in loud environments. (William, et.al, 2012)

The greater the decibel (dB) level of sound, the more noise exposure and the worse the health effects on those in the sensitive zone (William, et.al, 2012). According to US statistics, the manufacturing industry has the highest rate of noise-induced hearing loss cases as a result of occupational noise exposure. (Figure 1.3). (Patrick, 2014)

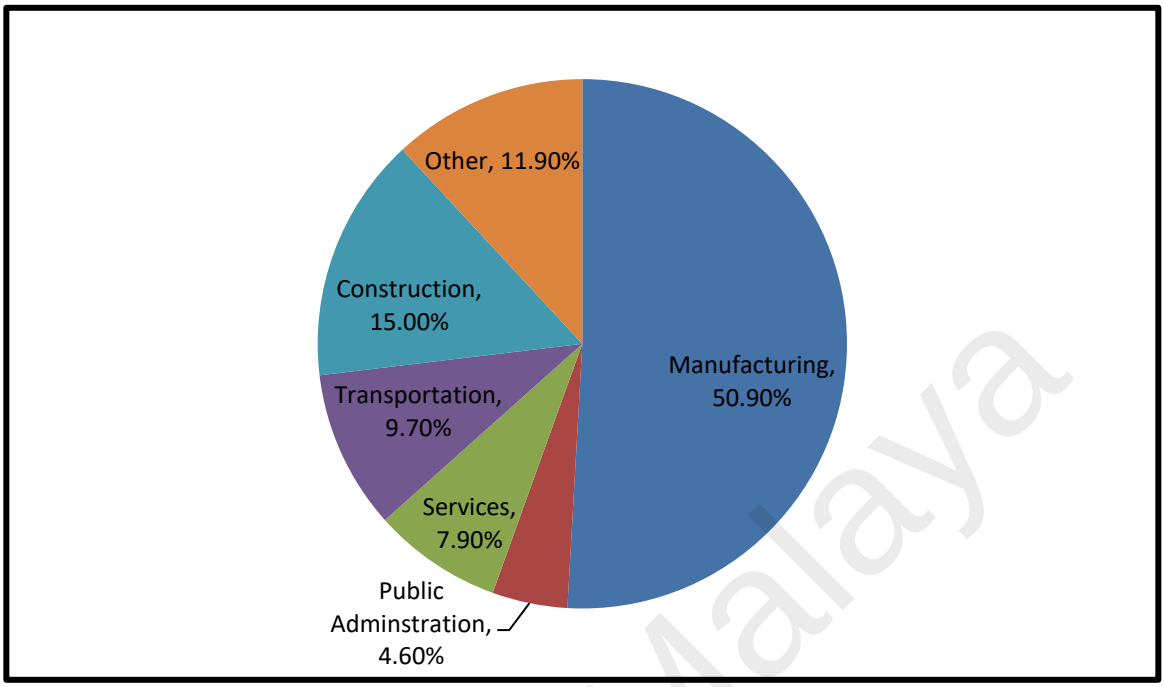

Figure 1.3: In the United States, there are incidences of noise-induced hearing loss (NIHL) in every type of employment. (Patrick, 2014)

Manufacturing faces a number of challenges, including downsizing of new materials and collaboration between engineers and biologists to expand the reach of nature and living things. The ability to develop, make, and construct anything on a large scale for the benefit of an organization is experiencing significant change, and there are increasing interconnections between machines and humans in the manufacturing sector.. Furthermore, these miniaturizing techniques, when combined with effective machine-human interaction, tend to improve both product quality and process efficiency. (Kapoor, 2016)

The industrial sector had the highest score of 50.9 percent out of 100, suggesting that 529 workers in the United States have been affected by noise-induced hearing loss. The construction business accounts for 15.0 percent, other industries for 11.9 percent, transportation for 9.7%, services for 7.9%, and government administration for 4.6 percent. (Figure 1.3). (Patrick, 2014)

1.2 PROBLEM STATEMENT

Noise is undesired, excessive sound that travels about us all the time. The noise is a source that goes down a route before being sent to the receiver. Although sound cannot be seen, it may be quantified in terms of strength and duration. The clattering sound, as well as the pressure in the ears, are indicators of intensity. Excessive sound exposure over a lengthy period of time is known as duration. Individuals may experience acute symptoms such as headaches, tiredness, and exhaustion as a result of noise. Individuals' performance may be affected by this acute impact. (Rabinowitz, et.al, 2011)

Long-term noise exposure is the most common cause of hearing loss, and the damage comes gradually. It may go unnoticed at first, but it will have a long-term effect on the individual. Due to a lack of public knowledge, people are prone to disregarding signs of hearing loss. In order to improve human hearing and communication, noise-induced hearing loss may need the usage of hearing aids. Sudden, extremely loud sounds, such as explosions or fire arms discharges, can cause noise-induced hearing loss. The eardrum can burst and the bones in the middle ear can be damaged when exposed to loud noises, resulting in noise induced hearing that can be transient or permanent. (Masilamani, 2012)

Because manufacturing principles are primarily concerned with time and quantity, they pay less consideration to the environment (Figure 1.4). Depending on the demands of the firm, time, cost, and quantity are all related considerations in production management. The company desires a shorter manufacturing time, lower costs, and high-quality output. These are the three critical dimensions that every manufacturing companies must consider. However, the organizations do not completely disregard the environment; rather, they concentrate on safeguarding resources and persons from the effects of the environment. If these methods continue, contamination will result, particularly noise exposure from industry. (Cantley, et.al, 2015)

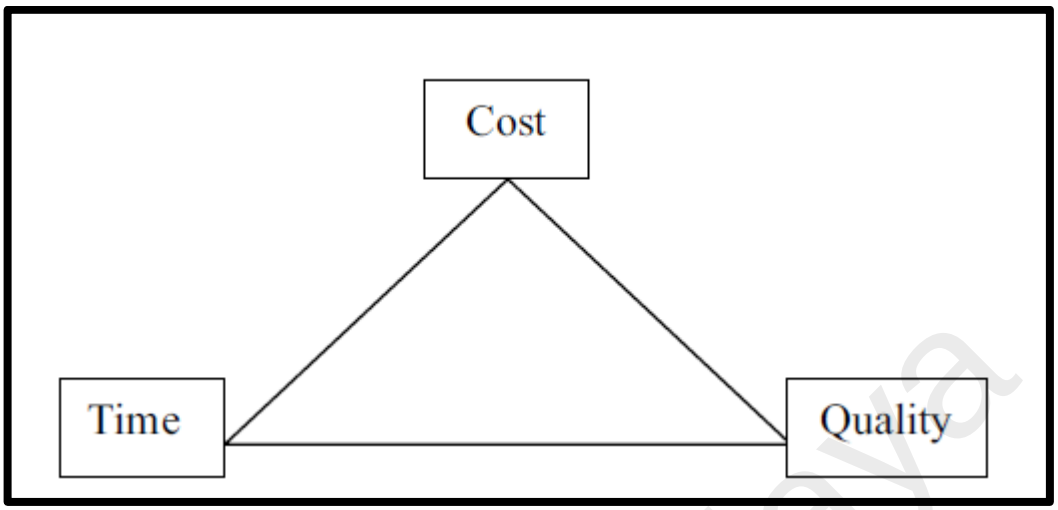

Figure 1.4 Three-dimensional manufacturing management. (Cantley, et.al, 2015)

Noise exposure is a factor in numerous situations that lead to poor safety and health. The instances demonstrate how a high degree of noise exposure causes workers to perform poorly and communicate poorly, posing a greater risk to their safety and health. One of the explanatory variables that will lead to accidents as a result of excessive exposure is noise. As a result of noise-related incidents, ambient noise will create a noisy atmosphere, resulting in occupational safety and health concerns. (Rabinowitz, et.al, 2011)

Noise is one of the most common workplace safety and health risks, and it must be kept to appropriate levels according to industry standards and regulations (William, et.al, 2012). From 2005 to 2014, the number of instances of noise-induced hearing loss increased, indicating that a higher proportion of people are affected. (See Figure 1.5.) (SOCSO 2010). The goal of occupational noise exposure study is to detect noise exposure, assess it according to regulations, and examine the impacts on workers who work in the relevant zone. (Rabinowitz, et.al, 2011)

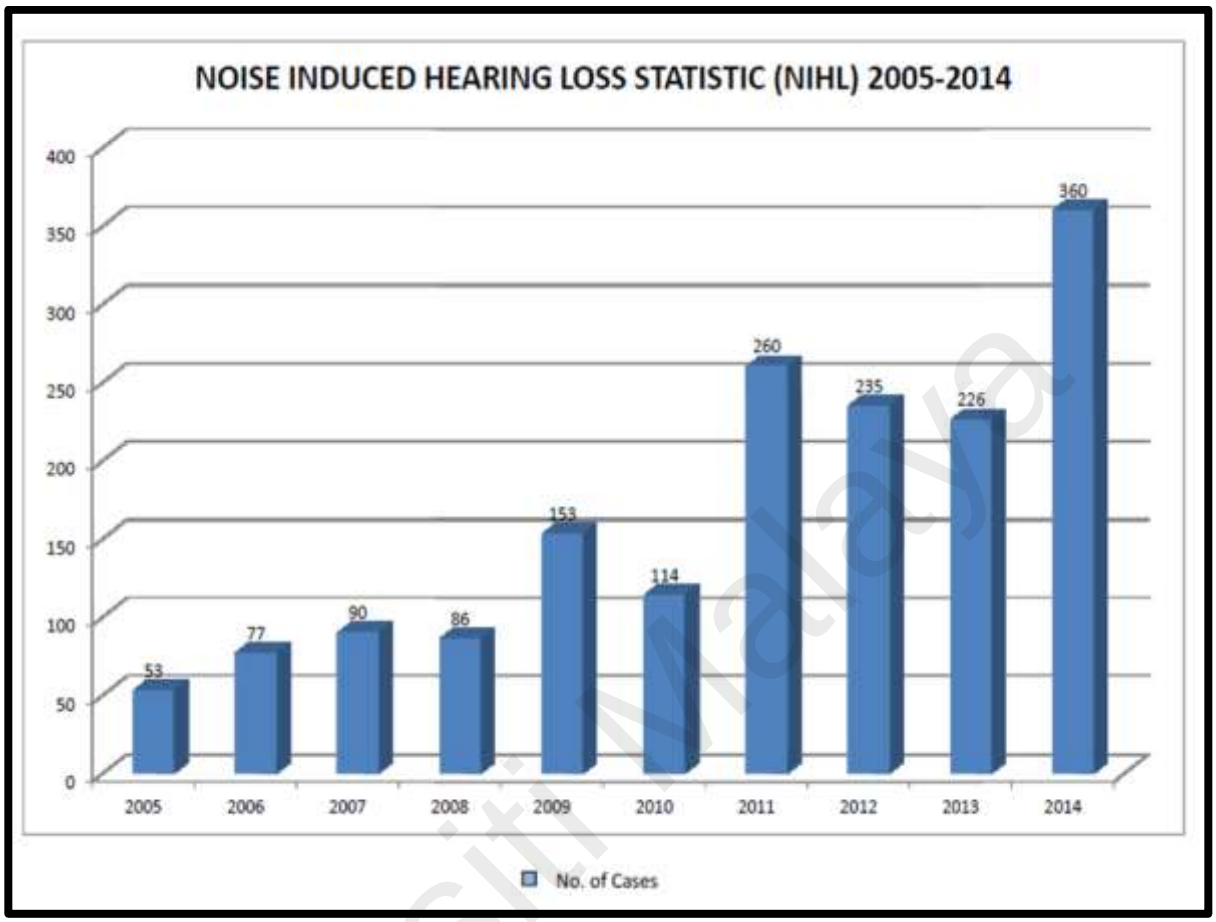

Figure 1.5: Statistics on noise-induced hearing loss (NIHL) from 2005 to 2014. (SOCSO, 2014)

According to the Social Security Organization (SOCSO), the year 2014 had the most cases, at 360. In 2005, just 53 cases were documented, making it the year with the fewest. Throughout the year, the number of occurrences climbed from 53 in 2005 to 360 in 2014. This implies that the subject of noise-induced hearing loss is understudied, based on the premise that noise exposure is excessive across a wide range of occupations. Manufacturing, construction, and other industries might be harmed. Noise exposure must be carefully regulated in the future to reduce the number of cases of noise-induced hearing loss. (SOCSO, 2014)

1.3 STUDY JUSTIFICATIONS

Noise exposure may occur anywhere and at any time, and it will inevitably damage the hearing of those who are exposed to it. Hearing loss has thus far eluded therapy, and the person will face long-term impairment as a result of the lack of treatment. In a higher proportion of hearing loss sufferers, the manipulation is impacted by the intensity and length. Increased noise levels and longer exposure durations can lead to hearing damage. To minimize this, noise exposure must be kept to a minimum. Loud noise can harm the ears physically, causing a ruptured eardrum and bone damage in the middle ear. Aside from that, loud noise might harm the mental cognitive process by creating tension and making it difficult to accomplish tasks. (Rabinowitz, et.al, 2011)

This study is being conducted with the goal of determining the degree of noise exposure in the responding region. This research is also being carried out in order to offer information on remedial action and, as a result, to adopt corrective control measures. As a result, this can help decrease the number of cases of occupational noise exposure and bring them down to acceptable levels that meet with the relevant regulatory requirements, reducing the risk and effect of noise exposure to the bare minimum. There will also be a comparison made between noise levels in 2016 and noise levels in 2019. (Cantley, et.al, 2015)

The noise exposure is a fascinating issue, with most researchers focusing their efforts on evaluating noise exposure and determining the health effects associated with it. Noise exposure must be constantly monitored and analyzed on a regular basis. This can contribute to the creation of a safer atmosphere. (Masilamani, et.al, 2012)

The Department of Labor's Office of Safety and Health (DOSH) recorded 57,639 occupational incidents in 2010, up 4% from 2009. According to the Social Security Organization (SOCSO), the economic sectors with the greatest accidents include manufacturing (31%), public services and social security (18%), commercial (17%), renting, businesses, and real estate (8%), transportation (7%), and building (7%). (7 percent). In 2014, the remaining industries accounted for around 18% of the total. (SOCSO, 2014)

Claims for industrial accidents climbed to RM1.549 billion, up 19.1% from the previous year. The Social Security Administration keeps track of all of these claims (SOCSO).

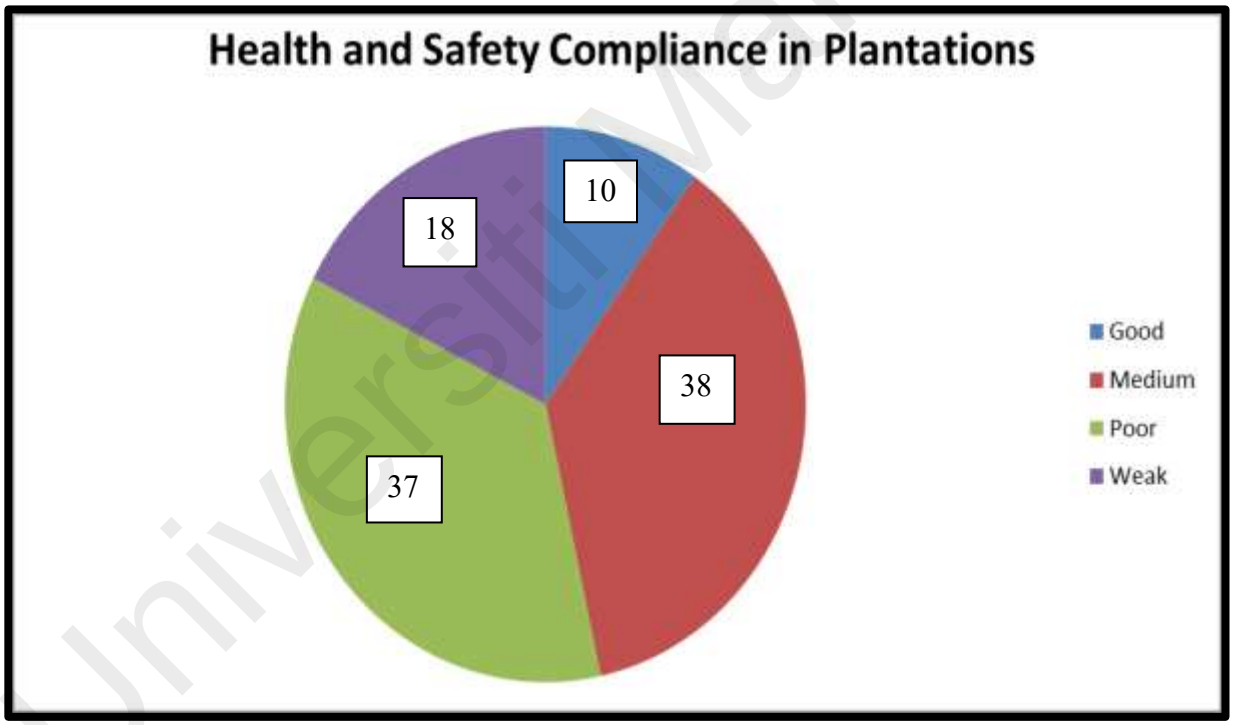

Figure 1.6: In the Johor Plantation industry, there is a high level of safety and health compliance. (DOSH, 2011)

Despite the government's numerous campaigns and initiatives, most plantation and factory employees are still unaware of their safety and health. The Department of Safety and Health

(DOSH) has not categorized most of the 103 plantations in Johor as outstanding in terms of health and safety compliance. When it comes to health and safety, noise exposure is also taken into account. Good compliance is made up of 10 plantations covering 9.7%, medium compliance is made up of 38 plantings covering 36.9%, bad compliance is made up of 37 plantations covering 35.9%, and weak compliance is made up of 18 plantations covering 17.5%... As seen in the graphs above, many plantations still do not fully comply with health and safety regulations, including noise limitations. (Figure 1.6). (DOSH, 2011)

From this statistics we can assume that plantation sector also consist of safety and health issues which has to be monitored and to comply with the regulations, assessment should be done towards the problem. This study is going to fully concentrate on the noise exposure by studying the environment noise level exposed at the respective area then comparing with the national legislations and also to find the significant changes of environment noise level to determine the future control measure. Besides that, a comparison will done to check the significant change between the years and to assess the control measures done in the past and to ensure whether it caused significant changes after implementing the control measures.

1.4 OBJECTIVES

The study's aims are to

1.4.1 To study and identify noise exposure at production area.

1.4.2 To compare the noise levels at production area with the legal requirement.

1.4.3 To compare the recent and past noise levels. (2016 and 2019)

1.5 HYPOTHESIS

1.4.1 The noise levels at production area are low.

1.4.2 The noise levels at production area with the legal requirement is within action level

1.4.3 There are no significant differences between noise levels with the line of machineries

1.4.4 There are no significant differences between recent and past noise levels. (2016 and 2019)

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Sound is the transmission of energy in the form of a pressure wave via an elastic medium. The characteristics of a pressure wave influence its pitch and intensity. The pitch of a sound is determined by its frequency, which is measured in Hertz (Hz) and is a function of cycles per second. The pressures range from 20 micro Pascals to 200 Pascals, which span several orders of magnitude. As a result, sound is measured on a logarithmic scale, and sound pressure is expressed in decibels (dB). (Scott, et.al, 2013)

There are three distinct weighting scales that may be used to quantify sound: A, B, and C. The human perception of loudness at various frequencies was used to construct these weighting systems. The human ear has the ability to perceive sounds across a wide frequency range. At high frequencies, A-weighting accentuates measurements, whereas at low frequencies, it deemphasizes hose. B-weighting is comparable to A-weighting but is less commonly employed. C-weighting is most commonly used to impulse and blast sounds, which have a fast rise and decrease in sound pressure. It may also be used as a comparison value for identifying low frequency noise when combined with A-weighting.

Noise is an unpleasant sound that is constantly present in our environment. This noise is always received from a source, and the routes via which the noise travels are located between the receiver and the source. (See Figure 2.1.) Sound is a force having actual dimensions and specific qualities, such as intensity and duration, despite the fact that we cannot see it. Intensity refers to the loudness of a sound or the pressure that goes through the ear. The intensity of a sound is generally measured in decibels. Noise can cause immediate difficulties such as communication breakdowns, decreased focus, and drowsiness, as well as interference with work performance. (Tak, et.al, 2008)

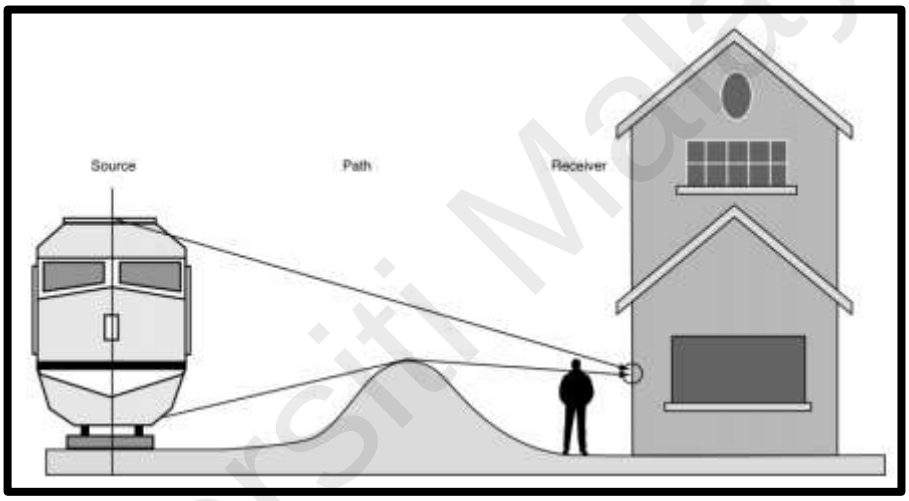

Figure 2.1: Noise travel pathway (Tak, et.al, 2008)

Malaysia's manufacturing industry employs 18.1 percent of the country's total workforce, and the country is notorious for using loud machinery to produce goods. Despite the fact that businesses are required to report any hearing loss cases to the authorities on an annual basis, occupational hearing loss instances are still rare. (Masilamani, 2012)

2.2 NOISE DEFINITIONS

When compared to the baseline audiogram, a typical threshold shift indicates an average shift of 10dB or more at frequencies of 2000, 3000, and 4000 Hz. (OSHA, 2019)

An aberrant audiogram indicates a hearing loss, hearing impairment, or a chronic standard threshold shift. (OSHA, 2019)

Excessive noise levels are defined as a daily noise exposure level of more than 82dB (A), a daily personal noise dosage of more than 50%, a maximum sound pressure level of more than 115dB (A) at any time, or a peak sound pressure level of more than 140dB. (OSHA, 2019)

The A–weighted decibel (dB (A)) is a sound pressure level measurement unit that is adjusted to the A–weighted frequency scale utilizing an electrical network with IEC standards and a reference sound pressure level of 20 micro Pascals. (OSHA, 2019)

The C–weighted decibel (dB(C)) is a sound pressure level measurement unit that is adjusted to the C–weighted frequency scale utilizing an electrical network with IEC standards and a reference sound pressure level of 20 micro Pascals. (OSHA, 2019)

The daily personal noise dose refers to an employee's cumulative noise exposure over the course of an eight-hour workday. (OSHA, 2019)

Hearing impairment is defined as a change of 25 decibels or more in an employee's permanent hearing threshold level at 500, 1000, 2000, and 3000 Hz compared to the typical audiometric reference level. (OSHA, 2019)

Noise-induced hearing loss is known as "noise-induced hearing loss." (OSHA, 2019)

The corresponding continuous sound pressure level for an eight-hour working day is described as the "daily noise exposure level." (OSHA, 2019)

The peak sound pressure level is the maximum C–weighted instantaneous sound pressure level of any collision. (OSHA, 2019)

The sound pressure level is represented in decibels and is calculated as twenty times the common logarithm of the ratio of a sound pressure to a reference sound pressure of 20 micro Pascals. (OSHA, 2019)

Noise exposure refers to the amount of sound pressure that a person's unprotected ear is exposed to. (OSHA, 2019)

A personal hearing protector is a gadget that protects a person's hearing from damaging acoustic disturbances. (OSHA, 2019)

The Worldwide Electro technical Commission is a non-profit organization that creates and publishes international standards for electrical, electronic, and related technologies. (OSHA, 2019)

Ambient noise is a term that refers to all of the noise in a given environment, which is often a composite of sound levels from a range of close and remote sources. (FMA, 1967)

A sound level measured using an instrument linked to an electrical network that fulfils the International Electro technical Commission's requirements is referred to as an A-weighted sound level (IEC). (FMA, 1967)

Continuous noise is defined as noise with only minor variations in sound level during the observation time. (FMA, 1967)

Someone who works in a factory for the occupier or for someone who hires the occupier to do all or part of the work that the occupier undertakes in the course of and for the purpose of the occupier's trade or business is referred to as an employee. Employee exposure refers to the noise levels measured using noise measuring equipment at a position that most nearly resembles the noise levels at the employee's head position during normal operation. (FMA, 1967)

Engineering control refers to lowering the noise level reaching an employee's eardrums by reducing the amount of noise conveyed to the employee's eardrums or the amount of noise created, but does not include employing hearing protection equipment to reduce the noise level. (FMA, 1967)

The comparable continuous sound level is the level at which an employee would get a given daily noise dose if exposed to it constantly for an 8-hour workday. (FMA, 1967)

The difference in decibels between an ear's audibility threshold and the conventional audiometric reference level is referred to as the hearing threshold level. Hertz is a frequency measuring unit that is equal to cycles per second in numerical terms. The phrase "impulsive noise" refers to a sudden shift in sound intensity that lasts longer than a second. (FMA, 1967)

A noise dosimeter is a device that directly indicates a daily noise dosage by combining a function of sound pressure with time. The volume of sound generated is referred to as "noise level." Noise measuring equipment might include a sound level meter or a noise dosimeter. The absence of sound levels more than 80 dB is referred to as quiet (A). A sound level meter is a device that measures the amount of sound in a given space. (FMA, 1967)

2.3 NOISE RELATED LEGISLATION

According to Section 17(1) of the Occupational Safety and Health Act of 1994, every employer and self-employed person is practicably accountable for ensuring that none of them poses a risk to their safety or health in any way. (OSHA, 1994)

According to Section 17(2) of the Occupational Safety and Health Act of 1994, employers and self-employed people are legally obligated to provide prescribed information in any prescribed manner and under any prescribed circumstances if their safety or health is at risk. (OSHA, 1994)

Every employer must determine whether his employee may be subjected to excessive noise at work in the manner permitted by the Director General under Regulation 3 of the Occupational Safety and Health (Noise Exposure) 2019 Act. If the machinery, equipment, process, work, control measures, or operation at the workplace change, the employer must determine whether his employee is exposed to excessive noise in the workplace under sub regulation (1) within one year of the previous determination or if the Director General directs them to do so. Any employer that breaks the aforementioned sub rule faces a fine of up to ten thousand ringgit, a year in prison, or both.. (OSHA, 2019)

Regulation 4 of the Occupational Safety and Health (Noise Exposure) 2019 requires an employer to hire a noise risk assessor if the employer believes that any of his workers may be exposed to excessive noise based on the identification made under sub regulation 3(1). (OSHA, 2019)

The noise risk assessor chosen by the employer subject to sub regulation (1) must be registered with the Director General in the manner prescribed by the Director General and possess a valid certificate to perform noise risk assessments issued by the Director General. The noise risk assessor shall use noise measuring equipment that satisfies the International Electro technical Commission's standard to conduct the noise risk assessment referred to in sub regulation (1). (OSHA, 2019)

The noise risk assessor shall produce a report and submit it to the employer within one month of the completion of the noise risk assessment stated in sub regulation (1). The noise risk assessor's findings and recommendations in regard to the noise risk assessment must be included in the report referred to in sub regulation (4). The employer shall inform the employee who is exposed to excessive noise of the findings and suggestions provided under sub regulation (4) within fourteen days of receiving the noise risk assessor's report (5). If the noise risk assessor's assessment includes recommendations for any action that must be done under these Regulations, the employer must follow those recommendations within thirty days of receiving the report. (OSHA, 2019)

If the Director General requires so, the employer shall have the noise risk assessment referred to in sub regulation (1) reviewed within five years after the last noise risk assessment. Any person who breaches sub regulations (1), (2), (3), (4), (5), (6), (7), or (8) of Regulation 4 commits an offence and faces a fine of not more than ten thousand ringgit, or a year in jail, or both.. (OSHA, 2019)

Based on the report referred to in sub regulation 4(4), an employer shall provide adequate information relating to the effects of noise exposure on a person's hearing and the requirements under Occupational Safety and Health (Noise Exposure) 2019 Regulation 5 information, instruction, training, and supervision to any of his employees who appear to be exposed to excessive noise. Sub regulation (2) said that an employer must provide

training to the employee referred to in sub regulation at least once a year (1). Any employer who breaches sub regulation (1) or (2) commits an offence and faces a fine of up to ten thousand ringgit or a year in prison, or both. (OSHA, 2019)

Every employer must ensure that none of his employees are exposed to a daily noise exposure level exceeding 85dB (A) or a daily personal noise dose exceeding 100%, a maximum sound pressure level exceeding 115dB (A) at any time, or a peak sound pressure level exceeding 140dB under the Occupational Safety and Health (Noise Exposure) 2019 Regulation 6 noise exposure limit (C). (OSHA, 2019)

If it seems to an employer, based on the report referred to in sub regulation 4(4), that any of his workers is subjected to excessive noise above the limit set out in sub regulation (1), the employer shall take such actions as are necessary to reduce the excessive noise. Before taking the actions specified in sub regulation (2), the employer must assess whether it is possible to reduce excessive noise by engineering or administrative restrictions, according to sub regulation (3). (OSHA, 2019)

After completing the evaluation required by sub regulation (3), if the employer decides that it is possible to minimize such excessive noise by engineering control, the employer shall do so. The employer is not required to eliminate such excessive noise by engineering control if it is not feasible to do so. It is not practicable to minimize such excessive noise only via engineering and administrative control; nevertheless, such excessive noise can be reduced through engineering and administrative management. If engineering control combined with administrative control is not possible, the employer must rely only on administrative management to reduce excessive noise. If administrative control is not possible, the employer must adopt additional effective noise-reduction measures, such as the use of a personal hearing protection. (OSHA, 2019)

The employer shall prepare a report on the evaluation and provide a copy to the Director General within thirty days of receiving a written request from the Director General. When

an employer employs engineering control to minimize excessive noise, as stated in paragraphs (4) (a) and (b), the employer must keep the engineering control in good working order. Any employer who breaches regulation 6 sub regulations (1), (2), (3), (4), (5), or (6) commits an offence and faces a fine of up to ten thousand ringgit or a year in prison, or both. (OSHA, 2019)

Under Occupational Safety and Health (Noise Exposure) 2019 Regulation 7, if an employer provides a personal hearing protector to an employee to reduce excessive noise, the employer must ensure that the personal hearing protector is suitable and efficient, is properly inspected, maintained, and made available at all times, and will reasonably attenuate the employee's person. (OSHA, 2019)

Any employer who violates sub regulation (1) commits an offence and is subject to a fine of not more than ten thousand ringgit, or to imprisonment for not more than one year, or to both. (OSHA, 2019)

Any location at the workplace where a person is exposed to excessive noise above the limit stated in paragraph 6(1) (a), (b), or (c) shall be marked with the words "HEARING PROTECTION ZONE" or in such other manner as the Director General determines and as far as feasible.. (OSHA, 2019)

Sub regulation 2 states that in any hearing protection zone, an employer shall supply a personal hearing protector and guarantee that every employee or other person in the hearing protection zone utilizes the personal hearing protector given under paragraph (a). Any employer who violates sub regulation (1) or (2) is guilty of a criminal offence punishable by a fine of up to ten thousand ringgit, a year in prison, or both. (OSHA, 2019)

If a noise risk assessment report referred to in sub regulation 4(4) reveals that any employee is subjected to excessive noise exceeding the limits set out in paragraph 6(1) (a), (b), or (c), the employer must conduct audiometric testing on that employee on an annual basis in

accordance with Occupational Safety and Health (Noise Exposure) 2019 Regulation 9 audiometric testing. To carry out the audiometric testing required by sub regulation, the employer must select an audiometric testing center approved by the Director General (1) Based on the audiometric testing done on the employee, the audiometric testing center should pick an occupational health doctor to analyses the employee's audiogramme. If an occupational health doctor discovers that an employee's audiogram is abnormal, that employee must have a medical examination... (OSHA, 2019)

In order to identify or rule out any occupational or non-occupational hearing issue, the medical examination referred to in sub regulation (4) should comprise a medical history taking, physical examination, and other required tests. When an occupational health doctor analyses an employee under sub regulation (4) and finds an occupational noise-induced hearing loss, hearing impairment, or permanent standard threshold shift, the occupational health doctor shall inform the Director General within seven days. Within thirty days after the date of the audiometric testing, the audiometric testing center shall provide the employer with a report on the audiometric testing. The employer shall tell the employee of the findings of the audiometric testing within twenty-one days of receiving the report required by sub regulation (7). (OSHA, 2019)

If the results of the audiometric testing show that any employee has a temporary standard threshold shift, the employer must have the employee retested by an audiometric testing center within three months of the previous audiometric testing and take such steps to protect the employee's hearing from further deterioration. If the audiometric testing report indicates that any employee has an occupational noise-induced hearing loss, hearing impairment, or permanent standard threshold shift, the employer must notify the Director of the Department of Occupational Safety and Health's nearest office within seven days of receiving the report. If no personal hearing protector has been supplied to such employee previously, supply a personal hearing protector to such employee and teach such employee on how to use the personal hearing protector under sub regulation (7). Any person who

violates sub regulations (1), (2), (3), (4), (6), (7), (8), (9) or (10) of regulation 9 commits an offence and is subject to a fine of not more than ten thousand ringgit or a period of imprisonment of not more than one year, or both. A medical practitioner who is registered with the Director General to undertake medical surveillance programs of employees is referred to as an "occupational health doctor" for the purposes of this regulation. (OSHA, 2019)

When audiometric testing is performed, the employer must ensure that it is done at no cost to the employee and that it is done within three months of the employee starting work in any area of the workplace that is exposed to noise exceeding the noise standard, according to Occupational Safety and Health (Noise Exposure) 2019 Regulation 10. (OSHA, 2019)

According to Occupational Safety and Health (Noise Exposure) 2019 Regulation 11, an employer must keep and maintain a record that includes the following: the report of the noise risk assessment referred to in sub regulation 4(4) for a period of not less than thirty years, and the report of his employee's audiometric testing referred to in sub regulation 9(7) for as long as the employment (OSHA, 2019)

When an employer ceases to carry on business and another person takes over, the employer must give over all records referred to in paragraphs (1)(a) and (b), and the other person must retain and maintain such documents for the periods indicated in paragraphs (1)(a) and (b), respectively. When the periods referred to in paragraphs (1) (a) and (b) have expired, the employer must provide the Director General at least three months' written notice of his intention to dispose of the records. Any employer who violates sub regulations (1), (2), or (3) of regulation 11 commits an offence and is subject to a fine of not more than ten thousand ringgit or a period of imprisonment of not more than one year, or both. (OSHA, 2019)

The Permissible Exposure Limit specified in the Factories and Machinery Act 1967 (Noise Exposure) Part 2 of Regulation 1989 that no personnel should be exposed to continuous sound levels above 90 dB (A) or noise levels above 115 dB (A) at any time. (FMA, 1989)

The application said that the Factories and Machinery Act 1967 (Noise Exposure) Part 3 of Regulation 1989 is mandatory for workplace excessive noise level exposure that affects people in any vocation. (FMA, 1989)

Part 4 of Regulation 15 under Methods Compliance of the Factories and Machinery Act 1967 (Noise Exposure) Regulation 1989 states that the occupier shall limit and maintain the noise level exposure by any reasonable control. Part 5 of Regulation 26 under Hearing Protection Devices of the Factories and Machinery Act 1967 (Noise Exposure) Regulation 1989 stated that the occupier is not required to pay for the employee's hearing protection device. Employees are obliged to use hearing protection devices that are comfortable, consistent with occupational requirements, and do not endanger their health. (FMA, 1989)

Part 7 of Regulation 27 under Employee information and training of the Factories and Machinery Act 1967 (Noise Exposure) Regulation 1989 said that the occupier shall establish training programs and ensure that all personnel exposed to noise participate in them. The noise effects, the purpose of hearing protection devices, the advantages and drawbacks of hearing protection devices, the goal of audiometric testing, and the explanation of test processes are all things that must be communicated. Every two years, these training programs will be repeated. (FMA, 1989)

Part 8 of Regulation 28 under Warning Signs of the Factories and Machinery Act 1967 (Noise Exposure) Regulation 1989 specified that warning signs must be posted at the entry and in exposed areas. The warning signs must be plainly visible, and hearing protection must be used. (FMA, 1989)

Part 9 of Regulation 29 under Exposure Monitoring Records of the Factories and Machinery Act 1967 (Noise Exposure) Regulation 1989 stated that the occupier should keep all exposure monitoring records, which should include the name of the employee and the daily noise dose, the location, date and time of measurement, and the noise level obtained, as well as the type, model, and date of construction. These records must be kept for the duration of the employee's employment. Part 10 of Regulation 34 under Penalty of the Factories and Machinery Act 1967 (Noise Exposure) Regulation 1989 states that anybody who violates any regulation's provision is guilty and will be fined not more than one thousand Ringgit. (FMA, 1989)

Section 23 of the Environmental Quality Act of 1974 states that no individual should be subjected to noise that exceeds the permissible level of volume, quality, or intensity as defined in Section 21. (EQA, 1974)

2.4 RELEVANT STUDIES

Relatively, noise-induced hearing loss is a rare occurrence within the occupational scope – about 7% in the industrialized countries and higher in the developing countries - 21%. Based on the studies shown, it can be seen that most cases of hearing loss is caused by age

factor. Gender wise, studies also record those men loses their hearing much frequent as compared to women. Other factors also include socioeconomic position, hereditary, and ethnicity. (Healthy Working Lives 2020)Hearing loss is also shown to be induced by a person's lifestyle habit such as smoking and present health conditions such as high blood pressure, and diabetes. On another note, occupational hearing loss can be caused by vibrations and chemical substances. The production of loud noise from the use of firearms for instance, is also contributory to this percentage. In short, Noise-Induced Hearing Loss (NIHL) are at high risks among occupational groups that involve the military, construction workers, agriculture as well as other forms of tasks that exposes workers to loud, frequent noises with extreme vibrations. (Healthy Working Lives 2020).

As previously mentioned however, NIHL is a relatively lower occurrence compared to other occupational risks. This is probably contributory by the appropriate measures taken to reduce the noise exposure at occupational site. This starts with the employer's obligation to ensure that his/her employees' health and safety is well maintained. This involves knowing what steps may be made to mitigate current hazards as well as what risks in the workplace cannot be avoided. Gaman and Gheorghe (Gaman and Gheorghe, 2014) Furthermore, it is the employer's obligation to devise alternatives to mitigate current unavoidable hazards and tailor the work environment to each individual. This of course, includes the adaptation to technical progress to innovative technological support. Moving on, it is the employer's responsibility to replace present dangerous elements in the work site with a less hazardous element. Most importantly, the employer should communicate importance of safety measures as well as present risks in the work site to ensure workers understand and are conscious about their surroundings. (Chang et al. 2003; Gaman and Gheorghe 2014) Additionally, this measure also extends by being informed of the global policy of NIHL prevention in terms of technology, organization of work, working conditions, and social relationships.

These prevention steps are necessary to ensure that the rate of NIHL is kept to a bare minimum. However, it is also important to note that constant occupational exposure to loud

noise may affect workers' blood pressure. For context, noise has proven to result in adverse effects on human physiology. (Chang et al. 2003) This indirectly causes hypertension which is contributory to various cardiovascular disorders. Systolic blood pressure has substantial links with age and work relationships, as demonstrated by Pearson's correlation. Pearson's idea, however, was found to be less likely to be accurate in a research involving employees in their 30s who were subjected to mean noise levels well beyond the average level. Chang and his colleagues (Chang et al., 2003) although minor, blood pressure, heart rate, and noise level were all important in the study. As a result, long-term occupational noise exposure has no substantial impacts.

Masilamani, et.al, (2012) Noise-Induced Hearing Loss and Related Factors among Malaysian Vector Control Workers were investigated. The objective of this study was to confirm that persons over the age of 40, those who have worked in the sector for more than 10 years, those who use guns, and those who listen to loud music are at a higher risk of noise-induced hearing loss. The vector control employees group had an odds ratio of 3.45, which spans a 95 percent confidence interval, according to the data.

Mctague et al. investigated the impact of daily noise exposure monitoring on occupational noise exposure in industrial workers (2013). The daily exposure has decreased by 6%, indicating that they are now inside the 85 decibel OSHA action level. Aside from that, daily exposure has decreased by 2%, bringing it down to 90 dB.The study's findings indicate that workers are exposed to less radiation as a result of more practical monitoring by volunteers. Noraidi investigated the effectiveness of occupational noise management in Malaysia (2013). The study's goal was to assess and contrast young people's knowledge and attitudes concerning noise at work in two countries. The two countries in question are Australia and Malaysia. Young adults' attitudes were compared to employees' attitudes. The data show that young Malaysian adults are less worried than their Australian counterparts about wearing hearing protection. The goal of this study is to highlight the need of implementing occupational hearing loss programs in Malaysia in order to enhance workers' attitudes and knowledge.

Scott and colleagues looked at noise exposure reconstruction and trend analysis in two big automobile factories (2013). At one plant, the number of workers exposed to noise levels above 90 dB decreased by 41% between 1970 and 1998.Between 1970 and 1999, the number of workers at the other facility decreased by 31%. This demonstrates the long-term effectiveness of hearing conservation initiatives.

Shuai et al. (2013) conducted study on The Effects of Occupational Noise Exposure on Hypertension and Cardiovascular Disease in Workers at a Chongqing Automobile Manufacturing Company. Noisy and non-noisy participants were divided into two groups. Noise levels of 90 dBA or higher were used in the noisy group, whereas noise levels of 70 dBA or lower were used in the non-noisy group. The research took done in Chongqing, China, between 2011 and 2012, for roughly a year. A link was identified between occupational noise, hypertension, and hearing loss in the study. However, no conclusive relationship between occupational noise and electrocardiography has been discovered.

Choi, et al. investigated Noise-Induced Hearing Loss in Korean Workers: Co-Exposure to Organic Solvents and Heavy Metals in National Industries (2014). In the corresponding employees, the pure-tone average increase was 1.64 times higher, and occupational noise exposure was 2.15 times higher. This demonstrates that many people are exposed to high levels of radiation. Heavy metals and organic solvents can induce hearing loss and increase occupational noise exposure, according to one study.

Hui-Nee investigated the safety culture in Malaysian workplaces through an analysis of occupational accidents (2014). According to the Department of Occupational Safety and Health (DOSH), roughly 37 percent of fatal injuries occur in the construction business, whereas 22 percent occur in the manufacturing industry. Hearing loss and back pain account for 34% of occupational diseases.

Occupational illnesses are caused by 4% of chemical agents. In the year 2011, 176 out of 2429 cases (about 7% of all cases) resulted in death. . The study's goal is to reveal a lack of a safety culture as well as non-compliance with applicable acts and legislation. Malaysia's main objective is to halve the incidence of fatal car accidents by 2015.

According to a research published in the journal Effects of Occupational Noise Exposure on Hearing Loss by Smith, (2014), 60 percent of people use ear protection when working in a noisy environment, and 97 percent feel that wearing ear protection is important. The study's conclusion is that there is an intriguing dynamic improvement in using ear protection rather than merely claiming that it is essential by looking at perceived importance vs acting on it by utilizing protection.

Cantley, et.al, (2015) researched on Ambient Noise Exposure, Hearing Acuity, and the Risk of Acute Occupational Injury Exposure levels more than 82 dBA are more likely to cause monotonic and substantial exposure. Higher risk predicts more catastrophic injury patterns. The pattern of damage is linked to hearing loss. Although there was no significant predictor of risk that increased with hearing loss, the objective was to compare workers with and without hearing loss to the risk of harm.

Gyamfi, et al. (2015) conducted a cross-sectional study on the noise exposure and hearing capabilities of quarry workers in Ghana, and found that the majority of the equipment create noise levels that above the threshold limit. 176 research participants were subjected to moderate exposure, which is 41 dBA to 55 dBA, and 2% to severe exposure, which is 71 dBA to 90 dBA, which was selected as the threshold.
The onset of hearing loss is linked to age, length of employment, and non-independent usage of earplugs. Excessive noise exposure causes hearing loss in quarry employees, according to the findings, and there are several variables that contribute to this.

CHAPTER 3

METHODOLOGY

3.1 STUDY DESIGN

This investigation was conducted using a cross-sectional study design. The incidence and distribution of health events in a work population are described in this cross-sectional research. Cross-sectional research is useful for developing ideas regarding the etiology of occupational diseases, such as noise exposure. It may also be used to start and assess successful health-care programs. Because it is used to measure at a single moment in time, this study design is the most often utilized method for researchers. (Perk, et.al, 2011)

This cross-sectional study's strength is that it is rapid, inexpensive, and practical. It also enables the investigation of a variety of illnesses or exposures. The benefit of a cross-sectional research is that it can assist in predicting the status of the working population. It can also assist in health planning and prioritizing health issues such as occupational noise exposure issues. (Perk, et.al, 2011)

3.2 STUDY LOCATION

A Kernel Crushing Plant on Carey Island, Selangor Darul Ehsan, was chosen as the research location as shown in Figure 3.1 below.

Figure 3.1: Carey Island Satellite Map Location of Kernel Crushing Plant (Jayasankaran, 1995)

3.3 STUDY VARIABLES

3.3.1 Dependent Variables

i) Level of Noise

3.3.2 Independent Variables

i) Line of Machineries

3.4 STUDY INSTRUMENT

Sound Level Meter and Calibrator were used to measure noise exposure while checklists were also important instruments for not missing out any task.

Figure 3.2: A sound level meter is used to determine the amount of noise exposure.

3.5 SAMPLING DATA COLLECTION

A comparison of noise assessment data collecting using a comparative study.

3.5.1 STUDY SAMPLE

3.5.1.1 Noise Monitoring

There were many working areas at Kernel Crushing Plant such as maintenance workshop, warehouse, electrical workshop, production, logistic, quality control lab and others. The noise monitoring sample area was selected using purposive sampling technique where the production area was selected because there were machineries that produce noise at the production area. (Thompson, 2012).

3.5.2 SAMPLING METHOD

3.5.2.1 Noise Monitoring

The noise level in the region was measured using a sound level meter. The calibrated sound level meter was placed at a height of 1.2 meters above the ground and measured for 5 minutes each spot. There were also noise level measurement of noise 1 meter away from machine that were marked using a measuring tape at its layout and also on the floor plan. There were total of 8 target point around one line of machineries and total target points around 4 lines were 32 target points. Then the data were retrieved to obtain the results and analyzed. The results were then compared with the respective national legislation.

3.6 CHECKLIST

3.6.1 INVESTIGATION DETAILS OFFICER CHECKLIST 1

Contact the complaint before performing a noise assessment to obtain the essential information needed to begin an inquiry.

No	CHECKLIST	
1	Work activities	
2	Layout of workplace (Machinery/Operation)	
3	Requirement of man power in industrial activity	
4	Profiling of equipment/ machinery/ transportation/ tools used in workplace	
5	Legal requirement/ legal register	
6	Flowchart/ sop of work process	
7	HIRARC reports/ JHA/ HAZOP report	
8	Audit reports on work process compliancy	
9	Sop for handling machinery	
10	Inspection of machine and safety equipment	
11	Review of installation safety device or control system or machinery used in industry or workplace	
12	Previous employer noise sampling data.	
13	Complaint documents regarding noise issues.	
14	Departments/areas where noise may be an issue.	
15	Training records for hearing conservation program.	
16	Photos of the responding area	
17	Measure distance from worker to the primary noise Source.	

OFFICER CHECKLIST 2 – NOISE ASSESSMENT EQUIPMENT CHECKLIST

No	CHECKLIST	
1	Sound Level Meter	
2	Protective case for Sound Level Meter	
3	Sound Level Meter battery life/charged	
4	Wind Shield	
5	Tripod	
6	Calibrators	
7	Memory card for Sound Level Meter	
8	Camera	
9	Laptop/Notebook	
10	Paper/Record Sheet/Pen	
11	CD (Data Transfer)	
12	Measuring Tape	
13	Paper Tape	
14	Personal Protective Equipment	
15	Extra Batteries	

OFFICER CHECKLIST 3 – STUDY INSTRUMENT

No	SOUND LEVEL METER	
1	**An overview of the monitoring system** • Follow-up sampling anytime exposure varies (enough to determine continued compliance) • Notify impacted personnel so they may watch noise monitoring if desired • Sampling must reflect a "whole shift" to analyses each worker's exposure.	
2	**Provisions and tools** • Slow response on the “a” scale (SLM) • Calibrator (if available) • Calibrator (if available) • Fresh batteries, insert and verify "battery acceptable" • Documentation form (s)	
3	**SLM should be calibrated before use (if calibrator available)** • Calibrate and record pre-calibration • Do not use if SLM does not pre-calibrate.	
4	**Choose the employee who will be sampled.** • Explain what you're doing and why you're doing it; answer any questions they might have • Explain what you're doing and why you're doing it; answer any questions they might have. • Remind them to carry out their usual responsibilities.	

5	**Begin sampling** • Keep SLM away from body and direct microphone straight up • Keep SLM as close to worker's ear as possible • Make sure no one is standing between noise source and SLM Level will fluctuate; note greatest levels achieved	
6	**Periodically check noise level throughout sampling period** • Check noise levels once every hour, if feasible • Ask worker whether regular work shifts, unexpected noise, etc. are present during the sample time. Make a note of the noise level.	
7	**Routine documentation** • Noise sources • Hearing protection • Environmental conditions • Time and SLM level (temperature, etc.) • Evidence of a typical working day (number of loads dumped, number of bags filled, tonnage processed, etc.)	
8	**End sampling** • Inform workers that the sample is over.	
9	**Post-calibrate SLM** • Calibrate and record post-calibration • Sampling is invalid if SLM does not post-calibrate.	

OFFICER CHECKLIST 4 – NOISE ASSESSMENT PROCEDURE

No	**SOUND LEVEL METER**	
1	Choose a period when the source noise is typical of the activity's greatest level of noise.	
2	Check the following SLM settings: i. 'Fast' time weighting ii. 'A' frequency weighting iii. SLM audio recording - this can be used to supplement evidence. iv. Microphone frontal incidence	
3	Before and after each set of noise measurements, calibrate the noise monitoring equipment.	
4	Mount the SLM to the tripod.	
5	Ascertain that the measurement is taken without the presence of source noise.	
6	For a minimum of 8 hours, measure constantly.	
7	Take pictures of the noise measurement sites in the background and at the source.	
8	Data which is saved.	
9	Re-calibrate the SLM if necessary. The findings obtained will not be valid if the variation from the initial calibration is higher than 1 dB(A), and the evaluation will have to be redone.	

Checklist adopted from www.ehp.qld.gov.au and www.mine-safety.mtu.edu

3.7 DATA ANALYSIS

The data was analyzed using the Statistical Package for the Social Sciences (SPSS) Version 23.0. The primary purpose of this software is to evaluate data from this study in order to guarantee that hypothesis testing is carried out.

CHAPTER 4

RESULTS & DISCUSSION

4.1 NOISE LEVELS AT PRODUCTION AREA

There were total of 4 lines of press machines and each line has different numbers of machine. The total numbers of machines present at production area were 72 machines but only 57 machines were running while 15 machines were not in service. The types of machines at all lines were press machines and the number of machines in each line varies the results of the noise level exposed. Line 1 was called First Press A comprised of 19 machines but only 16 machines running. The minimum noise level exposed from line 1 was 87.30dB, maximum level exposure was 88.10dB. The mean noise level exposed at line 1 was 87.64dB with standard deviation of 0.23. Line 2 was called First Press B comprised of 19 machines but only 14 machines were running. The minimum noise level exposed from line 2 was 86.40dB, maximum level exposure was 88.30dB. The mean noise level exposed at line 2 was 87.54dB with standard deviation of 0.56.

Line 3 was called Second Press A comprised of 17 machines but only 15 machines running. The minimum noise level exposed from line 3 was 87.40dB, maximum level exposure was 88.70dB. The mean noise level exposed at line 1 was 88.11dB with standard deviation of 0.48. Line 4 was called Second Press B comprised of 17 machines but only 12 machines running. The minimum noise level exposed from line 4 was 87.10dB, maximum level

exposure was 88.70dB. The mean noise level exposed at line 4 was 88.01dB with standard deviation of 0.72.

The total minimum noise level exposed from all four lines was 86.40 dB, total maximum level exposure was 88.70 dB and the total mean of all four line of press machine was 87.83 dB with total standard deviation of 0.56. According to the results obtained, the highest mean reading was 88.11 dB which is from line 3 where there were 2 machines only not in service with 15 machines running and the lowest mean reading was 87.54 dB which is from line 2 where there were 5 machines not in service with 14 machines running and this can be assumed that the noise exposure exposed to the maximum level due to the noise causing press machines which release noise energy through the process of crushing palm kernel.

Second Press machines which consists of line 3 and line 4 has lesser machines running but produced more noise exposure compared to first press machines of line 1 and line 2. This can be assumed that the number of machines will not determine the generation of noise. Basically the mindset of a human is the higher the number machine, the higher the noise level released. However, there were more machines which are not in service in both line 1 and line 2. This can be one of the main reasons why line 3 and line 4 has higher mean noise level exposed. The number of machines running and not running will determine the generation of noise so it is important to monitor not running machines as well and have even number of machines to generate even noise rather than one line high noise while the other lines lesser noise. (Gyamfi, et.al, 2015).

The main source of noise is expected from machines. The noise that releases from machines is very extensive and by analytical methods, can be measured and analyzed. The noise is basically the product of the machine operation and the physical parts can generate different types of noise. Usually the vibration of machine parts will generate the noise as the press machines has turbine gearbox which has slow speed rotor that spreads the vibration to the surrounding with certain frequency. These sound produced form the machines are within a certain frequency of range but clearly audible to human beings surrounded. This can be converted into excessive sound when there are too many machines

generating sound at the same single point of time and this will eventually be a major noise problem that interfaces the environment. (Marcel, et.al, 2012)

Table 4.1: Noise Levels at Production Area

Line	Noise Level (dB)		
	Min	**Max**	**Mean ± SD**
1	87.30	88.10	87.64 ± 0.23
2	86.40	88.30	87.54 ± 0.56
3	87.40	88.70	88.11 ± 0.48
4	87.10	88.70	88.01 ± 0.72
Total	86.40	88.70	87.83 ± 0.56

4.2 COMPARISON OF NOISE LEVEL AT PRODUCTION AREA WITH LEGAL REQUIREMENT

The results show all four line of press machines at production were above action level. When compare to the national legislation, the noise exposure level should not exceed 82dB (A). (OSHA, 2019) Thus, when compared we can assume that the production area still does not comply with the national legislative (Noise Exposure Regulation 2019). To comply with national legislation, there must be no machines that produce noise or either no worker should be exposed to the environment. These ideas cannot be taken into action because interaction of machines and humans are important for production, however, the management is mainly concern on productivity than safety and health compliance. (Cantley, et.al, 2015).

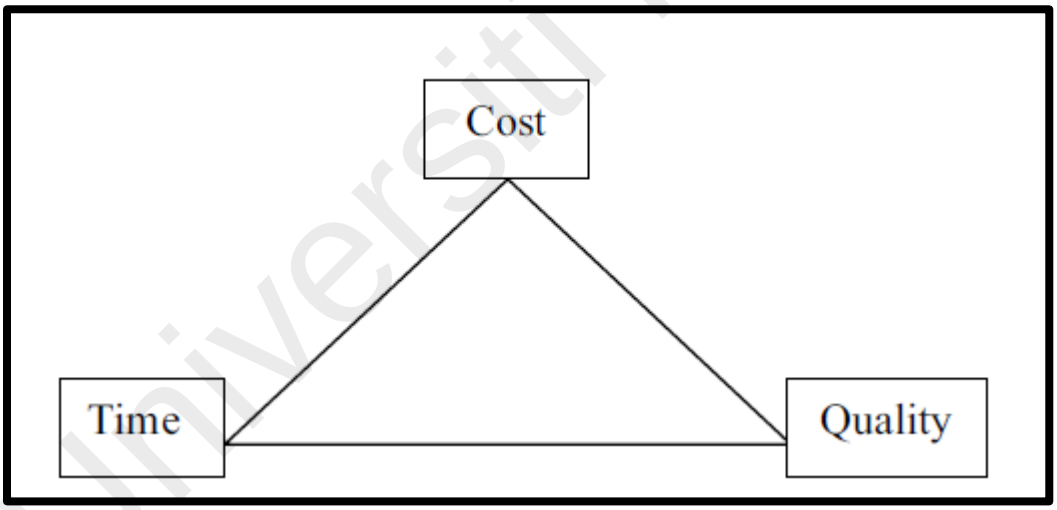

Figure 4.1: .Three-dimensional manufacturing management. (Cantley, et.al, 2015).

Based on Cantley, 2015 research, most of the management considers less on safety compliance because they are more concern on time, cost as well as. This is because these aspects will deliver profit to the management while safety aspects will incur cost that must be bared by the management time, cost, and quality are all linked concerns in manufacturing management, depending on the demands of the company. The management has a target of extracting 500 tons of crude palm kernel oil (CPKO) per day. To achieve this target, the management needs to have at least 57 press machines running and minimum nine workers maintaining, cleaning and operating machine activities. If lesser number of machines running, there are higher possibilities of complying with the legislation, but it will affect the production and targets. (Marcel, et.al, 2012).

Table 4.2: Comparison of Noise Level at Production Area with Legal Requirement

Line	**Noise Level (dB)**		
	Mean	**Action Level**	**Comply (YES/NO)**
1	87.64		NO
2	87.54		NO
3	88.11	82.00	NO
4	88.01		NO
Total	87.83		NO

4.3 NOISE LEVELS WITH THE LINE OF MACHINERIES

There were relationships between lines of machineries and it's an inferential analysis to compare more than two variables where there were 4 lines to be compared. When normality test is conducted, the test was normal and thus One-way Anova test was used to analyze the data.

According to the findings, there is no significant difference in noise levels across the machine lines since the significant value was more than 0.05 ($p = 0.104$).

This can be assumed that the reason of no significant difference between the lines of machineries is because the types of machines used in the production area were the same model and type of press machines. All 72 machines were palm kernel press and Model M-15 using Sumitomo Gear Reduction method with 75 horsepower motor. These standardize press machines are specially designed to crush palm kernels to extract oil and to get palm kernel cakes.

In addition, the number of machines running in each line is almost the same because they can't have more than 5 machines to be out of service because it will slow down the production process. Thus, the maintenance schedule is very important to make sure at least 57 machines must be running to reach production targets.

Table 4.3: Noise Levels with the Line of Machineries

Line	Mean ± SD	X^2 Value	F Value	P Value
1	87.64 ± 0.23	9.70	2.251	0.104
2	87.54 ± 0.56			
3	88.11 ± 0.48			
4	88.01 ± 0.72			

*significant value $p < 0.05$
*one-way Anova test

4.4 COMPARISON OF RECENT AND PAST NOISE LEVEL. (2016 AND 2021)

The noise level results of 2016 were used as a secondary data to compare with the latest data to find out the significant changes between recent and past noise level. The average mean of all lines in 2016 was 92.24 dB and the standard deviation was 1.89 while the average mean of all lines in 2021 was 87.83 dB and the standard deviation was 0.56. Based on observation, there were changes but to make the data valid, The Wilcoxon test was performed to see if there was a significant change between the noise levels in the environment in 2016 and the noise levels in 2021. There were only 2 variables to be compared and the normality test done showed that the results were not normal so Wilcoxon was the best test to be used to analyze the data.

According to the data, there is a significant difference in noise level between 2016 and 2021, since the significant value was less than 0.05. (p=0.001). The mean noise level value in 2016 was greater than the mean noise level value in 2021, according to the research. There were modifications to the press machines within this 6 years. Engineering control was done to control the noise exposure and this had proved significant changes of noise level.

The modifications done to the press machines were installment of perforated steel plate cover and the belt of press machines to narrower belts. When big surfaces shake, they create a lot of noise. Wherever practical, the management explored using perforated metal instead of solid plates. Normal covers have a high acoustic radiation effectiveness of vibrating surface, but perforated steel plate covers assist lower the acoustic radiation efficiency of vibrating surface. (Farhad, 2012).

Other than that, the belts inside the press machine were changed into narrower belts. This helped reduce the surface area that will result in low vibration and will not coincide with resonance frequencies. The compression and rarefaction sound waves tend to cancel each other out near the margins of big vibrating plates. Instead of square or roughly square surfaces, the same idea may be implemented by utilizing long narrow surfaces... (Mctague, et.al, 2013). The management replaced single broad belt with 3 narrower belts in purpose to lower the sound power and pressure and based on the results obtained, it was an effective method to reduce noise exposure.

Table 4.4: Comparison of Recent and Past Noise Level. (2016 and 2021)

	Mean ± SD (2016)	**Mean ± SD (2019)**	**Z Value**	**P Value**
Noise Level (dB)	92.24 ± 1.89	87.83 ± 0.56	-4.937	< 0.01

*significant value $p < 0.05$
*Wilcoxon test

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In conclusion, there was excessive level of noise exposed to the area and the results are mostly above action level when compared with the legal requirement (OSHA, 2019). Thus, hypothesis 1 and hypothesis 2 were both rejected.

There were no significant difference between noise levels with the line of machineries because the number of machines in each line were almost the same and the type of machineries was the also the same type. The maintenance schedule of all machineries falls on the same day so all machines are well maintained time to time. Thus, hypothesis 3 was accepted.

There were significant differences between recent and past noise level (2016 and 2016) and this was a positive thing because environmental noise level eventually reduced from the past compared to the present. This was because of the effective control measures taken by management in purpose to reduce area noise exposure at responding area. Thus, hypothesis 4 was rejected.

5.2 RECOMMENDATION

5.2.1 Management

Noise is undesired, excessive sound that travels about us all the time. The noise is a source that goes down a route before being sent to the receiver. Although sound cannot be seen, it may be quantified in terms of strength and duration. Organization must be responsible in prioritizing two major goals which are production and safety. This is to add the continual improvement standards to the respective management by improvising safety measure in an organization and to receive profit from production rather than loss of life or incur cost in irreversible health effects of workers. Besides that, management also needs to ensure safety and health is integrated across the organization.

These goals should be long term but in short term, the production will tend to precedence safety. The organization must evenly manage these two principles to achieve the primary goal. The management must have the art of balance to by prioritizing safety aspects and production in their system so that all compliances would not be neglected. (Karina, 2013)

Further specific outcome of this study, the recommendation must mainly focus on the hierarchy of control that has been accepted in numerous health and safety organization. Elimination, substitution, engineering control, administrative control, and personal protective equipment are the five primary components of the hierarchy of control (PPE).The most effective control starts with elimination which is by immediately eliminating the hazard that is noise causing machines. Elimination and substitution something to do with the source. Engineering control is by controlling the pathway of noise and administrative control and Personal Protective Equipment focuses on the receiver. (Tengku, et.al, 2013)

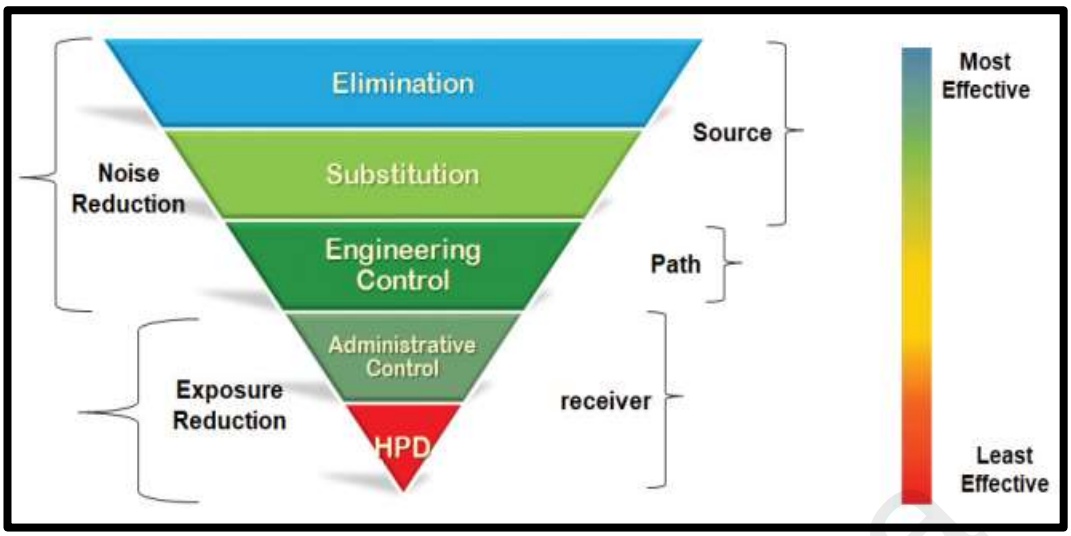

Figure 5.1: Hierarchy of Control. (Tengku, et.al, 2013)

Control measures might be activities done to decrease the risk of exposure to the hazard, or they can be actions taken to remove the hazard or lower the chance of the risk of exposure to the hazard occurring. The safe guarding of moving components of equipment, which eliminates the possibility for contact, is a basic control method. The hierarchy of control measures is frequently mentioned while discussing control measures.

This cannot be put into action as there will be no production as the noise causing machine is the only machine to produce crude palm kernel oil (CPKO). Substituting with less nosier machine is effective too but will incur cost to the management and not worth the choice for the management and generally the proposal of this idea will be rejected. Isolation is done by isolating the machines away from the workers but this idea will also be rejected by the management as the press machine must be operated together maintain by the workers all the time. The most effective control that can be done is engineering control which is by redesigning the machine or the layout of production area.

The open area of the production can be installed with rubber laminated curtains that is a good sound absorber and with not let sound pass through out to the environment. Besides that, the laminated curtains can also prevent external palm kernel expeller dust to travel out to the environment.

Administrative control can be done by providing training to the worker which will increase awareness, relocation of workers which workers would not work at one area but different areas where they are not exposed to only noise producing areas but also to quiet areas. Finally, the management should provide better personal protective equipment (PPE) with higher noise reduction rating (NRR) that will decrease more sound exposure within the environment.

5.2.2 Limitation

The limitation of this research was time constraint because the management only allocates 2 hours per day for 4 continuous days to collect data. This caused the monitoring time for target points to be reduced to only 5 minutes per target point. In addition, the workers working at production area were all contract workers who are not permanent working at the responding and they have frequent job rotations. Thus, personal monitoring cannot be conducted.

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