DETERMINATION OF INDOOR DISTURBANCE LEVEL USING NOISE MONITORING DEVICE AT JELI HOSPITAL

by

NOR NASUHA ALLYIA BINTI MOHD SHABRRY

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DECLARATION

I declare that this thesis entitled "Determination Of Indoor Disturbance Level Using Noise Monitoring Device at Jeli Hospital" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ______________________________

Name : ______________________________

Date : ______________________________

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LIST OF ABBREVIATION

ANOVA	Analysis of Variance
CCU	Critical Care Unit
ECG	Electrocardiogram
dB(A)	Decibels
GPS	Global Positioning System
HVAC	Heating, Ventilation & Air Conditioning
ICU	Intensive Care Unit
SLM	Sound Level Meter
WHO	World Health Organization

Determination of Indoor Disturbance Level Using Noise Monitoring Device at Jeli Hospital

ABSTRACT

An investigation related with noise pollution that could cause negative impacts on patients was carried out in Jeli Hospital, Kelantan. Noise can affect human health and well-being in a number of ways, including annoyance reaction, sleep disturbance, interference with communication, performance effects on social behavior and hearing loss. This study aimed to determine the noise level in Jeli Hospital, to compare noise levels of selected ward with WHO standards. Sound levels were recorded at three different wards. Every readings of noise level were recorded in decibel, dB(A) for two hours at five minutes interval, during day time and night time which is morning, evening and night. The average of noise level in the study areas were between 48.9 dB(A) to 62.5 dB(A) exceeding the recommended value by WHO which is 35-40 dB(A) during day and night time. The result of one-way ANOVA test that had been carried out on the dependent variable average noise showed a statistically significant differences with value $F(2,24) = 15.407$, $p = 0.000$.

Penentuan Tahap Gangguan Dalaman Menggunakan Peranti Pemantauan Bunyi di Hospital Jeli

ABSTRAK

Siasatan berkaitan pencemaran bunyi yang boleh menyebabkan kesan negatif kepada pesakit telah dijalankan di Hospital Jeli, Kelantan. Pencemaran bunyi boleh memberi kesan kepada kesihatan manusia dan kesejahteraan dalam beberapa aspek, termasuk tindak balas kegusaran, gangguan tidur, gangguan komunikasi, kesan prestasi ke atas tingkah laku sosial dan kehilangan pendengaran. Kajian ini bertujuan untuk menentukan tahap bunyi di Hospital Jeli, untuk membandingkan tahap bunyi wad dipilih piawaian WHO. Tahap bunyi direkodkan di tiga lokasi wad yang berbeza. Setiap bacaan paras bunyi yang telah direkodkan dalam unit desibel, dB(A) selama dua jam pada selang lima minit, pada waktu siang dan malam yang pagi, petang dan malam. Purata paras bunyi yang direkodkan di kawasan kajian adalah di antara 48.9 dB(A) kepada 62.5 dB (A) yang melebihi nilai yang disarankan oleh WHO iaitu 35-40 dB(A) pada siang hari dan malam. Hasil sehala ujian ANOVA yang dijalankan ke atas bunyi purata pembolehubah bersandar menunjukkan perbezaan statistik yang signifikan dengan nilai $F (2,24) = 15.407$, $p = 0.000$.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Pollution usually occurs when there are some substances that cause environmental change according to the situation and also have a major impact on our daily lives. Pollution disturbs our ecosystem and the balance in the environment. With modernization and development, pollution has reached its highest peak giving the rise to global warming and human illness. Pollution occurs in different forms of water, soil, air, noise, thermal, heat, radioactive and also light (Future, 2009).

Noise is often referred to as unwanted sound. Noise evaluations are useful to assess or predict the unwantedness, disturbance, objectionableness, undesirability, unacceptability, perceived noisiness or simply the noisiness of the sound environment in real life (Kryter *et al.,* 1985). High levels of noise are often found in the hospital environment, and the potential negative impacts of noise on patients have been demonstrated. Hospital noise had been associated with patients risks for the cardiovascular response, increased the length of stay sleep disturbance and increased the incidence of re-hospitalizaton (Hsu *et al.,* 2012)

1.2 Problem Statement

Hospital is getting noisier, proofed by several studies performed by the World Health Organization (WHO) revealed that hospital noise levels have increased consistently since 1960. Noise levels in most hospitals far exceed recommended guidelines. The high ambient noise levels, as well as peak noise levels in hospitals, have serious impacts on patient and staff outcomes ranging from sleep loss and elevated blood pressure among patients to emotional exhaustion and burnout among staff (Ulrich *et al*., 2004). The study is carry out to know the level of noise in Jeli Hospital whether it is exceeding the recommendation level by the World Health Organization (WHO). Since the population in Jeli is increased every year and undergoing a process of urban development. The continuous of the noise level study is very important to overcome the problem of noise pollution (Ryherd *et al*., 2008). WHO have recommended that noise levels should not exceed 35 dB(A) in rooms where patients are treated or observed and 30 dB(A) in ward rooms (Berglund *et al*., 1999).

The noise level in hospitals is usually higher than these recommendations and even higher in intensive care units (Lei *et al*., 2009). Researchers have concluded that all hospitals regardless of their type, size of patients that they care for at all times of the day and every day of the week, exceed recommended noise levels put forth by WHO (Choiniere, 2010).

1.3 Objectives

i. To determine noise level in selected wards at Jeli Hospital
ii. To compare noise levels in Jeli Hospital with the World Health Organization (WHO) standards

CHAPTER 2

LITERATURE REVIEW

2.1 Pollution

The Environmental Quality Act 1974 (Act 127) was established to ensure the safety and comfort of the people in this country. According to this act, pollution means any change directly or indirectly to the physical, chemical, biological and radioactive any part of the environment with the release issue or lay waste to the detriment of any beneficial use for causing a dangerous situation to health, safety or welfare of the public as well as animal and plant life.

2.2 Noise Pollution

Noise is derived from the Latin word 'nausea' implying unwanted sound or sound that is loud, unpleasant or unexpected. The noise originates from human activities, especially the urbanization and the development of transport and industry. Though the urban population is much more affected by such pollution, however, small town or villages alongside roads or industries are also the victims of this problem. Noise is becoming an increasingly omnipresent, yet unnoticed form of pollution even in developed countries (Singh, 2004).

Noise pollution is a problem, which displeases human or machine created a sound that disrupts the activity of balance in human or animal life and can equally be described as an unwanted sound dumped into the environment (Olayinka, 2012). Hospitals, medical suites and aged care facilities are all subjected to noise pollution. More research is appearing to demonstrate problem caused by noise, which includes high blood pressure and increased heart rate in workplaces increased errors and staff attrition in hospitals, and a lack of speech privacy in professional offices and suites (Abbas *et al.,* 2015).

2.3 Sources of Noise Pollution

The noise originates from human activities, especially urbanization and the development of transport and industry. Although the urban population is much more affected by such pollution, small town alongside roads or industries was also a victim of this problem (Singh, 2004). Road traffic, jet planes, garbage trucks, construction equipment, manufacturing processes, and lawn mowers are some of the major sources of this unwanted sounds that are routinely broadcast into the air (Berglund, 1995).

Noise pollution occurs when there is unwanted or disturbing sound, that is when sound either interferes with normal activities or disrupts or diminishes one's quality of life. Noise pollution can be sourced externally or internally. In the context of a health care facility, external noise includes traffic, deliveries, and sirens. Internal noise can include ventilator noise and alarms, suctioning, heart monitor alarms, nebulizers, pulse ox meter tones and alarms, telephones ringing, air conditioning, television, radio, banging, rubbish bin or trolley noises, intercoms, staff bleeps, talking (staff and nurses), visitors, fellow-patients, and general activities (Abbas *et al*., 2015).

Hospital noise is a hazard to the community. Mechanical devices, ventilation systems, and patients and staff are general sources of noise within hospitals. The use of technological devices creates potentially harmful noise levels, especially in hospitals. Crowded places like hospital polyclinics are also important sources of noise within the hospital environment and any noise exceeding the recommended levels may affect the health of both patients and hospital staff (Gultekin *et al*., 2013). Indoors, noise travels through air and depending on the structure of the building and room, noise may be insulated by walls or windows.

2.3.1 Daily Care of Patients and Staff

Seemingly innocuous daily care activities can easily produce bothersome noise. Morning is when most patients are having daily care such as baths, getting dressed, bed linen changing, and when most visitors and staff arrive (Dube *et al*., 2008). Other noises heard include noise from staff footsteps which was 89 dB(A), vacuum cleaners 74 dB(A), and the telephone rings 68 dB(A) (Akansel and Kaymakci, 2008). Additionally, other noise sources are flushing toilets 44 to 76 dB(A) and bed making 56 to 66 dB(A) (Hilton, 1985). Rolling carts are frequently heard moving through the hallway. Noise measurements for trolley cart sides being lowered have been documented at 85 dB(A) (Hodge and Thompson, 1990).

Akansel and Kaymakci (2008) showed that the number of staff working in the intensive care unit (ICU) is directly related to the noise level. The staff levels are the highest in the mornings and during shift changes therefore, the patients are the most disturbed by the noise levels in the morning and during shift changes. Additionally, ward rounds, equipment replacement activities, patient care activities, and patient transfers took place during the morning hours, contributing further to the noise. The patients did not think noises from treatment and caring activities such as massage, oxygen supplies and respirators were troubling because these tend to produce a constant rhythmic low level noise.

2.3.2 Talking or Human Behavior

Talking, socializing, or entertainment devices such as the television cause distractions or upset in the health care environment for some patients. Conversations may be beneficial for the intended conversational partner, however when overheard by someone else they can contribute to the noise level. Additionally, visitors and in-room entertainment devices can cause distress for those who want or need quiet to recuperate.

Hilton (1985) documented that as the number of nurses around a patient's bed increased, the noise levels increased. Sicker patients need more urgent and consistent nursing and medical care, contributing to more noise production (Kahn *et al*., 1998). The presence of staff has a significant positive correlation with the measured noise levels, therefore the staff needed to be cognizant of noise producing activities and be concerned with means to reduce them (Akansel and Kaymakci, 2008). Akansel and Kaymakci (2008) stated, staff conversations were the fourth most disturbing noise source for patients. These conversations and laughter often concerned patients because they assumed they are the subject of these conversations however, two out of the 35 patients in the study stated that the staff conversations they overheard were interesting and did not because they concern (Akansel and Kaymakci, 2008). In Kahn *et al.,* (1998) study, more than 50% of noises were attributed to human behaviour, such as talking and watching television, meaning they are potentially modifiable.

Staff conversations happen at levels that can be heard by the patients, and the patients affirmed these staff conversations to be the most annoying noise (Russel 1999). The nurses station is a spot where both personal and professional issues can converse. The measured noise levels by the nurses station were reported as 50 dB(A) and 60 dB(A) (Hilton, 1985). Conversations among ICU staff measured 74 dB(A) (Akansel and Kaymakci, 2008).

2.3.3 Heating, Ventilation, and Air Conditioning (HVAC)

The main functions and concerns of HVAC systems are energy efficiency, condensation control, indoor air quality, noise control, temperature control, air pressure control, humidity control, and thermal comfort. HVAC systems and their corresponding control systems are the primary methods of containing contaminants in one area from entering to another (Babineau, 2008). Hospitals operated continuously place continuous high work demands on HVAC systems, increasing noise issues from HVAC systems.

Low frequency noise is more likely to stem from the mechanical equipment while high frequency energy corresponds more often to the high velocity airflow through the heating ventilation air conditioning (HVAC) systems (Ryherd *et al.*, 2008). Babineau (2008) discussed the various HVAC needs for each individual type of space within a hospital setting whereby some of those needs are as follows, operating rooms, ICU nurseries, and protective environment rooms require a positive pressure in regards to the surrounding areas airborne infection isolation environments require a negative pressure compared to surrounding areas and autopsy, sterilization, and soiled laundry rooms need air vented to the outdoors.

2.3.4 Medical Equipments

Another source of noise in hospitals is in room medical equipment noise. High frequency energy often corresponds to alarms and mobile medical equipment (Ryherd *et al*., 2008). One aspect to keep in mind is the close proximity of these devices to the patient throughout their stay making these noise sources a particular concern that needs to be addressed. Biley (1994) found that equipment alarms and the bleeping of monitoring equipment are the most commonly described causes of stressful noise to patients. Standards required that medical equipment alarms, such as the mechanical ventilator alarms, have preset volumes that cannot be modified to guarantee patient safety and to audibly alert staff consistently to problems in all areas of the unit (Ford *et al*., 2008).

Some common noise levels are telemetry alarm levels at over 70 dB(A), electrocardiogram (ECG) alarms at 75 dB(A), intravenous infusion alarms between 44-80 dB(A), measured infusion pump alarms at 61 dB(A), and monitor alarms at 68 dB(A) (Ford *et al*., 2008). Evidence exists, though, that patients develop a tolerance for the noise from noisy mechanical equipment because of their trust in doctors and their understanding that staff needs to use the equipment for their own greater good health (Topf, 1983).

2.4 Effects of Noise Pollution

Noise can affect human health and well being in a number of ways, including annoyance reaction, sleep disturbance, interference with communication, performance effects on social behaviour and hearing loss. Noise can cause annoyance and frustration as a result of interference, interruption, and distraction.

Activity disturbance is regarded as an important indicator of the community impact of noise (Kumar, 2004).

2.4.1 Physical Effect

Noise is in fact a biological stressor that excessive and continuous exposure to it has proven a health risk. Health risks are caused by the noise exposure are high blood pressure, coronary heart disease, ulcer and migraine headache that are proven by research there is a relation between the noise exposure and increasing ratio of health problems, indications that noise exposure can cause the chances of viral infections and toxic substances production in the body (Shahid and Bashir, 2013). Exposure to loud sound increases arousal response in the body that adrenaline is released in the blood heart rate, blood pressure, and respiration increases gastrointestinal mobility is restricted, blood vessel contracts and muscles are stretched.

Noise can contribute to some physical effect such cardiovascular, physical symptom, length of hospital stay and sleep disturbance. Various studies have found long-term effects of noise exposure on cardiovascular function, such as hypertension or heart rate increases when people were exposed to audio taped critical care unit (CCU) noise such as an abrupt noise or staff conversation (Topf, 1983). This noise is a physiological stress the subject received while sleeping. Noise levels greater than 70 dB(A) raised the cardiovascular rates of the patients (Falk and Woods, 1974).

Hearing loss was found to occur when peak values exceeding 100 dB(A) from orthopaedic surgery instruments caused inner ear damage and long-term problematic tinnitus (Nott and West, 2003). Additionally, hearing loss occurred when a normal individual experienced sudden intense noise and prolonged exposure to noise levels over 85-90 dB(A) (Selfe, 1982). The body may undergo some physical changes when startled including increased adrenaline, pupil dilation, and secretion (McCarthy *et al*., 1991).

In a few studies, the length of hospital stay was found to be impacted by noise exposure. Fife *et al.*(1976) wanted to observe the physiological effect of construction noise on patients because very few clinical studies doing so existed. Noise sources were pile drivers, dump trucks and tractors running outside the patient room windows. The researchers found that construction noise altered the length of stay for those occupying the cataract surgery ward at three different time periods which were one year prior to construction, one during construction, and one year after construction was completed. Chosen subjects were those patients undergoing simple cataract surgery who would most likely not have any complications from pre-existing conditions. The hospital stay was significantly longer for patients occupying the ward during the construction noise. Furthermore, in the Hagerman *et al.,* (2005) study, the group exposed to worse acoustic conditions had higher re-hospitalization rates at three months.

Sleep deprivation has been confirmed to change the mood, alertness and task performance increase daytime fatigue, harmfully impact respiratory muscle function and reduce ventilator control which delays removal of mechanical ventilation (Chen and Tang, 1989). Psychological factors as well as noise exposure influence sleep disturbance (Hatfield *et al*., 2002). In a hospital environment, 10-50% of patient arousals from sleep are from the noisy ICU environment (Stanchina *et al*., 2005). Walder *et al*. (2000) conveyed that older patients woke up numerous times during their ICU stay because of noise.

Sleep for patients were promoted by reducing the peak noise levels in that investigation. The Stanchina *et al.* (2005) study hoped to clarify the disagreements found in previous studies by looking at whether peak noise or the change in noise level from baseline was more important in inducing sleep disruption. They hypothesized that adding white noise to the environment would reduce arousals by reducing the magnitude of the changing noise levels. Their conclusion was that the peak noise was not the main factor in determining ICU noise sleep disruption, since adding white noise considerably reduced sleep arousal's in normal individuals.

2.4.2 Psychological Effect

There are many psychological effects due to the noise pollution for example annoyance, noise sensitivity, deafness, work performance and sleep disturbance. It can cause annoyance, which is emotional state of displeasure associated with any condition realized by a person or a group of persons, adversely affecting them. Speech interference, excessive noise produces a lack of the ability to communicate. Noise can affect the work performance directly and indirectly because those activities which require more concentration such as proof-reading and complex analysis are found to be noise sensitive (Shahid and Bashir, 2013).

It is defined as an emotional state of displeasure associated with any condition realized by a person or a group of persons, adversely affecting them. The lower frequency noise is observed to produce more annoyance as the loudness level is high for the low-frequency sound, it affects any person's behavior directly and indirectly. The direct effects include aggressive behavior associating with preexisting anger and alcohol or other psychoactive agents. Indirect effects of annoyance are a lack of peace of mind, enjoyment of one's own property and the enjoyment of loneliness (Shahid and Bashir, 2013).

Weinstein (1978) hypothesized that certain patients were sensitive to the noise, while others were insensitive or less sensitive toward the noise produced. People may become conditioned to a noise and develop a lack of sensitivity over a period of time to a particular noise. However, overall these individuals may still be noise sensitive to new noises they are not conditioned to (Biley, 1994). Furthermore, individuals may be unaware of a noise they are producing because of adaptation, they simply do not notice it after becoming used to it. Adaptation explains the tolerance some people have to the high levels of noise found in surgical wards and other units.

The effect of noise on audition is well recognized. Mechanics, locomotive drivers, telephone operators and all have their hearing impairment as a result of noise at the place of work. Physicians and psychologists are of the view that sustained exposure to noise level above 80 to 100 dB(A) is risky and thunderous noise cause temporary or permanent deafness. Hypertension which was a relatively low level of noise affects human health adversely and it may cause hypertension, disrupt sleep and or hinder cognitive development in children (Kiernan, 1997).

Noise can affect the work performance directly and indirectly. This is studied by exposing the person to noise in the controlled environment. Those activities which require more concentration such as proof reading and complex analysis are found to be noise sensitive. Events involving impulsive noise can produce a lack of performance ability because of startle effect. Continuous exposure to noise affects the memory. Not only occasional memory is affected but also material observation memory is decreased (Shahid and Bashir, 2013). It is reported that the children who are subjected to the aircraft noise during childhood have reading acquisition and reduce motivational capabilities.

Peaceful and undisturbed sleep is required for physiologic, behavioural and mental health. Both continuous and intermittent noise disturbs the sleep. As a result of sleep disturbance, a number of psychological and behavioural effects are observed which can be even severe. Primarily, it results in difficulty in falling asleep, frequent awakening, and waking too early. These symptoms lead to increase of blood pressure, heart rate and amplitude, vasoconstriction, depression, fatigue and decreased performance. It is known that continuous noise of noise level greater than 30 dB(A) can disturb the sleep.

2.5 Impact of Noise on Patients and Staff

2.5.1 Sleep Disturbance

Sleep was a physiologic phenomenon that was essential for maintaining health, relieving stress and anxiety, and helping the body recover. Sleep can be disturbed by sudden environmental changes and its influence was thought to be a noteworthy impact of noise. Sleep disturbance in hospitalized patients has been studied and minimizing disruption of sleep cycle was currently considered as a part of patient care. Patients have been reported to experience improved or worsened neurological and cardiovascular problems depending on the environmental stress from being hospitalized (Tembo, 2009). Noise in hospital rooms was reported to be the most significant factor interfering with patient sleep (Lei *et al.,* 2009). Furthermore, higher ambient noise levels in hospitals were found to correlate with longer hospitalizations.

2.5.2 Re-hospitalized

There was some evidence that noise negatively impacts wound healing. In one study, patients, stay longer in the hospital after a cataract surgery during a period when noise levels were higher due to construction (Fife *et al.,* 1976). The noise levels that were high more than 60 dB(A) need more medications required by surgery patients post recovery and could slow down the recovery of sick children (MacKenzie *et al.,* 2007). This high noise level might contribute to undesirable physiological and behavioral effects on the children admitted (Morrison *et al.,* 2003).

2.5.3 Work Performance

Though average and peak noise levels reported from critical care units are generally lower than sound levels thought to cause hearing impairment in otherwise healthy individuals, they are universally higher than those recommended by the WHO. Noise is associated with subjective and objective (cardiovascular) measures of stress among critical care nurses and is a significant risk factor in the 'burn-out' of nursing staff. Noise diminishes the performance of health care providers in tests of mental efficiency.

Indeed, patients have reported a less desirable staff attitude in noisier conditions. An increased background level of noise tends to lead to greater amplitude of speech in an attempt to make oneself heard the 'Lombard effect', which has implications for patient confidentiality. Furthermore, it creates an atmosphere in which communication between staff or between staff and patients may break down, and mistakes may be made.

2.6 Standard of Noise in World Health Organization (WHO)

During the data sampling, standard of noise level in the WHO guidelines was used to be compared between the noise level in Jeli Hospital. The World Health Organization (WHO) is the experts produce health guidelines and standards and help countries to address public health issues (World Health Organization, 2007). WHO have recommended that noise levels should not exceed 35 dB(A) in rooms where patients are treated or observed and 30 dB(A) inward rooms (Berglund, 1999).

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Study Area

Figure 3.1 showed the area of Jeli Hospital. This hospital was still in the renovation and new building to serve the patients with comfortable facilities, as the population in Jeli are increase each year.

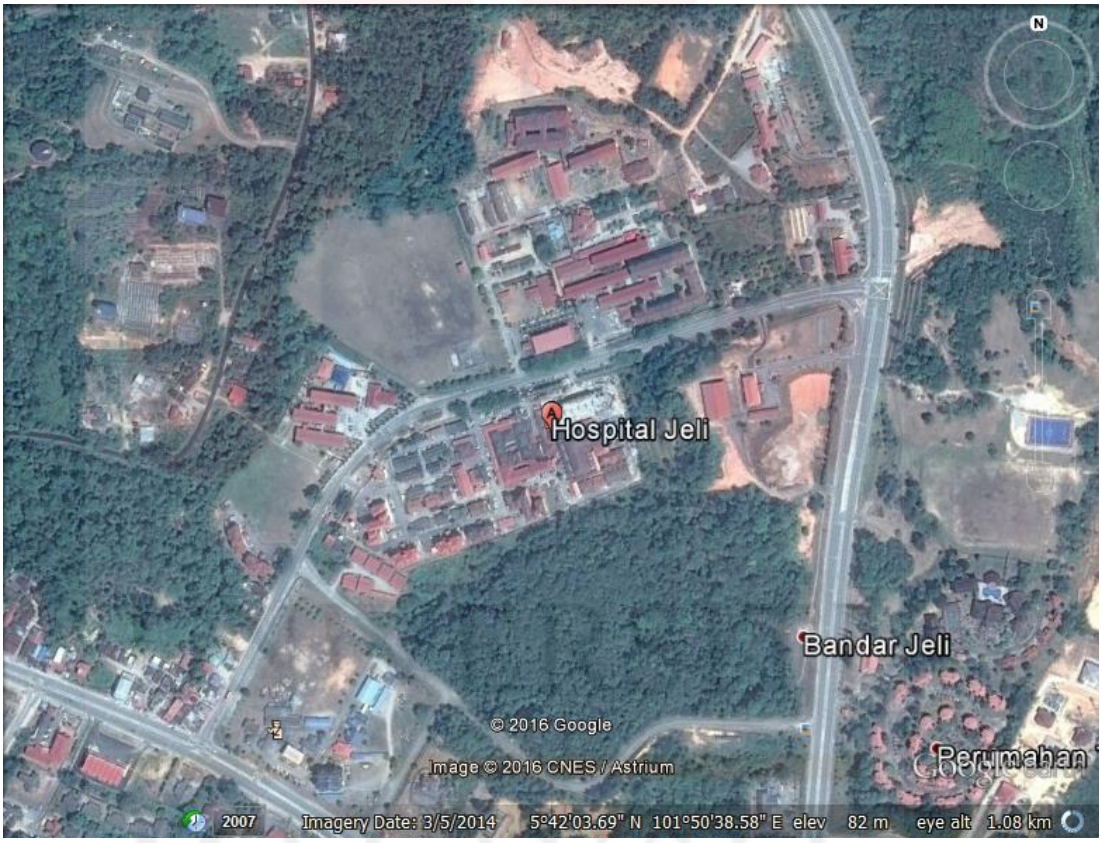

Figure 3.1: Location of Jeli Hospital Kelantan

Jeli Hospital is a government hospital located in Jeli, Kelantan, Malaysia that located 5°42'03.69" N 101°50'38.58" E. Jeli Hospital is a 24 beds hospital and it is a non-specialist district hospital providing outpatient services and inpatient services.

Patients required special and intensive care are recommended to Hospital Raja Perempuan Zainab II. Services that are available at Jeli Hospital included clinical services which are emergency room and Trauma Unit, Outpatient Department, Inpatient Unit, Hospital Medical Centre and Maternity Ward. In this study, it is proposed that data collection will be done at three different stations, which are Maternity Ward, Emergency Room, and Inpatient Ward.

3.2 Equipment

In this study, the data was collected using the sound level meter, Model TM-102 and GARMIN GPS. These equipment were provided by Environmental Laboratory, Faculty of Earth Science, and Universiti Malaysia Kelantan.

3.2.1 Sound Level Meter (SLM)

A sound level meter in the Figure 3.2 was used for an acoustic sound that travels through air measurements. Sound level meters are commonly used in noise pollution studies for the quantification of different kinds of noise, especially for industrial, environmental and aircraft noise.

Figure 3.2: Sound Level Meters (SLM)

3.2.2 Global Positioning System (GPS)

The global positioning system (GPS) equipment as shown in the Figure 3.3, recorded valuable information during the data sampling. It can record the tracks, way point, mark point of the outcrop being taken, elevation of the area, the position of the area in latitude and longitude value for the three different locations of data sampling in Jeli Hospital.

Figure 3.3: Global Positioning Systems (GPS)

3.3 Methodology

Sound levels were sorted in 24-hour stretches, based on night and day, and at three different locations which were maternity ward, inpatient ward, and emergency room. Data sampling was recorded in the morning at 8.00 to 10.00 a.m., afternoon at 2.00 to 4.00 p.m. and evening at 8.00 to 10.00 p.m. Readings will be recorded at every five minutes interval within two hours. The readings were taken for one day per week, where a day for a selected station. The reading will also be taken three months time.

3.4 Measurement method

3.4.1 Sound Level Meter (including microphone) mounted on tripod

A pole or tripod was used to hang up the sound level meter device as shown in the Figure 3.4. This instrument was placed in the three wards at the corner of room and opposite with the patients.

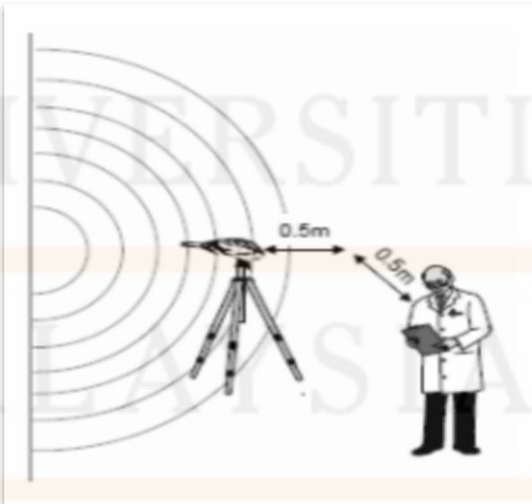

Figure 3.4: Sound Level Meter mounted on tripod (Source: Bruel and Kjaer 1980)

Sound level meter including a microphone mounted on a tripod is the method used most commonly and the standard methodology for most noise measurements where compliance or enforcement action may be taken as a result of the investigation. Care should be taken not to make noises whilst observing the meter in this method and ensuring the least amount of reflective surface from your body is exposed to the meter.

3.4.2 Affected Height of the Receptor

A noise reading should always be taken at the height of the receptor. If the receptor is at the ground level, take a measurement at the ground level 1.2 to 1.5m off the floor as shown in the Figure 3.5. The instrument was placed in the three wards at the corner of room and opposite with the patients.

Figure 3.5 : Sound Level Meter measurement (Source: Bruel and Kjaer 1980)

Inside a room in the hospital measurements inside buildings was carried out at which the noise of interest dominates. The preferred positions were at least 1 m from wall or other reflecting surfaces 1.2 m to 1.5 m above the floor, and 1.5 m from windows. As shown in the Figure 3.6 the presence of furnishings or other reflective surfaces, which may result in shielding or scattering of the noise, should also be considered.

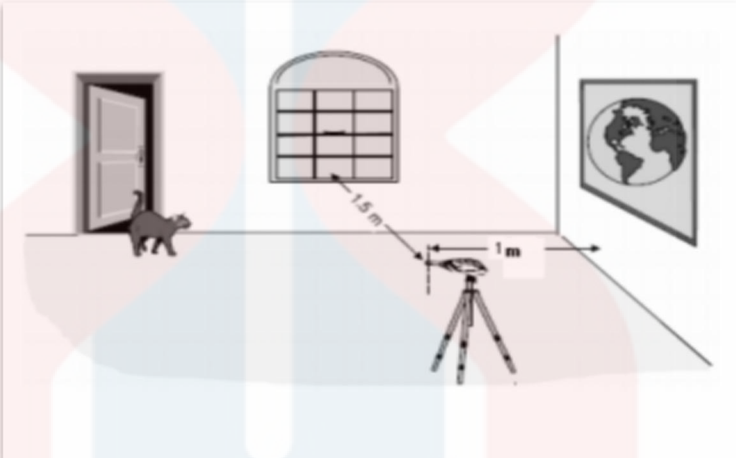

Figure 3.6: Minimum distance from nearest reflective surface inside room (Source: Bruel and Kjaer 1980)

3.5 Statistical Analysis

In this study, one way ANOVA was used for the statistical analysis. Average also being used to calculate the average of data that will be recorded in the three location. The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of three or more independent groups.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Sampling Result Analysis

The overall data obtained was the result of three months noise level sampling session. The averages of the result were compared to the standard noise level by World Health Organization (WHO). The data were illustrated in the graph and discussed.

4.1.1 Maternity Ward

Raw data was tabulated into bar chart graph to compare the noise level of the Maternity Ward between three months which were May, June and July. The bar chart were divided into three components which were average, maximum and minimum of the noise level as shown in Figure 4.1. The maximum value of noise level at a maternity ward in May was 73.6 dB(A) in morning meanwhile the minimum level of noise was 51.0 dB(A) during the evening. The average of noise level recorded was 57.63 dB(A) which was the highest compared to noise produced in morning with 55.4 dB(A) and night time 53.3 dB(A).

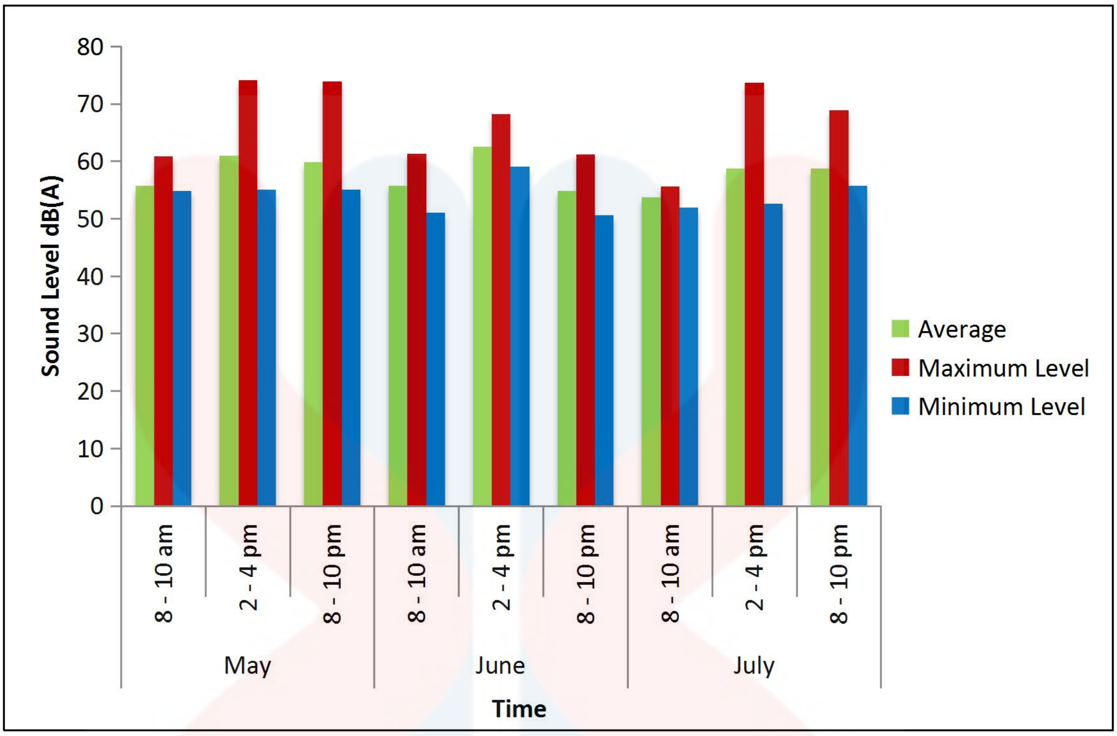

Figure 4.1: Noise level recorded at Maternity Ward

The graph in the Maternity Ward in June showed the maximum level of noise produced in the morning was 71.4 dB(A). The minimum level of noise decreased to 48.1 dB(A) at night. Meanwhile, the average for Maternity Ward in June in the morning and evening was 55.7 dB(A) and 54.3 dB(A), during night time. The maximum level of noise taken in early in the morning July was 56.4 dB(A) in the evening. The minimum level of noise produced in morning was 47.5 dB(A) meanwhile, the average for Maternity Ward was 50.5 dB(A), 52.9 dB(A), and 50.3 dB(A) for each two hours reading in morning until night.

The highest maximum level of noise recorded at Maternity Ward during early in the morning in May and June was slightly increased because of phones ringing. Phone ringing can cause increased noise levels due to the relatively small size of the treatment room and the sound reflecting was strong because telephone were generally located at the nurse stations, some of the phones being unnecessarily loud over 70 dB (A) (Mackenzie, 2007). During the period of the collecting data process on noise levels in the ward, it was found that the highest sound levels generated were coming from the nurses and the staff in the wards.

The sources of noise normally was produced from the conservation between the nurses as shift schedule change around 8 to 9 am. Many studies have found that staff conversation in particular was a major sources of loud noises on the hospital unit (Alloauchiche *et al.,* 2002). The source of noise was also coming from the visitors and the children who were running around in the ward can lead to high noise reading. Noise recording in June showed the lowest value of minimum level during night time. The noise level in this ward during night time was decline due to fewer visitors in the night time, except for only one of the family members was allowed to taking care of patients and mostly at night the patient was resting.

4.1.2 Emergency Department

Raw data was tabulated into bar chart graph to compare the noise level of the Emergency Department between three months which were May, June and July. The bar chart were divided into three components which were average, maximum and minimum of the noise level as shown in Figure 4.2. The maximum level of noise during the evening of May, the noise increased to 74.1 dB(A) and the minimum level recorded in the morning was 54.8 dB(A). The average noise level recorded in was 54.7 dB(A) in the morning. The highest average was recorded in the evening which was 61.0 dB(A) and decrease to 59.8 dB(A) at night time.

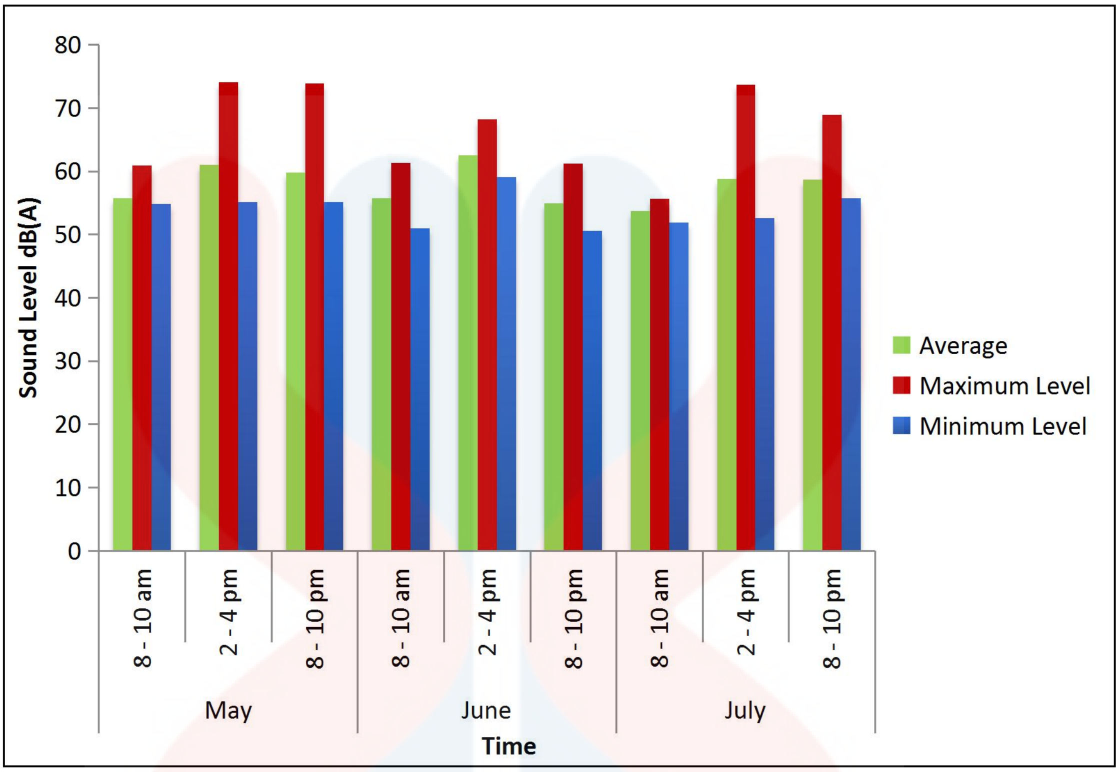

Figure 4.2: Noise level recorded at Emergency Department

The maximum level of noise produced increase to 68.2 dB(A) in evening and the minimum level of noise decreased to 51.0 dB(A) in morning. The average of noise level recorded in June was 55.7 dB(A) meanwhile, 62.5 dB(A) in the evening was the highest reading compared between morning and night time which was 54.9 dB(A). The maximum noise level of this department during the evening was 73.7 dB(A) and the minimum level of noise decreased to 51.9 dB(A) in morning. The average for Emergency Department in July was 53.7 dB(A) in morning, 58.8 dB(A) evening and 58.7 dB(A) at night time.

The noise level in the emergency department showed the maximum reading of noise was higher in evening than morning and night time. From my observation this happened because of in emergency department there were many sources of sounds contributing to the loud noise levels come from mechanical equipment in use alarms, paging systems, telephones, computer printers, staff conversation, and noises generate, by roommates and visitors (Ulrich *et al.,* 2004) for example that leads to increasing of reading data due the sound that comes from equipment used in the emergency department.

The maximum reading during night time in May and July increased up to 73.9 dB (A) because of the sound level meter was allocated near the treatment room for asthma patients using oxygen resuscitation machine or mechanical ventilation. During that night there were two to three people and a baby that keep using the machine because they were suffering from hard breathing. The sound of the machine to some extent, affect the readings. The lowest minimum noise level in June was during night time. This minimum level of noise remained stable from 50 to 60 dB(A).

4.1.3 Inpatient Ward

Raw data was tabulated into bar chart graph to compare the noise level of the Inpatient War between three months which were May, June and July. The bar chart were divided into three components which were average, maximum and minimum of the noise level as shown in the Figure 4.3. The maximum level noise produced of this ward in May was increased to 63.2 dB(A) during the evening. Meanwhile, the minimum level of noise was 47.7 dB(A) at night time. The average of the noise level in morning 54.9 dB(A), slightly decrease 52.5 dB(A) during the evening and decreasing to 49.9 dB(A) night time.

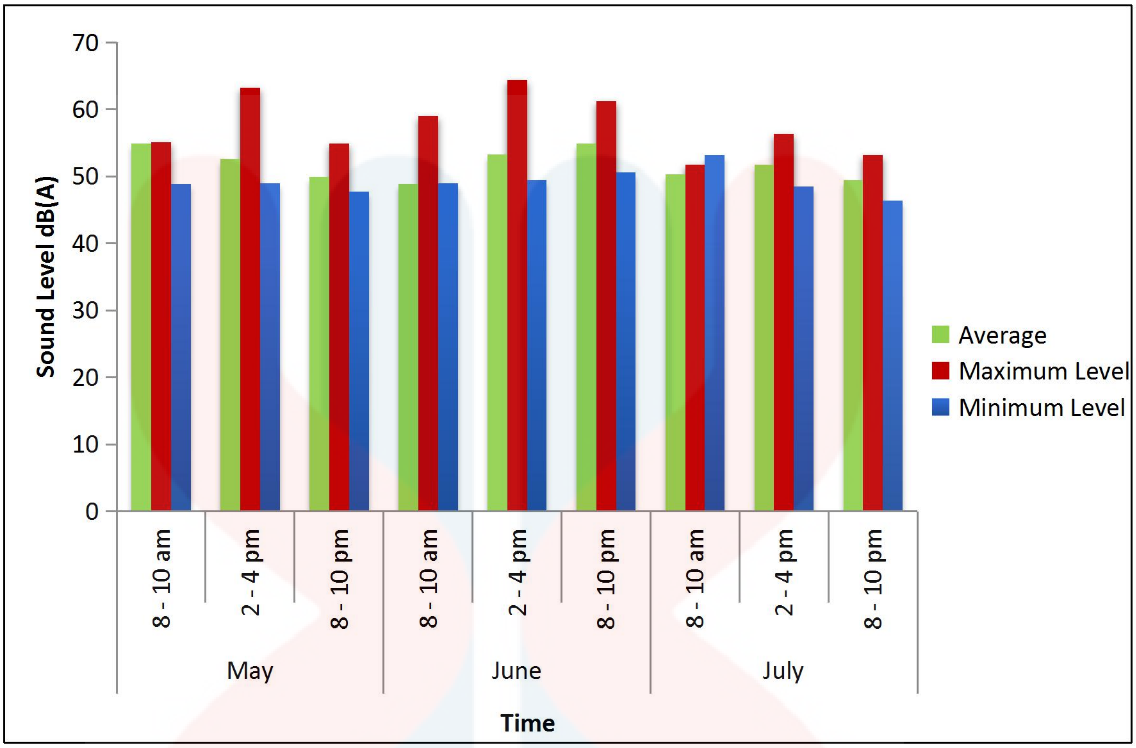

Figure 4.3: Noise level recorded at Inpatient Ward

The maximum level of noise in the inpatient ward in morning was increased to 64.4 dB(A) during the evening and the minimum level of noise decrease to 49.0 dB(A) in morning. The average for Inpatient Ward in June was 48.9 dB(A) in the morning, 53.3 dB(A) during the evening and 51.1 dB(A) at night. The maximum level of noise in morning was rose to 56.3 dB(A) meanwhile, the minimum level of noise decreased to 48.5 dB(A) in morning and the evening. The average for Inpatient Ward in July was 50.3 dB(A) in the morning reading, 51.5 dB(A) was during evening and 49.4 dB(A) at night.

The noise maximum level in this ward was low compared to other wards. The area in this ward was quite large because the wards were separated by gender male and female. The atmosphere was rather quiet in the morning because at this time the patient was still resting and sleeping. The sound level meter was placed far from the registration counter where the nurses or doctors will gather to perform their task produced low noise level in this ward. Noise level for the three months May, June, and July shows that the maximum level of noise was produced the evening.

The reading levels increased slightly during the evening than morning because patients receive more visitors from their family members who contributed to the noise level was relatively high, and also nurses who were working to distributed food using a trolley also produce the high noise pollution. Mostly during night time noise level was low because there were not many nurses and doctors on duty at night. Several of the worker and staff who work the in night shift only that were allowed to stay in the hospital. Visitors also have progressively less at night. The probability of increased noise level was less because at night the phone, fax machine, slamming the door, trolley and other sources of thing that lead to less noise at night were not really functioning during night time.

4.2 Comparison with World Health Organization (WHO)

The average of noise level recorded in the three selective location within three months were compared to the noise level guideline that was recommended by World Health Organization (WHO) which were in day time and night time as shown in Figure 4.4 and Figure 4.5. These comparison will be resulted that level of noise produced in Jeli Hospital were exceeding or below the decibels of guidelines provided.

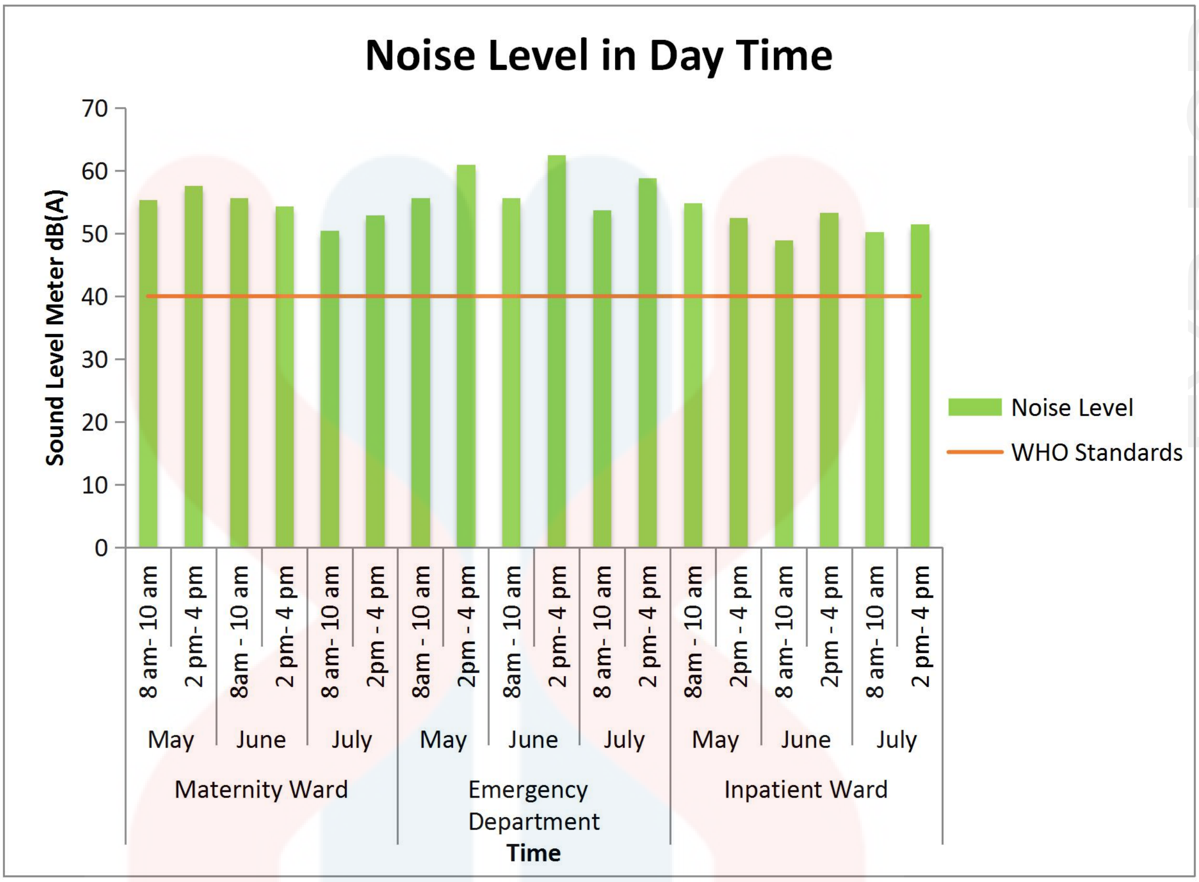

Figure 4.4: Comparison of noise level with World Health Organization (WHO) in Day Time

Environmental noise present in hospitals all over the world was a common stressor and was recognized as a serious health hazard and not just as a nuisance. The World Organization has drawn up guidelines to promote a community noise management plan and to reduce the effects of noise exposure on health. According to these guidelines, the recommended noise levels in hospital areas should be 35-40 dB(A) in the daytime and 30-40 dB(A) in the evening and the acceptable noise levels in indoor spaces (dwellings) were set to 35 dB(A), whereas limits were set to 30 dB(A) for bedrooms to avoid sleep disturbances.

Noise level recorded at Maternity Ward, Emergency Department and also Inpatient Ward had exceeded the recommended guidelines by World Health Organization (WHO). In May the rate was quite high compared to noise from the other two months. Meanwhile, the noise level produced in June decreased due to Ramadhan, and showed a continue decreasing in July as all of Muslim were celebrating the Eids.

The data recorded showed decreasing in decibel at each station due to operation hours of the hospital in the night time as shown in Figure 4.5. According to World Health Organization (WHO) suggested standard level, noise produced should not exceed 35 dB(A) for night time.

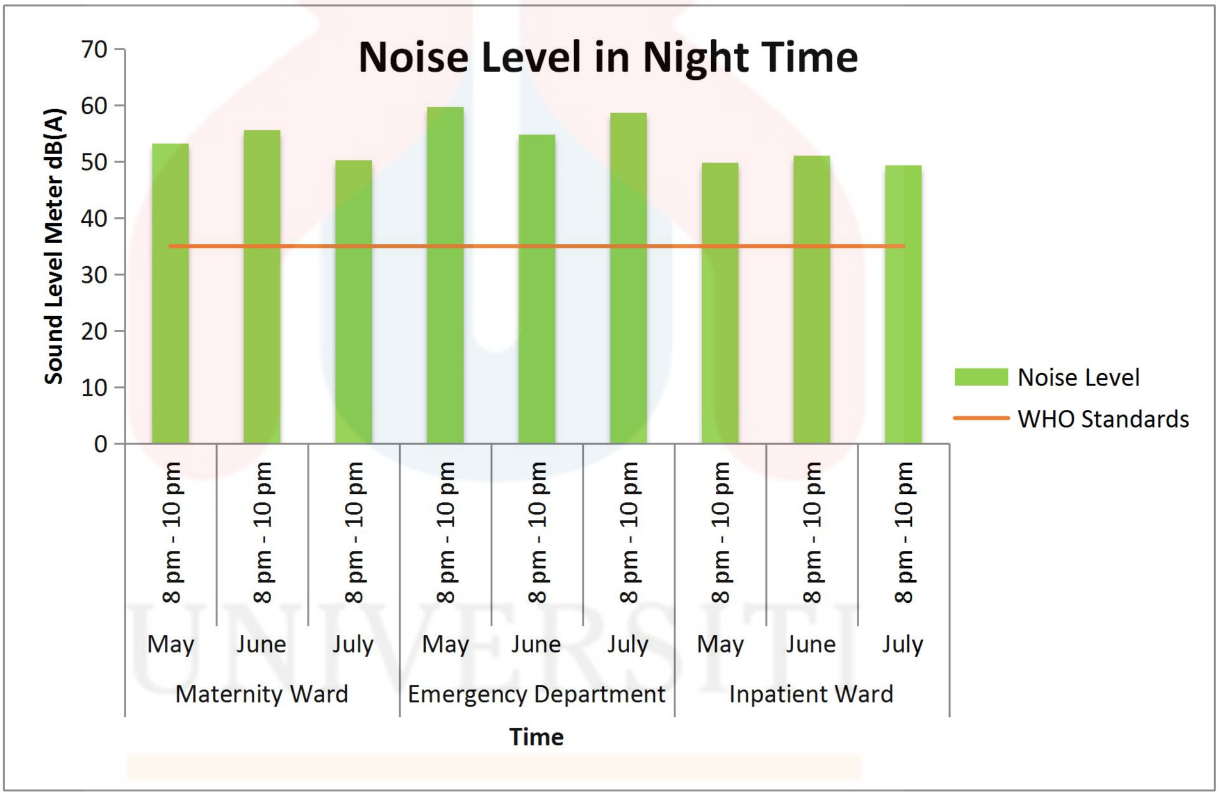

Figure 4.5: Comparison of noise level with World Health Organization (WHO) in Night Time

The comparison of noise level between selective ward and recommended guidelines by WHO standard levels. The high noise level has increased due to children crying and screaming, because of the Pediatric Ward placed near to the Maternity Ward. Meanwhile in the Emergency Department was affected by the siren of an ambulance because the accident may occur anytime. The noise level in Inpatient Ward also decreases due to less number of a visitor during night time.

4.3 Data Analysis

4.3.1 One Way ANOVA

To evaluate the noise level in hospital wards, a one-way analysis of variance (ANOVA) was conducted with the independent variable, which the average of noise as the dependent variable shown in the Table 4.1.

Table 4.1 : Analysis of Variance of Noise Level

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	195.09	2	97.545	15.407	0
Within Groups	151.948	24	6.331	-	-
Total	347.038	26	-	-	-

The result showed that the value was a statistically significant difference between groups as determined by one-way ANOVA $F(2,24) = 15.407$, $p = 0.000$.

CHAPTER 5

CONCLUSION

5.1 Conclusion

Sounds impacts produced by patients and staff occurred in many different ways. Unwanted sound or noise was a major problem in hospitals the world over. As the conclusion, the noise level in this study was exceeding the recommended guidelines by World Health Organization (WHO). The Emergency Department in Jeli Hospital showed the highest noise level between another two wards, which were Inpatient and Maternity Ward due to the noise produced by medical equipment that used to treat the patients. Emergency Department also was a 24 hours operation for unexpected accident different with other wards that have their own time for visiting hours. High noise levels negatively impact patients and staff health and well-being thus, may slow the process of healing among patients.

5.2 Recommendation

In order to upgraded more on this study, noise level data reading can be conduct in every department or wards in the Jeli hospital to compared which area that have the highest noise level reading and replace the time for reading data record from three days to one week to get the accurate level of noise. Noise level in the other sensitive ward for example pediatric ward and intensive care unit (ICU) also can be added as selective location for noise monitoring. The level of noise can be compared between sources produced and factor influence in the wards. Noise monitoring also can be done in the ward that have wider space since the previous study had been done in the less space of the treatment room.

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APPENDICES

Maternity Ward (May)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	53.5	51.0	51.9
	52.4	61.1	52.0
	52.5	53.6	51.8
	52.5	67.1	51.1
	52.6	54.1	52.1
	73.6	52.0	52.0
	52.1	59.4	51.9
	52.4	51.0	54.1
	53.1	54.0	53.3
	52.5	57.2	52.7
	51.5	53.3	53.6
	51.8	54.4	53.5
	51.1	58.5	59.7
	52.1	52.3	54.4
	52.0	53.8	53.7
	53.9	52.2	52.6
	51.9	54.6	56.4
	52.0	55.1	52.1
	51.9	57.0	53.6
	54.4	53.9	53.8
	52.5	53.3	52.5
	52.1	53.9	52.1
	52.7	63.0	52.7
	52.2	55.5	52.2
Average	55.40	57.63	53.30
Maximum	73.6	67.1	59.7
Minimum	51.1	51.0	51.1

Emergency Department (May)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
	55.1	55.1	55.1
	56.4	55.2	61.2
	55.1	56.1	60.5
	55.3	55.3	54.8
	55.2	57.9	56.4
	55.4	56.8	57.5
	55.7	56.3	56.6
	56.1	72.7	68.3
TIME/DECIBEL dB(A)	57.2	74.1	73.9
	55.8	62.3	59.9
	54.8	71.6	61.7
	55.3	61.0	62.7
	55.2	61.8	55.3
	55.2	55.4	55.7
	55.8	59.3	55.8
	60.9	55.2	59.6
	55.4	58.7	57.1
	55.1	57.1	70.4
	55.7	63.4	59.3
	55.1	60.0	61.4
	54.8	58.2	59.3
	55.3	63.3	62.6
	55.8	60.0	61.3
	55.2	63.6	55.3
Average	55.70	61.0	59.82
Maximum	60.9	74.1	73.9
Minimum	54.8	55.1	55.1

Inpatient Ward (May)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	49.6	50.5	49.5
	50.4	55.1	53.2
	51.7	63.2	49.4
	50.6	49.9	54.9
	50.0	51.5	49.8
	50.1	56.1	50.8
	49.9	53.6	50.0
	49.7	50.3	47.9
	52.5	55.3	49.2
	50.3	53.4	48.9
	49.7	51.5	49.0
	50.8	49.7	50.1
	50.0	50.4	51.5
	49.0	52.3	49.3
	51.7	53.1	48.1
	50.5	53.2	49.7
	49.3	57.5	50.2
	52.2	51.7	48.2
	52.7	50.5	49.1
	55.1	49.7	51.2
	48.9	50.9	49.6
	51.1	49.0	47.7
	50.5	51.4	49.2
	49.5	52.1	51.6
Average	54.92	52.58	49.92
Maximum	55.1	63.2	54.9
Minimum	48.9	49.0	47.7

Maternity Ward (June)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	52.5	54.2	50.3
	52.7	53.8	50.0
	52.9	55.1	51.6
	68.6	55.3	68.0
	53.4	51.3	50.6
	51.5	52.6	54.2
	55.7	51.0	50.0
	51.0	52.1	50.8
	51.7	52.3	49.5
	53.4	57.2	49.5
	53.9	61.2	48.2
	51.0	56.9	54.0
	54.5	52.8	51.4
	62.8	54.6	48.8
	53.3	54.5	51.4
	56.6	55.1	49.1
	53.2	52.7	49.5
	55.6	53.4	51.8
	52.3	54.0	54.3
	52.3	52.1	48.1
	55.0	55.2	49.5
	52.1	54.6	52.4
	71.4	51.9	53.1
	70.3	59.8	51.1
Average	55.7	54.3	55.7
Maximum	71.4	61.2	68.0
Minimum	51.0	51.0	48.1

Emergency Department (June)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	58.8	60.0	50.6
	58.3	68.2	51.6
	57.7	61.4	55.8
	60.8	65.1	61.2
	58.6	61.4	60.2
	55.9	64.4	53.9
	58.7	60.2	52.7
	61.2	66.9	53.6
	56.5	62.6	55.6
	53.8	60.1	53.2
	55.0	60.3	54.9
	61.3	61.9	54.8
	57.0	61.5	53.1
	53.3	60.3	53.0
	55.0	61.6	55.1
	51.0	62.1	54.6
	52.1	60.9	52.8
	55.4	60.7	52.7
	52.8	65.3	62.1
	51.3	61.9	57.8
	53.8	66.0	55.1
	54.6	61.5	53.2
	52.7	59.1	52.0
	51.2	65.8	58.9
Average	55.7	62.5	54.9
Maximum	61.3	68.2	61.2
Minimum	51.0	59.1	50.6

Inpatient Ward (June)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	52.0	51.5	49.6
	52.4	52.5	49.0
	53.7	54.5	50.1
	52.0	52.2	52.2
	50.2	51.3	50.0
	51.8	56.9	48.3
	52.1	60.2	49.7
	49.8	49.9	50.2
	49.2	50.7	51.5
	51.5	55.2	49.9
	49.6	50.0	48.7
	50.1	50.1	63.4
	50.2	50.4	50.5
	49.7	53.3	50.0
	49.0	54.7	51.7
	59.0	55.5	54.2
	50.5	50.4	51.1
	49.6	49.4	49.3
	51.7	64.4	50.8
	49.7	49.8	52.2
	49.2	53.6	51.8
	52.1	54.7	51.2
	50.3	56.6	49.8
	49.1	51.0	51.1
Average	48.9	53.3	51.1
Maximum	59.0	64.4	63.4
Minimum	49.0	49.4	48.3

Maternity Ward (July)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	49.9	56.4	50.4
	48.7	53.8	52.7
	47.5	54.4	49.0
	49.3	63.3	49.2
	53.4	53.7	51.8
	48.9	55.8	49.6
	48.7	51.7	48.8
	50.9	52.5	51.6
	48.6	53.0	48.2
	48.5	48.9	48.8
	50.3	51.7	49.7
	52.0	49.2	50.2
	52.7	51.2	51.9
	50.0	50.5	52.2
	53.6	53.8	50.0
	52.1	52.0	48.5
	48.3	54.3	52.0
	53.7	53.9	50.1
	50.3	51.8	51.1
	51.9	50.6	49.3
	49.2	51.5	51.6
	50.1	49.6	49.4
	53.8	50.2	52.3
	49.2	55.9	49.3
Average	50.5	52.9	50.3
Maximum	53.8	56.4	52.7
Minimum	47.5	48.9	48.2

Emergency Room (July)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	55.2	57.2	57.1
	53.7	55.9	61.6
	53.3	54.4	57.2
	54.9	52.6	58.5
	55.6	61.2	57.4
	55.3	60.3	56.1
	52.0	59.3	57.9
	53.2	63.5	58.5
	52.2	64.9	56.6
	53.1	56.6	61.7
	52.4	54.7	68.9
	54.5	53.7	62.1
	53.2	54.7	60.3
	52.1	62.9	58.0
	54.7	58.4	59.4
	54.3	57.7	56.4
	55.1	63.0	55.7
	54.2	57.0	56.0
	55.0	58.4	58.2
	54.1	73.7	57.1
	52.7	57.7	60.3
	51.9	59.5	60.1
	52.8	61.3	56.1
	53.1	53.3	58.8
Average	53.7	58.8	58.7
Maximum	55.6	73.7	68.9
Minimum	51.9	52.6	55.7

Inpatient Ward (July)

	8.00-10.00 am	2.00-4.00 pm	8.00-10.00 pm
TIME/DECIBEL dB(A)	49.7	50.9	48.4
	51.1	55.1	48.8
	49.5	50.6	48.9
	51.0	49.5	47.5
	51.7	49.3	49.9
	49.0	48.7	53.2
	51.4	56.3	47.0
	50.1	51.9	48.3
	49.4	48.8	46.4
	49.8	49.8	53.1
	50.5	53.0	46.4
	49.9	55.7	47.4
	50.1	55.2	51.7
	50.7	49.8	48.4
	50.0	53.6	47.7
	49.6	51.7	52.3
	50.3	50.5	49.2
	49.5	50.2	49.0
	50.1	50.2	50.9
	52.8	50.1	49.2
	50.3	50.5	51.1
	51.7	55.1	50.0
	52.4	48.5	49.4
	48.5	51.8	50.5
Average	50.3	51.5	49.4
Maximum	51.7	56.3	53.2
Minimum	48.5	48.5	46.4

Noise level sampling in the Maternity Ward

Noise level sampling in the Inpatient Ward