THE ENVIRONMENTAL IMPACTS OF CONSTRUCTION ACTIVITIES

LING MING TENG

UNIVERSITI TUNKU ABDUL RAHMAN

THE ENVIRONMENTAL IMPACTS OF CONSTRUCTION ACTIVITIES

LING MING TENG

A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Quantity Surveying

Faculty of Engineering and Science
Universiti Tunku Abdul Rahman

August 2011

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

Signature : _____

Name : _____

ID No. : _____

Date : _____

APPROVAL FOR SUBMISSION

I certify that this project report entitled **"THE ENVIRONMENTAL IMPACTS OF CONSTRUCTION ACTIVITIES"** was prepared by **LING MING TENG** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Quantity Surveying at Universiti Tunku Abdul Rahman.

Approved by,

Signature : _____

Supervisor : Prof. Dr. Ng See Seng

Date : _____

Specially dedicated to
my beloved grandmother, mother and father

ACKNOWLEDGEMENTS

The author cannot fully express her deepest gratitude to **Dr Ng See Seng,** her project dissertation supervisor for his patient guidance, useful advice, and comments in assisting the improvement and the completion of this piece of research.

A debt of gratitude to the 30 respondents and interviewees who had taken time off their hectic schedule to assist in the completion of her questionnaires vital for this piece of research.

The author would be remiss if she did not express her sincere appreciation to her family and friends who had been her pillars of strength throughout the course of conducting the research. Their encouragement and pressure had led to her perseverance to perform the best she could. She would not be in her position today without their help. She is sincerely grateful for all the blessings she had obtained.

THE ENVIRONMENTAL IMPACTS OF CONSTRUCTION ACTIVITIES

ABSTRACT

The construction industry is one of the economic sectors that play an important role in contributing to Malaysian economic development. As compared to other industries, construction has an important activity and that is consumption of energy and non renewable resources and it also generates a fairly large amount of pollutants, including air emissions, noise, solid waste, and water discharge. Environmental impact can occur at the various stages of property development, from construction to occupation, if inadequate mitigation measures are taken. Therefore, the adverse environmental impacts initiate by construction activities cannot be neglected.

The rationale underlying this piece of research is to investigate the causes, effects and also the solutions to improve environmental impacts due to construction activities in Kuala Lumpur. This study is carried out based on literature review, questionnaire survey, and also interview. Basically, the environmental impacts being studied in this research are focused on noise pollution, air pollution, and water pollution.

In order to improve the working environment of construction site to a better condition, managerial and advanced technologies, developing alternatives or using green in building material, and good planning are necessary. Through this research, the author wishes that the environmental impacts due to construction in Malaysia will be reduced.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS / ABBREVIATIONS

CIDB	Construction Industry Development Board
DOE	Department of Environment
NIOSH	National Institute of Occupational Safety & Health
GDP	Gross Domestic Product
dB	decibels
L_{Aeq}	maximum permissible sound levels
$L_{eq(8)}$	Sound level for 8 hours
TWA	Time-Weighted Average
PM	particulate matter
DPM	diesel particulate matter
rho	Spearman Rank Correlation Coefficient
API	Air Pollution Index
WQI	Water Quality Index
PM10	suspended particulate matters
TSP	total suspended particulate
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
SS	Suspended Solids
DNA	deoxyribonucleic acid
PVC	Polyvinyl chloride
PU	polyurethane
SO2	sulphur dioxide
NO2	nitrogen dioxide
CO	carbon monoxide
O3	ozone
NH_3N	Ammoniacal Nitrogen

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Research Background

The construction industry is one of the economic sectors that play an important role in contributing to Malaysian economic development. The property construction sectors expanded rapidly in the late 1980's as a result of the high demand for houses. Due to the rapid construction development, environmental issues are becoming areas of concern in construction industry.

Environment as defined in the Environmental Quality Act 1974 means the physical factory of the surroundings of the human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants ant the social factor of aesthetics. In Malaysia, there are very few studies and researches conducted on the subject of the severity of pollution towards the environment during construction in the previous because of the low awareness. The issues regarding sustainability and green construction have been duly highlighted in the Construction Industry Master Plan (2005 – 2015) as being of significant importance for the Malaysian Construction Industry. The Malaysian government is also committed to addressing sustainability issues and meeting its target and obligations in this regard.

Compared with other industries, construction has an important consumption of energy and non renewable resources and also generates a fairly large amount of pollutants, including air emissions, noise, solid waste, and water discharge.

Environmental impact can occur at the various stages of property development, from construction to occupation, if inadequate mitigation measures are taken. Therefore concern for the environment needs to be addressed throughout the project cycle; that is right through planning, designing, construction, and occupation. Environmental issues depend on the activities undertaken during implementation and the sensitivity of the project site. The most damaging impact normally occurs during the construction stage.

According to Cole (2000), the limited attention given to the on-site construction impacts is due to (1) the perceived relatively lower significance of construction impacts compared with the lifecycle impacts associated with building design and management and (2) the inherent temporality related to the on-site construction (generally speaking, a non-existing environmental management in the construction process is not noticed during the life span of the building).

1.2 Problem Statement

Nowadays, more and more environment impacts occurred due to the construction activities. Such environmental impacts have threatened human beings' health and safety and cannot be neglected anymore. As to minimize the environmental impacts during the construction period, constant observation and assessment should be carried out. In order to achieve sustainable construction in Malaysia, factor affecting the environmental impacts and the degree of pollution towards the environment should be identified.

1.3 Aim and Objectives

The aim of this study is to investigate issues concerning the current environmental impacts in relation to construction activities. In addition, to minimise the negative effects of construction activities contribute to the environment.

The objectives of this study are:-

(1) to identify the causes of environmental impacts due to the construction activities.
(2) to identify the effects of environmental impacts due to the construction activities.
(3) to search for solutions and make suggestions to solve and improve the current environmental impacts due to construction activities.

1.4 Scope and Limitations of Study

The scope of research is mainly focus on the literature review, questionnaire survey, and interview. The environmental impacts that investigated in this research included noise, air, and water.

The questionnaire survey was designed based on factors identified from literature review that contributed to causes of pollution of noise, air, and water. The questionnaire survey was distributed to the developers, consultants, and contractors in Kuala Lumpur. Interview was accomplished by the interviewees regarding to issues of environmental impacts.

The limitation to this piece of research is that the, the research study is only being conducted in Kuala Lumpur and the findings cannot be generalised to the whole population due to the fact that the sampling methods applied are non-random. Furthermore the respondents involved might possess the characteristics that are unique to them instead of being representative of the whole population. As a result, the findings are only good for the population involved in this research.

1.5 Chapter Outline

Chapter 1 consists of a research background of construction industry in Malaysia, follow by the discussion of the problems statement, aim and objectives, scope and limitation of this study. And lastly, the chapter outline of this study.

Chapter 2 contains literature review which is through, comprehensive, relevant, and consistent with the research topic. In this chapter, the sustainable development, construction activities, impacts of construction industry to the environment and assessment of environmental impacts due to construction activities will be discussed. Besides that, critical points of view are concluded to a case study.

In Chapter 3, theoretical aspect of research methodology will be carried out. Various approaches have been used to conduct this research to data collection. This chapter also includes the research design; which demonstrate how the questionnaire survey and interview are designed and how the data is collected.

Chapter 4 will present the result of data collected and analysis data based on respondents' feedback. The consistency of the survey results will be evaluated and discussed by application of suitable literature reviews. A summary on the interviewee's opinions will be carried out and critical comment will be made on the summary.

In the final Chapter, the conclusion of the analysis will be carried out. And lastly, some recommendations and suggestions to solve improve the current environmental impacts due to construction activities will be included.

CHAPTER 2

LITERATURE REVIEW

2.1 Sustainable Development

The term Sustainable Development was coined in 1987 in 'The Brundtland Report' as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainability is a complex issue. Gosen et.al (2009) stated that sustainable development has three components; social, economic and ecological/environmental sustainability. Environmental sustainability included increasing energy efficiency, reducing the amount of energy a structure needs in the long term, using sustainable materials such as recycled materials and renewable materials. Environmental sustainability also includes measures which are designed to benefit the environment, such as the use of nontoxic building materials and water reduction measures.

Economic sustainability is the term used to identify various strategies that make it possible to utilize available resources to best advantage. In most scenarios, the measure of economic sustainability is presented in monetary terms. For example, energy efficiency which saves money in the long term, the use of materials which are economically feasible to install, maintain, replace, and repair. Social sustainability can include a consideration of how a building will be used, and the integration of design which makes the building highly flexible so that it can be easily repurposed as needs change, rather than being replaced.

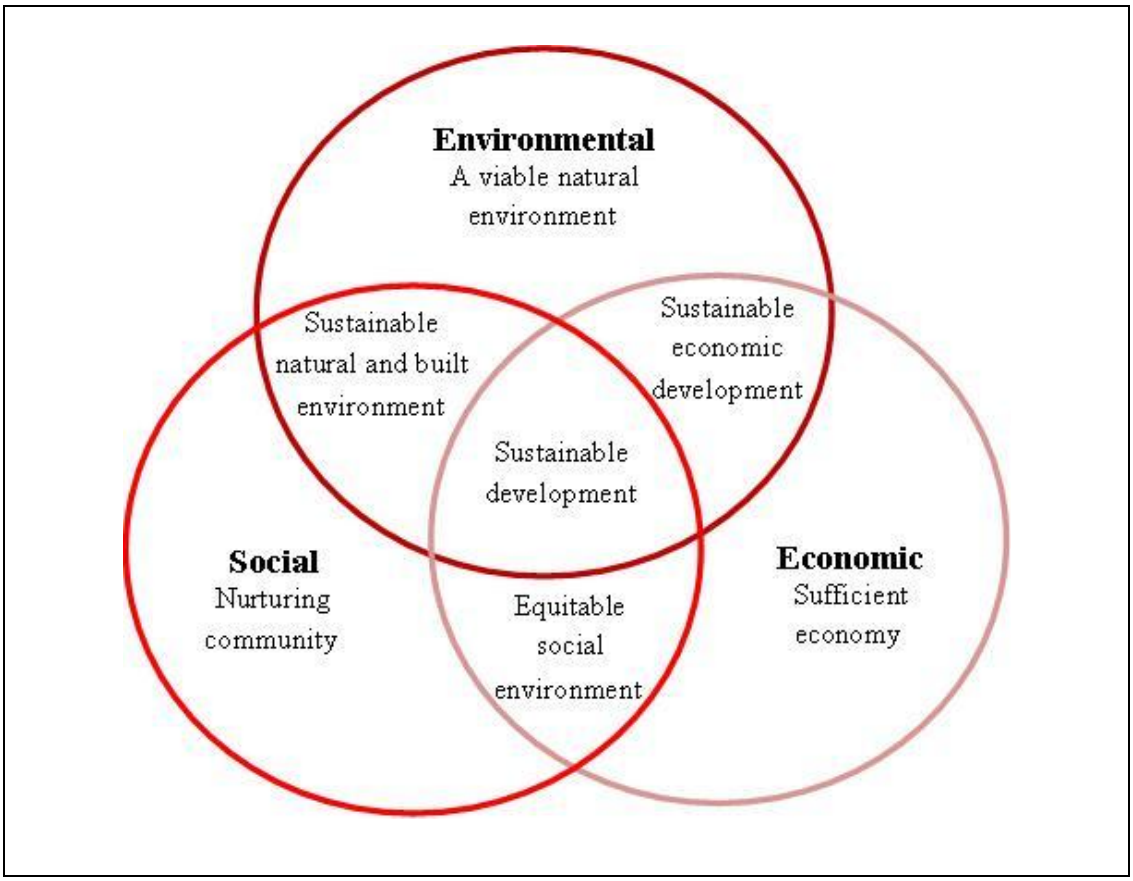

Figure 2.1: Fundamental of Sustainable Development (Agenda 21, 1992)

Agenda 21 (1992) reported that sustainable development required a systematic consideration of the environment when decisions made on economic, social, fiscal, energy, agricultural, transportation, trade and other policies, as well as the implication of policies in these areas for the environment. Referring to figure, the concept of sustainable development is a balanced development which takes environmental, social, and economic system into consideration to provide a healthy and useful life for all human beings, in the present and also the future. Sustainable development in modern context is best define as "the design of human and industrial system to ensure that humankind's use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment. (Mihelcic et al. 2003)"

Sustainability requires a rare balance between the three sets of goals; social, economic and environmental. Sustainable or "green" construction is a type of

construction which is concerned with environmental impacts in addition to the creation of a usable structure. A construction which concerned about the construction's environmental impacts and long term building use, considering whether a structure is economically rational to build and maintain, and also whether a structure fits sustainably into the social structure in the area where it is being built is considered a good sustainable construction. When people build sustainably, it means that they build in a way which is considered sustainable, meaning that the building practices used can be utilized in the long term without causing damage to the environment.

Bon & Hutchinson (2000) confirm that in efforts to achieve sustainability, minimizing pollution and waste production itself is inadequate. Environmental issues are a global concern (Chan & Chan, 2004) and protecting the environment is a main issue in construction industry (Ding, 2005). Efforts put in by all the parties concerned in the construction industry, has made the negative environmental impacts of construction projects to be wider better understood by architects, engineers, operators, and owner (TCPA, 2003).

2.2 Construction Activities

2.2.1 Preconstruction Stage

The preparation of the site is the very essential thing to do before any construction project is start. When the builder has taken over the site, three major operations shall be done; there are site clearance, building setting out, earth works and datum level establishment.

2.2.1.1 Site Clearance

During the site clearing works, the following shall be monitored:-

- Extent of the site clearing works
- Grubbing out of roots
- Removal of rubbish, vegetable matter etc from site
- Removal and diversion of existing utilities

Clearing is defined as the removal of all trees, brush, and so forth, and is required in all work areas. Grubbing is defined as the removal of stumps and roots. Clean up debris resulting from site clearing operations continuously with the progress of the work. Besides that, remove all waste material and debris from site in such a manner are needed as to prevent spillage. Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times are also necessary in site clearance stage.

From the site, remove trees, brush, shrubs, down timber, rotten wood, rubbish, and other vegetation, as well as fences and incidental structures or demolition of existing building are necessary to allow for new construction. It is not always necessary to remove all stumps systems beneath embankments. Trees and brush should be cut off close to the original ground surface so that the initial layers of fill can be placed and compacted properly.

2.2.1.2 Site Setting Out

Setting out is the first stage of construction in a site. This involves outlining the structure on the ground. It is necessary to consider the angle to plot boundary line when setting out the building on the ground. Setting out begins from a plot corner and marked with pegs. Drawings are usually used to locate the extent of the building line within the mapped area and mark corners. After the setting out proceeded, the profile boards which is either timber or metal boards will be set off the building line. Profile boards are needed at all trench and wall intersections to locate the position of

trench, foundation, and wall and also indicate the foundation width and wall thickness.

For any new house or extensions or alterations mapping out is very important to avoid costly errors. There are factors to consider when laying out the building plans on site. These include the size of the plot, neighbours, driveways, and sun direction. Besides that, planning requirements by the local authorities and services required to the site, such as electricity, water, sewers, communication, and roads.

2.2.1.3 Earthworks and Datum Level Establishment

Earthworks are works created through the moving and/or processing of quantities of soil or unformed rock; activities of cutting or filling of soil to satisfy the project requirements. Earthwork plays major role in construction project because it prepares the construction platform, the temporary drain system, and also the foundations.

Datum level defined as any level surface, such as mean sea level, used as a reference from which elevations are reckoned. Datum is a fixed point that serves as the benchmark for all level in a building. Cut and fill of the existing ground might be necessary to meet the requested level of building, based on the measurement set on the site datum.

2.2.2 Construction Stage

2.2.2.1 Substructure

Substructure can be defined as all structure below the superstructure which in general terms is considered to include all structure below ground level but including the ground floor bed. Groundwork and subsurface works form an essential part of any build, whether it is a private dwelling, railway line, or new road. Most groundwork

and substructure works are undertaken to prepare the site for the proposed structure and to create foundations necessary for its support. Substructure work involves excavations and backfilling of soils. Examples of substructure are pilings, foundations, basements, and retaining walls.

2.2.2.2 Superstructure

Superstructure can be defined as all structure above substructure both internally and externally. Superstructure consists of primary elements, secondary elements, and finishes or so called architectural works. Primary elements basically are the components of the building carcass above the substructure excluding secondary elements, finishes, services, and fittings. Secondary elements are the completion of the structure including completion around and within openings in primary elements. Superstructure works included frame, upper floors, roof, staircases, external and internal walls, partitions, windows and doors. Architectural works are the finishing work to a building. Finishes are the final surface which can be self finished as with a trowelled concrete surface or an applied finish such as tiling. In addition, architectural works also include internal fixtures and fittings, M & E fittings, painting and decorating.

2.2.2.3 Infrastructure

Infrastructure is the basic physical and organizational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function. The term typically refers to the technical structures that support a society, such as roads, water supply, sewers, electrical grids, telecommunications, and so forth. The infrastructural works may also involved excavation, backfilling, and trenching.

2.3 Impacts of Construction Industry to the Environment

The construction sector which being one of the most important contributors to overall socio-economic development in every country is, on the other hand, a major consumer of natural non-renewable resources and also a significant polluter to the environment. Environmental awareness and protectionism is going strongly especially among the developed countries.

As a developing country, Malaysia realised that the construction industry plays an important role in its economic growth. Over the last 20 years, the industry has been consistently contributing between 3% - 5% of the national GDP (Construction Industry Development Board (CIDB, 2011). However, the industry is not without weaknesses. Challenges have been in the areas of productivity, quality, safety, technology, unproductive practices, and also environmental impacts.

The demand for environment conservation through extensive use of non-fossil fuel energy sources, biodegradable materials, composites, recycling and reuse of waste materials together with the climatic changes and depletion of resources will also demand the construction industry to change.

In her advance towards a developed country in year 2020, Malaysia has not been spared from environmental problem. Lack of awareness for sustainable development principle is one of the barriers of sustainability (Azapagic, 2003). In efforts to increase awareness, the CIB Report (CIB W82, 1998) introduced steps to reduce environmental impact that result from construction.

2.4 Assessment of Environment Impacts from Construction Activities

Activities that may cause environmental impacts during construction include site preparation (e.g., clearing and grading); facility construction (e.g., geothermal power plant, pipelines, transmission lines); and vehicular and pedestrian traffic. Shen and Tam (2002) classified construction environmental impacts as the extraction of

environmental resources such as fossil fuels and minerals; extending consumption of generic resources, namely, land, water, air, and energy; the production of waste that require the consumption of land for disposal; and pollution of the living environment with noise, odours, dust, vibrations, chemical and particulate emissions, and solid and sanitary waste. The focus of this study in construction impacts are noise, air, and water.

2.4.1 Noise

Noise is unwanted sound, annoying, and damaging sound. Sound by itself is not pollution but when it interferes with a person's territory, it can create nuisance to the receptor. Noise reaches a listener by several paths (Harris, 1797). Before it can reach the ear, it first must travel at some distance through air. The transmission of sound is shown in Figure 2.2.

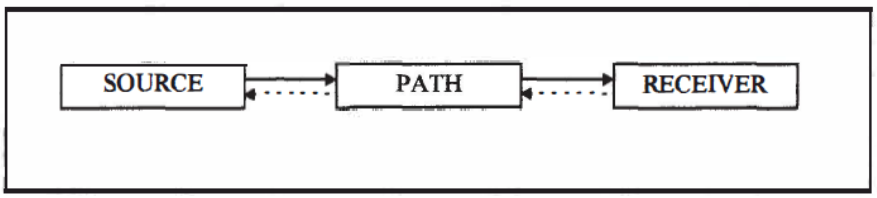

Figure 2.2: Schematic Diagram of Transmission of Sound (Harris, 1979)

Rapid population growth result in growing of noise problem. More people are making more noise. As population increases the requirement for lodging would also increases. Therefore, more and more construction projects are carried out. Noise arising from construction activities is a common problem. There are different sources of noise pollution at construction sites. The primary source of noise during the construction phase would be the construction of the geothermal power plant, which would occur over a period of 2 to 10 years.

Besides that, tools and equipment were found to be the major source of noise at construction sites (Sinclaire and Haflidson, 1995). The use of excavation

equipment, machinery, and trucks or heavy vehicles is very common in many construction sites. For examples, air compressor, hand-held breaker, concrete mixer, bull dozers and excavators. Construction activities will contribute to an increase in noise levels at the project site and along the pipeline route typical of any roadwork.

Occupational exposure to high noise levels from such vehicles, tools and equipment places hundreds of thousands of construction workers at risk of developing hearing impairment and hypertension (NIOSH, 1990). In the construction industry, noise-induced hearing impairment is the most prevalent irreversible occupational hazard and it is estimated that 120 million people worldwide have developed hearing difficulties due to noise. Workers in the construction industry are at a particular risk.

2.4.1.1 Standard Measurement of Noise Pollution

According to Department Of Environment (DOE), measurements of noise levels are often necessary for any of the following purpose:

(a) Assessing the existing noise climate.
(b) Assessing compliance to noise limits for noise source(s) and/or project development.
(c) Assessing environmental impact and potential community response.

Intensity or loudness is measured in decibels, dB. The basic instrument used for the measuring of noise is the sound level meter. This instrument is designed to respond in approximately the same way as the human ear and gives objective assessment of sound pressure level. A normal hearing range usually ranges from 0 to 140 dB. A whisper is around 30 dB, and normal conversations are usually 45 to 50 dB. Sounds that are louder than 85 dB can be uncomfortable to hear and hearing begins to be damaged. Extreme sounds, 120 dB or louder can be quite painful and can result in temporary or permanent hearing loss. Noise contours at construction sites indicate that large portions of construction sites may have sound levels over 85–

90 dB. Construction workers working on or around heavy equipment have particularly high noise exposures (Utley and Miller, 1985).

Receiving Land Use Category	Day Time 7.00 am - 10.00 pm	Night Time 10.00 pm - 7.00 am
Noise Sensitive Areas, Low Density Residential, Institutional (School, Hospital), Worship Areas.	50 dBA	40 dBA
Suburban Residential (Medium Density) Areas, Public Spaces, Parks, Recreational Areas.	55dBA	45 dBA
Urban Residential (High Density) Areas, Designated Mixed Development Areas (Residential - Commercial).	60 dBA	50 dBA
Commercial Business Zones	65 dBA	55 dBA
Designated Industrial Zones	70 dBA	60 dBA

Figure 2.3:Maximum permissible sound levels (L_{Aeq}) by receiving land use planning and new development (Environmental Noise Limits and Control, 2007)

Receiving Land Use Category	Noise Parameter	Day Time 7.00 am - 7.00 pm	Evening 7.00 pm - 10.00 pm	Night Time 10.00 pm - 7.00 am
Residential (Note 2 **)	L_{90}	60 dBA	55 dBA	* (Note 1)
	L_{10}	75 dBA	70 dBA	*
	L_{max}	90 dBA	85 dBA	*
Commercial (Note 2 **)	L_{90}	65 dBA	60 dBA	NA
	L_{10}	75 dBA	70 dBA	NA
Industrial	L_{90}	70 dBA	NA	NA
	L_{10}	80 dBA	NA	NA

NOTES

*1. *At these times the maximum permissible levels as stipulated in the Schedule 1 for the respective residential density type shall apply. This may mean that no noisy construction work can take place during these hours.*

**2. *A reduction of these levels in the vicinity of certain institutions such as schools, hospitals mosque and noise sensitive premises (apartments, residential dwellings, hotel) may be exercised by the local authority or Department of Environment.*

Where the affected premises are noise sensitive, the limits of the Schedule 1 shall apply.

3. *In the event that the existing ambient sound level (L_{90}) without construction, maintenance and demolition worksis higher than the L_{eq} limit of the above Schedule, the higher measured ambient L_{eq} sound level shall prevail. In this case, the maximum permissible L_{10} sound level shall not exceed the Ambient L_{90} level + 10 dBA, or the above Schedule L_{10} whichever is the higher.*

4. *NA – Not Applicable.*

Figure 2.4: Maximum permissible sound levels (percentile L_n and L_{max}) of construction, maintenance, and demolition work by receiving land use (Environmental Noise Limits and Control, 2007)

2.4.1.2 Effects of Noise Pollution

Noise pollution can affects human beings in several ways, such as hearing problems, cardiovascular issues, sleep disturbances, interference in verbal communication and mental health problem.

Exposure to noise can damage one of the most vital organs of the body, the ear. Hearing impairment due to noise pollution can either be temporary or permanent. A noisy environment can be a source of heart related problems. Studies have shown that high intensity sound cause a dramatic rise in blood pressure as noise levels constrict the arteries, disrupting the blood flow. The heart rate (the number of heart beats per minute) also increase. These sudden abnormal changes in the blood increase the likelihood of cardiovascular diseases in the long run.

When noise is at 45 decibels, no human being can sleep. Noise can interrupt a good night's sleep; the person would feel extremely annoyed and uncomfortable. People deprived of uninterrupted sleep show a sharp dip in their energy levels which often results into extreme exhaustion. Very high levels of noise can wake people from their sleep and keep them awake or disturb their sleep pattern. This can considerably decrease a person's ability to work efficiently and make them irritable and tired the next day.

A noisy environment that produces more than 50-60 decibels simply does not allow 2 people to communicate properly. Interpreting the speech of a second person becomes quite difficult and may lead to misunderstandings and may also cause problems such as partial deafness. Exposure to loud sound can lead to high stress levels as well as stimulate violent behaviour. A constant noise in the vicinity can also trigger headaches, make people tense and anxious, and disturb emotional balance.

To prevent excessive noise levels, all contractors will be required to provide working machinery and equipment with noise suppression devices equivalent to original equipment. The construction activities will only occur during the daytime hours and should not affect night-time noise levels.

2.4.1.3 Case Review

In Tan's study, noise sampling points are set at the boundary of the construction site. Two measurement stations are identified and assumptions are made which the noise data of the station are only the readings from the construction activities noise. Three distances are measured from each station, which are 15m, 30m and 60m respectively away from the site boundary. The microphone is positioned at a height of 1.2m – 1.5m above the ground. Equipment used is an integrating sound level meter. The instrument is set to sample the A-weighted sound level and the energy-equivalent sound level for 8 hours, $L_{eq(8)}$ is to be acquired. The measurement are made from 8am till 5pm and assume that the noise level at night time is not serious due to no construction activity being carried out. Besides that, eight major construction equipments had been chosen for measuring the noise level received by the workers at the source of noise.

The result of the case studies was attached in the appendix and only will focus on the data of station B due to more activities were carried out near to the said station. According to the DOE, maximum permissible sound levels (L_{Aeq}) by receiving land use suburban residential area is 55 dB. Table 4.6 in Appendix D shows the maximum noise levels, which are 66.4 dB, 59.3 dB and 60.1 dB recorded at station B respectively. From the data showed, the author concluded that nuisance were to be experienced by the residents around the said construction site within the distance of 60m from then site boundary.

Table 4.7 in Appendix D shows the noise level for few types of typical equipment used during construction phase. From the table, concrete hammering activity contribute the less noise, 76.3 dB while tile cutter activity contribute the most noise which is 87.6 dB. Other machine such as generator, concrete mixer, compactor, backhoe, dumping truck, water truck also produces noise from 77.6 dB to 83.9 dB. Sounds that are louder than 85 dB can be uncomfortable to hear and hearing begins to be damaged. According to NIOSH, the Noise Recommended Exposure Limit (REL) for occupational noise exposure is 85 dB, A-weighted, as an 8-hr Time-Weighted Average – TWA. Exposures at and above this level are

considered hazardous. In the author's opinion, workers who use the tile cutter in the said construction site may work at the risk of hearing loss.

2.4.2 Air

Air pollution normally refers to pollution of the atmosphere within which most pollutants have a varied life time before they are washed out by rain, transformed by reaction, or deposited to the ground (Petts, 1994). Polluted air usually measured in terms of "particulate matter" or the number of particles of these potentially hazardous substances as a percentage of air. It is contains one, or more, hazardous substance, pollutant, or contaminant that creates a hazard to general health.

Construction dust is classified as PM10, which is invisible to the naked eye. Another major source of PM10 on construction sites comes from the diesel engine exhausts of vehicles and heavy equipment. This is known as diesel particulate matter (DPM) and consists of soot, sulphates, and silicates, all of which readily combine with other toxins in the atmosphere, increasing the health risks of particle inhalation. Diesel is also responsible for emissions of carbon monoxide, hydrocarbons, nitrogen oxides, and carbon dioxide.

Construction activities that contribute to air pollution include land clearing and grading, operation of diesel engines, demolition, working with toxic materials, power plant and pipeline system construction, and transmission line construction. The open burning of waste and fires on disposal sites can cause major air pollution. The products of combustion include dioxins which are particularly hazardous which will cause illness and reducing visibility thus making disposal sites dangerously unstable. It may also cause explosions of cans, and possibly spreading to adjacent properties. Noxious vapours from oils, glues, thinners, paints, treated woods, plastics, cleaners and other hazardous chemicals that are widely used on construction sites, also contribute to air pollution.

Emissions generated during the construction phase include exhaust from vehicular traffic and construction equipment, fugitive dust from traffic on paved and unpaved roads, and the release of geothermal fluid vapours; especially hydrogen sulphide, carbon dioxide, mercury, arsenic, and boron. All construction sites generate high levels of dust; typically from concrete, cement, wood, stone, silica and this can carry for large distances over a long period of time.

2.4.2.1 Standard Measurement of Air Pollution

As refer to DOE, the air quality in Malaysia is described in terms of Air Pollutant Index (API). The API is an indicator of air quality and was developed based on scientific assessment to indicate in an easily understood manner, the presence of pollutants, and its impact on health. The API system of Malaysia closely follows the Pollutant Standard Index (PSI) developed by the United States Environmental Protection Agency (US-EPA).

The air pollutants index scale and terms used in describing the air quality levels are as follow:

Table 2.1: API scale versus Air Quality (DOE, 2007)

API scale	Air quality
0 – 50	Good
51 – 100	Moderate
101 – 200	Unhealthy
201 – 300	Very unhealthy
301 and above	Hazardous

The CAQM stations measure the concentration of 5 major pollutants in the ambient air, namely, suspended particulate matters (PM10), sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), and ozone (O3). These

concentrations are measured continuously on hourly basis. The hourly value is then averaged over 24-hour running period for PM10 and SO2, 8-hour period for CO, whilst O3 and NOx are read hourly. An hourly index is calculated for each pollutant. The highest index value recorded is then taken as the API for the hour.

2.4.2.2 Effects of Air Pollution

People have no choice but to breathe the air around them regardless of its quality. Air pollution can affect our health in many ways with both short-term and long-term effects. People with health problems such as asthma, heart, and lung disease may also suffer more when the air is polluted. When air is polluted, people breathe in ozone, particles, and harmful gases that can hurt their lungs, heart, and overall health. Short-term air pollution affect can cause wheezing, coughing, burning eyes, chest tightness, headaches, and breathing problems.

Breathing small amounts of air pollution over many years is also considered dangerous. It may even contribute to life-threatening diseases. Research has shown that PM10 penetrate deeply into the lungs and cause a wide range of health problems or so called long-term effects including respiratory illness, asthma, bronchitis, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys.

2.4.2.3 Case Review

In Tan's study, the air parameter to be monitored is the total suspended particulate (TSP). Equipment was set up to the highest spot of the site and the sampling process was run from 8am to 5pm and the air quality was assumed to be no significant dilemma at night due to stop of construction activities.

The concentration of total suspended particulate (TSP_{24}) in the air within the construction site is 133.32 $\mu g/m^3$ as attachment in Appendix D while the limit of

PM10 is 150 μg/m^3. The result of the experiment showed that the said site is under good condition as compared to the PM10 value in the Recommended Malaysia Air Quality Guideline.

In the author's opinion, the result may be not that accurate because the value in PM10 was based on a 24 hours running period while the study is only carried for 8 hours running period and later multiplied by 3 to get the assumed value of TSP_{24}. Besides that, the case was not tested on the level of sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), and ozone (O3). So, a more accurate Air Pollutant Index (API) cannot be calculated due to the insufficient info.

2.4.3 Water

Water is important elements in construction industry. Depending on its availability, it may be trucked in from off-site or obtained from local groundwater wells or nearby municipal supplies. Water pollution can come from a variety of sources, including industrial sources, landfills, or construction activities. During the construction phase, water would be required for dust control, making concrete and consumptive use by the construction crew. Excavation and piling works may produce muddy water and bentonite slurries in the construction site.

Construction activities can affect runoff water quality, adding pollutants to the storm drain systems and local waterways. Impacts to water resources during the construction phase would be sensible because of ground disturbing activities which related to road, well pad, and power plant construction could lead to an increase in soil erosion and surface runoff.

Sources of water pollution on construction sites include diesel and oil, paint, solvents, cleaners and other harmful chemicals, construction debris and dirt. Pollutants on construction sites can also soak into the groundwater, a source of human drinking water. Once contaminated, groundwater is much more difficult to treat than surface water.

2.4.3.1 Standard Measurement of Water Pollution

The DOE developed a Water Quality Index system (WQI) to analyse trends in water quality. WQI is computed based on 6 main parameters, which are Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (NH_3N), pH, Dissolved Oxygen (DO) and lastly Suspended Solids (SS). Then later, the water quality data were used to determine the water quality status weather in clean, slightly polluted, or polluted category and to classify the rivers in Class I, II, III, IV, or V based on WQI and Interim National Water Quality Standards for Malaysia (INWQS) every year. (DOE, 2011)

2.4.3.1 Effects of Water Pollution

Polluted water flowing from waste dumps and disposal sites can cause serious pollution to water supplies. Chemical wastes may be fatal or have serious effects if ingested, inhaled or touched and can cause widespread pollution of water supplies.

Water pollution may cause some serious disease to human beings, such as cancer, hormonal problems that can disrupt reproductive and developmental processes, damage to the nervous system, liver, kidney, and also damage to DNA. Water pollution may also result from interactions between water and contaminated soil, as well as from deposition of air contaminants, such as acid rain.

2.4.3.2 Case Review

In Tan's study, 4 sampling points (W1, W2, W3 and W4) were established at the nearest surface water bodies around the construction site, which are manmade lake nearby, trapped area in the temporary site drain, sump of the storm drain, and discharge from the site storm drain into the existing storm drain system. The manmade lake nearby and trapped area in the temporary site drain were provides

water supply for daily construction activities such as mortar mixing. The temporary toilets are set up nearby the storm drain and wastewater is discharge directly into the drain. 6 water parameters were being tested, which included Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solid (SS), Ammonical Nitrogen (AN) and pH value. Water Quality Index (WQI) is computed to define the water quality status.

From the result in Appendix D table 4.1, WQI for each sample is in good water quality except W3. Water quality of W3 is largely influenced by the wastewater from workers' squatters. In the author’s opinion, the WQI for each sample was in good water quality may because the case studies were carried out mainly on architectural works. Most of the construction activities which will contribute to water pollution had been done before the case was being studied. So, the result gathered should not be generalised to the underlying water quality.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Research is the foundation of modern organizational science in academics. It is a structured enquiry that utilizes acceptable scientific methodology to solve problems and create new knowledge that is generally applicable. Sekaran (2006) stated that research is the process of finding solutions to a problem after a thorough study and analysis and Cooper & Schindler (2001) stated that research is systematic inquiry that provides information to guide decision.

3.2 Types of Research

Basically, research can be classified by its purpose or by method. There are two major categories by purpose, which are Applied Research and Basic Research. While in case of method, it is characterized by the techniques employed in collecting and analyzing data. On the basis of method, research can be classified as historical, descriptive, correlational, ex-post facto and experimental.

3.2.1 Applied Research

Sekaran (2006) states, “Research done with the intention of applying the result of the finding to solve specific problem currently being experienced in the organization is called applied research.” Applied Research is use of past theories, knowledge and methods to solve a particular existing problem faced by a particular organization. It deals with practical problems arising out of overpopulation and scarcity of natural resources.

Applied research focuses on uncovering what needs are not being met and use that information in designing products or services that would create their own demand. Thus, applied research brings in new customers and also provides better products and services to the existing customers.

3.2.2 Basic Research

Basic Research also called Pure or Fundamental Research; it is to better understand certain phenomena or behaviour as it applies to all industries/business in general but does not seek to solve any existing problem. “Research done chiefly to enhance the understanding of certain problem that commonly occur in organization setting, and seek method of solving them is called basic or pure research”. (Sekaran, 2006)

There is no direct benefit as it is a research for the sake of research. It is conducted to satisfy any curiosity such as: (a) what makes things happen, (b) why society changes and (c) why social relations are in a certain way. In fact, it is the source of most new theories, principles, and ideas. Basic research rarely helps anyone directly. It only stimulates new ways of thinking. The main motivation is to expand man's knowledge. There is absolutely no commercial value to the discoveries resulting from such research.

3.2.3 Historical Research

Historical research is the process of systematically examining past events to give an account of what has happened in the past. This may help in explaining present events and anticipating future events. The data are not gathered by administering instruments to individuals, but are collected from original documents or by interviewing the eye-witnesses (primary source of information). In case primary sources are not available, data are collected from those other than eye-witnesses (secondary sources). The data thus collected are subjected to scientific analysis to assess its authenticity and accuracy.

3.2.4 Descriptive Research

Descriptive research is also called Statistical Research. The main goal of this type of research is to describe the data and characteristics about what is being studied. It concerns with determining the current practices, status, or features of situations. The idea behind this type of research is to study frequencies, averages, and other statistical calculations. Although this research is highly accurate, it does not gather the causes behind a situation.

Descriptive research is mainly done when a researcher wants to gain a better understanding of a topic. It is quantitative and uses surveys and panels and also the use of probability sampling. Descriptive research is the exploration of the existing certain phenomena. The details of the facts won't be known. The existing phenomena facts are not known to the persons.

3.2.5 Correlational Research

Correlational research are studies that are often conducted to test the reliability and predictive validity of instruments used for division making concerning selection of

individuals for the likely success in a course of study or a specific job. It helps us to understand related events, conditions, and behaviours. It is a statistical measure of a relationship between two or more variables, gives an indication of how one variable may predict another.

3.2.6 Ex-Post Facto Research

Ex-post Facto research is systematic empirical inquiry in which the scientist does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulated. Thus, in ex-post facto research or causal-comparative research the researcher has no control on the variables or he cannot manipulate the variables (independent variables) which cause a certain effect (dependent variables) being measured.

Since this type of a study lacks manipulation of variables, the cause-effect relationship measured are only tentative. Though it too describes conditions that exist in a situation, it attempts to determine reasons or causes for the current status of the phenomena under study.

3.2.7 Experimental Research

There are two types of research which are Quasi-Experimental Research and Experimental Research. Experimental research is where participants are assigned to groups based on some selected criterion often called treatment variable. Quasi-experimental research is where participants are pre-assigned to groups based on some characteristic or quality such as differences in sex, race, age, neighbourhood, etc.

The primary characteristic of experimental research is manipulation of at least one variables and control over the other relevant variables so as to measure its effect on one or more dependent variables. The variable (s) which is manipulated is

also called independent variables, a treatment, an experimental variables or the cause. Some of the examples of independent variables could be: temperature, pressure, chemical concentration, type of material and conductivity.

3.3 Types of Data and Variable

Ahmadi (2010) stated that data can be primary or secondary, and whether one or both are used, and which is used, depends largely on the research question and the availability of these data sources.

Variable is a value that is assigned to represent the characteristics of an item. There are two types of variable that are quantitative variable and qualitative variable.

3.3.1 Types of Data and Variable

Primary data consist of surveys, interviews and focus groups, which shows that direct relationship between potential customers and the companies. Primary data is more accommodating as it shows latest information. Primary data is accumulated by the researcher particularly to meet up the research objective of the subsisting project. Primary data is completely tailor-made and there is no problem of adjustments. Primary data takes a lot of time and the unit cost of such data is relatively high.

3.3.2 Secondary Data

In secondary data, information relates to a past period. Hence, it lacks aptness and therefore, it has unsatisfactory value. Secondary data is obtained from some other organization than the one instantaneously interested with current research project. Secondary data was collected and analyzed by the organization to convene the

requirements of various research objectives. Secondary data though old may be the only possible source of the desired data on the subjects, which cannot have primary data at all.

3.3.3 Quantitative Variable

A quantitative variable is naturally measured as a number for which meaningful arithmetic operations make sense. Examples: Height, age, crop yield, GPA, salary, temperature, area, air pollution index, etc (Difference type of Variable, 2010).

Quantitative methods as they are commonly conceived derive from experimental and statistical methods in natural science. The main concern is with rigorous objective measurement in order to determine the truth or falsehood of particular pre-determined hypotheses.

3.3.4 Qualitative Variable

Any variable that is not quantitative is categorical. Categorical variables take a value that is one of several possible categories. As naturally measured, categorical variables have no numerical meaning. Examples: Hair colour, gender, field of study, college attended, political affiliation, status of disease infection. Often categorical variables are disguised as quantitative variables (Difference type of Variable, 2010).

Qualitative methods have their origins in the humanities: sociology, anthropology, geography, and history. They differ from quantitative methods in aiming, not primarily at precise measurement of pre-determined hypotheses, but holistic understanding of complex realities and processes where even the questions and hypotheses emerge cumulatively as the investigation progresses.

3.4 Hypothesis

A hypotheses is a hunch, assumption, suspicion, assertion or an idea about a phenomenon, relationship or situation, the reality or truth of which you do not know. In research, conclusions are based two methods known as the deduction and induction. Both are widely used in research projects. This helps the researchers to understand, explain, or predict business phenomena.

3.4.1 Induction

Sekaran (2006) stated that Induction is a process of establishing a general proposition based on observed fact. To induce is to draw conclusion form one (or more) particular fact. The conclusion explains the facts. It is "bottom-up" in nature or from specific to general. In induction, we observe some happening, deduct a pattern, and draw conclusion.

3.4.2 Deduction

Deduction is a process of arriving conclusion by logical generalization of a known fact (Sekaran, 2006). Deduction follows an approach which is "top-down" or from general to specific. In deduction, we start from a theory and try to prove it right with the help of available information.

3.5 Types of Data Collection Method

Data collection is the process of gathering the specific information used to answer the research questions. There are a number of issues associated with data collection,

including the use of primary or secondary data, survey design, sampling, survey administration, and increasing response rates (Ahmadi, 2010).

3.5.1 Survey Method

The survey is a non-experimental, descriptive research method. The Survey method is the technique of gathering data by asking questions to people who are thought to have desired information. A formal list of questionnaire is prepared. The respondents are asked questions on their demographic interest opinion.

In a survey, researchers sample a population. Basha and Harter (1980) state that "a population is any set of persons or objects that possesses at least one common characteristic." Since populations can be quite large, researchers directly question only a *sample* (i.e. a small proportion) of the population.

3.5.2 Questionnaire Method

There are two types of questionnaires, structured questionnaire, and open-ended questionnaire.

The structured questionnaire uses a standardized list of work activities, called a task inventory, then jobholders or supervisors may identify as related to the job. It must cover all job related to tasks and behaviour. Each task or behaviour should be described in terms of features such as difficulty, importance, frequency, time spent, and relationship to performance.

The open-ended questionnaire asks the jobholder to describe the work in his or her own words.

3.5.3 Interview Method

There are two types of interviewing, informal, / conversational interview and general interview guide approach. Informal / conversational interview has no predetermined questions, in order to remain as open and adaptable as possible to the interviewee's nature and priorities; during the interview the interviewer "goes with the flow".

General interview guide approach is such the guide approach is intended to ensure that the same general areas of information are collected from each interviewee; this provides more focus than the conversational approach, but still allows a degree of freedom and adaptability in getting the information from the interviewee.

3.6 Research Design

3.6.1 Desk Study

Desk study is all about Literature review. The literature review materials consist of journal, articles, and reference books. In this section, the theory of sustainable development and construction activities are discussed. Further study of environmental impacts, such as noise, air, and water are carried out. Through desk study, related past research can be reviewed and it is an important part in the process of carrying out research as it helps to organise a research.

A case study by Tan Siew Ling, 2006 was being reviewed. The environmental impacts of a 222 unit double-storey terrace houses located in Johor were being discussed. The area of the project is approximately 2.9 hectares. The case was studied mainly during the Architectural works which included brick lying, wall and floor screeding, floor tiling and painting; and also Infrastructure works which included road buildings, electricity cables installation and phone line installation.

3.6.2 Filed Study

The field study is about research or primary data collection. In this section, the data collection will be through questionnaire survey and interview.

The questionnaire survey will be divided into two sections.

- Section A: General Information
- Section B: Structured Questionnaire

In Section A, general information such as respondent's nature of working company, number of working experience, work environment and how often respondent is work at site will be obtained.

Section B contains closed format with multiple choice question and focus on the knowledge and awareness of sustainable development and how the construction activities affect the environmental impacts. Besides that, negative effects occurred due to the environmental impacts was being questioned. The questions are mainly based on ranking system.

For the interview part, interviewees expressed their opinion regarding to the issues of environmental impacts due to construction and also provide essential solutions to improve or reduce the said negative impacts.

3.6.3 Data Collection

The postal questionnaire will be conducted as data collection technique for this research. This is because postal questionnaires or by hand are more suited to collecting a mass of information at a minimum expense in term of finance, human and other resources. 30 copies of questionnaire will be distributed to few local organization including developer, consultant and contractor located in Kuala Lumpur. One month period was allowed for the participants to complete and return the forms.

3.6.4 Data Analysis

The results of the data are generated in this stage and were analyzed by using pie chart, column chart, and Spearman Rank Correlation Coefficient. An analysis regarding the collected data will be prepared. The Spearman (rho) is a non-parametric test for measuring the difference in ranking between two group's of respondent scoring a number of issues, attributes or factors (Naoum, 2007)

To calculate (rho) the following simple formula will be applied

$$rho = 1 - \frac{6\sum di^2}{N(N^2 1)}$$

The numerical value of the correlation coefficient ranges between -1 and +1. The correlation coefficient is the number indicating the how scores are relating.
In general,

- Rho > 0 implies positive agreement among ranks
- Rho < 0 implies negative agreement (or agreement in the reverse direction)
- Rho = 0 implies no agreement

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

In order to achieve the objective of this research, findings and discussion regarding the results collected from the survey questionnaire and interview are analysed in Chapter 4. This chapter will involve the processing of the data that generated from the questionnaires and the interview conducted previously will be summarised.

The answers and information obtained from all the respondents will be analyzed by using pie chart and column chart. The causes and effects of noise pollution, air pollution, and water pollution due to construction activities will be ranked in table forms. Further, Spearman's Rank Correlation Coefficient will be calculated and the data will be analysed. Finally, a summary of the interview with Architect and Engineer will be carried out.

4.2 Preliminary Analysis

Preliminary analysis is conducted once clean data file had been collected. This process is crucial to inspect the data file and explore the nature of the research variables. Furthermore, preliminary analysis prepares the data for the conducting of specific statistical techniques to address the research questions (Pallant, 2002).

Hence, prior the commencement of ascertaining the relationship between the variables of the research, the data are analysed for descriptive frequency.

4.2.1 Respondent's background

4.2.1.1 List of Respondent

Throughout the survey, 30 respondents had provided cooperation and appropriate responses. Below is the list of respondents.

Table 4.1: List of Respondent

Respondent	Company	Respondent	Company
1	Kerjaya Prospek S/B	16	Wemal Construction S/B
2	KH Alliance Consultant	17	FPS Consultant S/B
3	KH Alliance Consultant	18	Menta Construction S/B
4	THL Consultant	19	Menta Construction S/B
5	THL Consultant	20	Menta Construction S/B
6	Pembinaan Kesan Sempurna S/B	21	Menta Construction S/B
7	Pembinaan Kesan Sempurna S/B	22	Menta Construction S/B
8	Pembinaan Kesan Sempurna S/B	23	Crest Builder
9	Pembinaan Kesan Sempurna S/B	24	PKT & K S/B
10	Sunrise Bhd	25	PKT & K S/B
11	Sunrise Bhd	26	PKT & K S/B
12	Sunrise Bhd	27	PKT & K S/B
13	Econcos Consultant S/B	28	Kerjaya Prospek S/B
14	Econcos Consultant S/B	29	Kerjaya Prospek S/B
15	Econcos Consultant S/B	30	Kerjaya Prospek S/B

4.2.1.2 Nature of Working Company

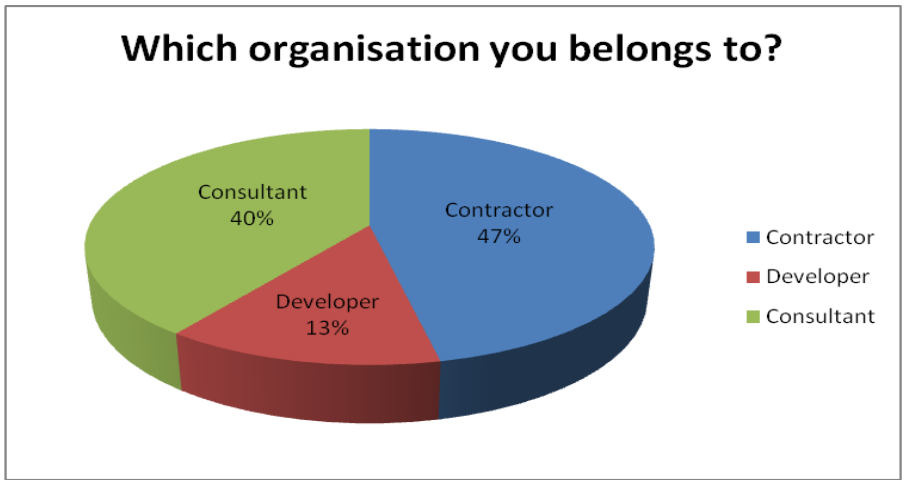

Figure 4.1: Respondent's nature of working company

As referred to figure 4.1, respondents from different nature of working company were selected. Among 30 respondents, 14 respondents were from contractor firm, which consist of 47%, 12 or 40% respondents were from consultant firm, and the remaining 4 or 13% respondents were from developer firm.

4.2.1.3 Years of Working Experience

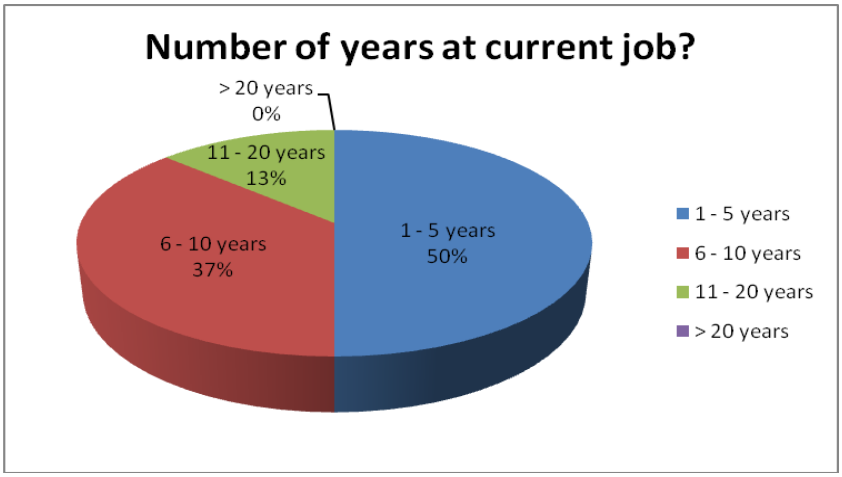

Figure 4.2: Respondent's years of working experience

From the figure above (Figure 4.2), 50% of the respondents which is 15 of them had 1 to 5 years of working experience. Besides that, 11 respondents or 37% had 6 to 10 years of working experience while 4 respondents or 13% had 16 to 20 years of working experience and 0% of the respondents had more than 20 years of working experience.

4.2.1.4 Working Environment

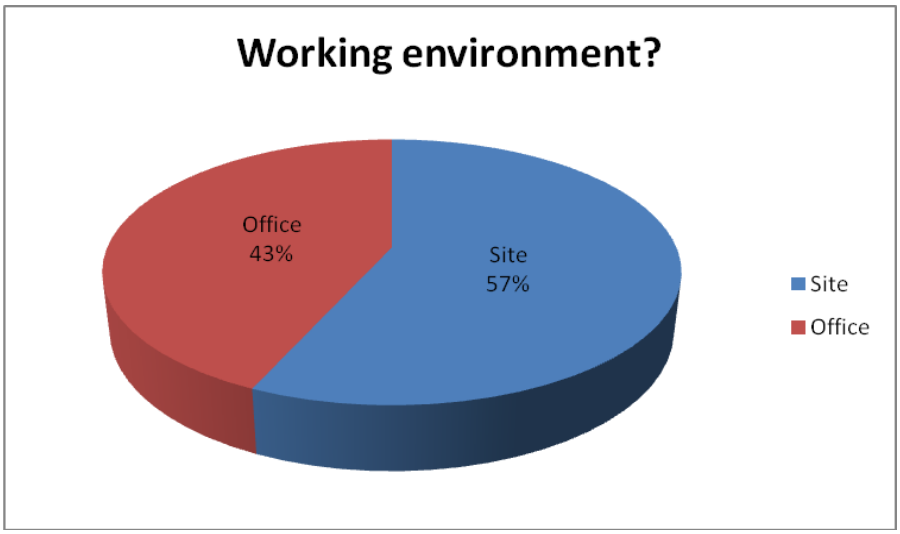

Figure 4.3: Respondent's working environment

The figure above (Figure 4.3) shows that 57% of the respondents worked at site, which consists of 17 out of 30 of respondents. The remaining 13 respondents or say 43% of the respondents worked at office.

4.2.1.5 Frequency Working at Site

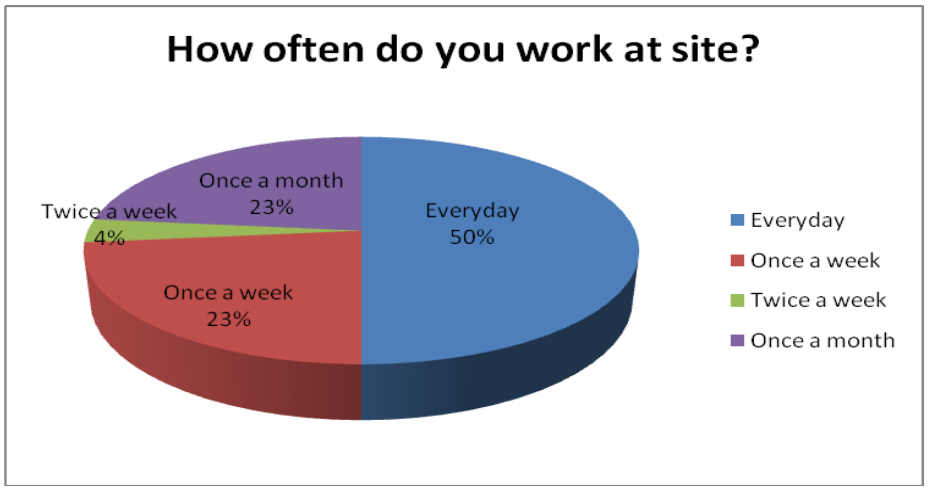

Figure 4.4: Respondent's frequency working at site

With reference to the Figure 4.4, 15 respondents worked at site every day, which is 50% of them. Besides that, there are equally 7 respondents or say 23% worked at site once a week and once a month. Only 1 respondent, 4% worked at site twice a week.

4.3 Data Analysis

4.3.1 Awareness and Types of Environmental Impacts during Construction

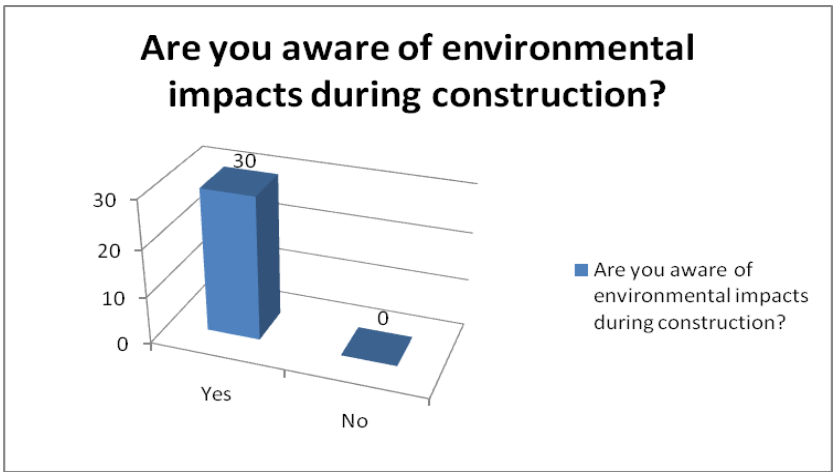

Figure 4.5: Awareness of environmental impacts during construction

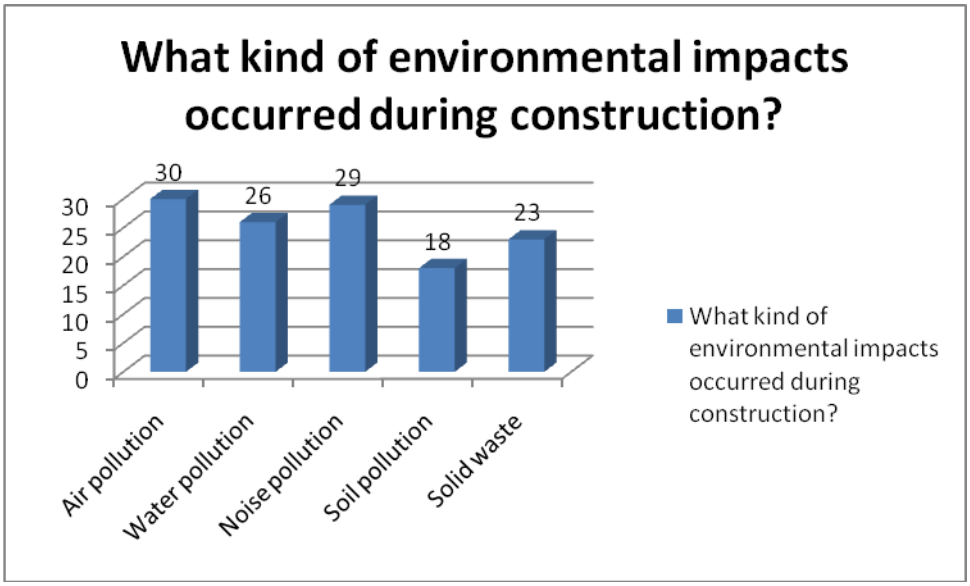

Figure 4.6: Types of environmental impacts occurred during construction

All the respondents were aware of environmental impacts occurred during construction, as shown on figure 4.5. For the types of environmental impacts occurred during construction, the respondents chose air pollution as the major impacts, with total 30 votes. It is followed by noise pollution with 29 votes, water pollution with 26 votes, and solid waste with 23 votes. Lastly, 18 respondents voted the soil pollution.

4.3.2 Construction Activities contribute to Environmental Impacts

Table 4.2: Ranking of construction activities contribute to Noise Pollution, Air Pollution and Water Pollution

Construction Activities	Noise Pollution's Ranking	Air Pollution's Ranking	Water Pollution's Ranking
Finishes Works	6	7	6
Infrastructural Works	2	3	5
Painting Works	7	2	1
Piling Works	1	1	2
Preliminaries Works	5	5	3
Structural Works	3	4	4
Timber Works	4	6	7

In order to identify the ranking of construction activities that result to different types of environmental impacts, the author had pre-set some activities for the respondents to rank the position. Table 4.2 indicates the ranking of different types of construction activities which will contribute to different types of pollution to the environment.

The most critical activity which contributed to noise pollution is piling works. Infrastructural works was ranked to be the second and structural works was placed at the third place. This is because the equipments or machinery used in these work phase produce extreme sound. The sound power level (dB) of those equipments is higher as compared to the others. For example, hammer drill which is needed when carrying out the piling works produces 112dB, and the crane which is needed for boring, placing precast concrete or concrete pouring produces 123dB (Appendix D). Other than that, timber works, preliminaries works, and finishes works were placed at fourth, fifth and sixth place respectively. The activity that contributed the least pollution to noise is painting works. This is because painters normally do not need heavy machinery to execute the works.

As shown at the table above, piling works contributed most to the air pollution. It is very similar as compared to the noise pollution. This is because while carrying out the piling works, the dust will be emitted; especially from concrete, cement, and soil. Painting works was placed at the second position, and followed by infrastructural works, structural works, preliminaries works, timber works, and lastly was finishes works. Paints which are not odourless or not green will lower the quality of the air and as the chemical molecules is released during painting; it will endanger human beings' health. Besides that, dust will also be emitted when structural works, preliminaries works, and timber works are carried out.

For the water pollution, activity which contributed most was painting works. The second activity was the piling works and followed by preliminaries works, structural works, infrastructural works, finishes works, and lastly was timber works. Painting works is placed at the first position because normally, after the painters have finished the painting works, they may directly wash the painting equipments and waste water with harmful molecules will pollute the water point nearby.

By using the Spearman's Rank Correlation Coefficient (rho), the relationship between the environment impacts due to the construction activities can be assessed. As for noise pollution and air pollution, the rho value is +0.429(Appendix C), it is said that there is a weak positive relationship between the variables mentioned. Hence, the activities resulted to noise pollution may also bring pollution to the air.

As reference to Appendix C, the rho value between noise pollution and water pollution, is -0.071, which indicates the low negative relationship between both the variables is considerable weak. As a result, activities pollute the noise may not generate pollution to water.

Based on the rho value in Appendix C, it shows that both air pollution and water pollution possess the value of +0.786, which signifies the strong relationship between the two variables mentioned. Hence, it is said that activities resulted to air pollution will definitely generate water pollution.

4.3.3 Environmental Impacts' Effects

Table 4.3: Ranking of effects caused due to Noise Pollution, Air Pollution, and Water Pollution (* Rank 7 is not applicable)

Effects	Noise Pollution's Ranking	Air Pollution's Ranking	Water Pollution's Ranking
Breathing problem	7	1	5
Coughing	7	5	3
Eyes Strain	7	3	2
Feel frustrated and exhausted	6	6	4
Headache	3	7	7
Hearing problem	1	7	7
Hypertension/ Stress	2	7	6
Irritation to nose	7	2	7
Skin itchiness/ Skin disease	7	4	1
Sleep disturbance	4	7	7
Unable to concentrate on work	5	7	7

Table 4.3 indicates the ranking of the effects of different types of pollution to the environment due to the construction activities. From the table, hearing problem was the major negative effect to the respondents when noise pollution occurs. Besides that, the respondents also felt hypertension or stressful and also headache when the noise level was in high level. Moreover, the respondents also experienced sleep disturbance, unable to concentrate on their works and also feel frustrated and exhausted when too much unwanted noise was produced. This is because when sound is louder than 60dB, people may feel annoyed and uncomfortable (DOE, 2007). The table shows that no breathing problem, coughing, eyes strain, irritation to nose and skin itchiness or skin disease when noise pollution aroused.

With reference to the table above, the respondents chose breathing problem as the key negative effect when air pollution occurred. Other than that, respondents also experienced irritation to nose, eyes strain, skin itchiness, or skin disease, coughing, and also felt frustrated and exhausted once air pollution arisen. Whereas, the respondent did not experience headache, hearing problem, hypertension or stress, sleep disturbance and unable to concentrate on work when air pollution occurred.

The table above also shows the negative effects to the respondent due to water pollution. Skin itchiness or skin disease was the main negative effect selected by the respondents when there was water pollution around them. In addition, the respondents were in the opinion that water pollution might result eyes strain problem, coughing, frustration, and exhaustion, breathing problem and also hypertension or stress. On the other hand, the respondent did not experience headache, hearing problem, irritation to nose, sleep disturbance, and loss of concentration during work.

By using the Spearman's Rank Correlation Coefficient (rho), the relationship between the negative effects due to the environmental impacts can be assessed. As refer to Appendix C, the rho value between noise pollution and air pollution is +0.182 which indicates that the low positive relationship between both the variables is considerable weak. Hence, the negative effects caused by the noise pollution may or may not cause to the air pollution.

Based on the rho value in Appendix C, it shows that between noise pollution and water pollution, there is a value of +0.245, which signifies the weak relationship between the two variables mentioned. As a result, negative effects caused by noise pollution may generate pollution to the water.

As for air pollution and water pollution, the rho value is +0.727 (Appendix C), it is said that there is a strong positive relationship between the variables mentioned. Hence, the negative effects caused by noise pollution will definitely generate pollution to the water.

4.4 Interview

4.4.1 Interview with Architect

First of all, the below summary was made according to the interview on August 4, 2011 with Ar. Lim Wei Liang, who work as an Architect in construction industry for over 10 years.

The interviewee mentioned that pollution is one of the global warnings, it's really serious, and one person or one country alone can't solve it. Technology and people bring pollution to the environment, but technology and people can fix it too. Environmental impacts such as noise pollution and air pollution matters were normally arisen when construction took place. This is due to the improper design or inadequate work planning to the work phase. Effects such as breathing problems and damage to the human's organ are usual negative impacts due to air pollution. Besides that, many unforeseen or unpredicted negative impacts which affected to the human beings were arisen due to construction. This is a very dangerous and serious issue which should be aware and necessary actions should be taken before more and more unwanted negative impacts arisen.

To improve or reduce the environmental impacts caused due to the construction activities, good planning and design are necessary. The interviewee stated that architect may suggest the employer to use green construction method or green material for their project. This is because, green buildings are getting momentum nowadays and green building products are even stronger, last longer, use resources more efficiently and they are manufactured in an environmentally sound manner. Green materials are normally made with salvaged, recycled, or waste material and also can reduce environmental impacts during construction, demolition, or renovation.

Green building enhances the well-being of occupants and minimizes negative impacts on the community and the environment. It provides a healthier and more comfortable environment; improve indoor air quality and most important, it can reduce the environmental impacts. Besides that, Lim also gives example on the green

building products he had used for his previous project. Green paint, which is odourless and allows less repainting cycles and therefore reduces impact on the environment.

4.4.2 Interview with Engineer

On August 5, 2011, the author had an interview with Lee Tack Fook, who works as an Engineer in construction industry for over 20 years. Below is the summary of the interview made.

The construction process and building use not only consume the most energy of all sectors in the country and create the most CO2 emissions, they also create the most waste, use most non-energy related resources, and are responsible for the most pollution. The air quality impact will be temporary and will primarily be in the form of emissions from diesel-powered construction equipment and dust from embankment and haul road areas. Noise and vibrations impacts will be from the heavy equipment movement and construction activities such as pile driving and vibratory compaction of embankments whereas water quality impacts were resulting from erosion and sedimentation.

As for the pollution issue, it is not in the extraction but in the processing of materials for construction. Not surprisingly, the construction industry has the biggest effect of all sectors because of the quantity of materials used in construction. In the past there was a simple general equation between the amount of pollution and the amount of energy in a process. On the whole the more energy required, and the more processes, the more waste and the more pollution was generated. Processes such as the processing of plastics for PVC, PU, and PI and the manufacture of galvanised metals were all very polluting. The loss of control of manufacturing processes therefore has a considerable environmental impact. Thus, necessary controlled by legislation to reduce the pollutions within the country are needed. Besides that, what people can actually do is reduce high energy material use, and use low energy materials as much as possible. Waste disposal from construction and many products,

even common products like gypsum plasterboard and mineral wool insulation are now labelled as hazardous and require special disposal. However here, as with waste disposal, the less processed a material is, and the less hazardous, the easier re-use, recycling or healthy disposal will be, for example through composting.

Besides that, the construction industry is such a huge consumer of materials, particularly of imported chemicals, minerals, metals and organic materials such as timber has brings impact on habitat erosion and destruction globally. Many essential materials are now in short supply. This is often mined in rare habitats with consequential and inevitable dangers to the ecology. Of course it is possible to extract materials from habitats without destroying them. However there will always be consequences to this kind of extraction in terms of cost, speed, and quantity. It is therefore imperative that people radically reduce their demand on such materials in order to allow this process to happen benignly. At present the whole world is heading in the opposite direction, and they will lose huge areas of unique habitat forever in the coming years unless people change the way they consume such materials. This is particularly as regards how people build. It means using less of these materials by building more simply, with more local and plentiful for example sustainable and renewable materials and with less waste.

4.4.3 Conclusion

Both the interviewees give very useful information on environmental impacts due to construction and the author was much appreciated. Their points of view regarding the causes and effects were identically with the author’s research which mainly on noise pollution, air pollution and also water pollution. Besides that, the interviewees also pointed that construction waste and manufacturing of construction materials will bring to serious environmental impacts. Therefore, the use of green material or green construction method in nowadays construction should be encouraged. Further, the interviewees also provide many effective solutions to improve said negative impacts.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Both the interviewees give very useful information on environmental impacts due to construction and the author was much appreciated. Their points of view regarding the causes and effects were identically with the author's research which mainly on noise pollution, air pollution and also water pollution. Besides that, the interviewees also pointed that construction waste and manufacturing of construction materials will bring to serious environmental impacts. Therefore, the use of green material or green construction method in nowadays construction should be encouraged. Further, the interviewees also provide many effective solutions to improve said negative impacts.

5.2 Realization of Study Objectives

The purpose of this study is to identify the causes, effects, and also solutions to improve the environmental impacts due to the construction activities. From the data collection and data analysis in Chapter 4, it is clear to know that various types and degree of environmental impacts were formed due to different construction activities. Besides that, different types of environmental impacts will cause different level of negative effects and harmful to human being's health. These environmental impacts can be minimised or improved through many methods. It is very rare for a construction site to be completely comfortable as noise, air and water are a norm in

the construction site. Although the construction site does not guarantee a comfortable working environment, the most the management can do for the site-based staffs is to provides the necessary equipments and facilities to improve their working environment.

5.3 Conclusion

In a nutshell, construction activities bring lots of negative impacts to the environment and also to human beings. The three variables incorporated in this piece of research; noise pollution, air pollution, and water pollution are some of the environmental impacts which occurred when construction activities were took place. On top of that, the construction site is never kind to anyone and thus, the least the management can accomplish is to provide what is considered as conducive to the environment for the construction workers so that they would not feel uninspired. Therefore, sustainable development shall be the priority to bear in mind in any development decision making. In conclusion, in order to induce a better working environment at site, adequate solutions should be carried out so that the worker involved will be aware that the work is worthwhile as they are very much appreciated and cared by their organisation.

5.4 Recommendation

Due to the author had conducted the data collection by means of non-random sampling method, the findings cannot be generalised to the underlying population. Hence, in future, it is recommended that the sample population is selected through random sampling so as the findings can be generalised to the whole of Malaysia with greater accuracy. In addition, recommendation for further study as similar to this topic is to conduct a real case study at construction site; this is because different construction project might create different types and different level of environmental impacts. With the real case study, a better understanding and analysis to this topic

will be generated. Researchers can also extend the study to a wider area of environmental impacts and not limited to certain pollution. Since there are still many other environmental impacts occurred due to construction, further research should be conducted so that more information can be gathered with regards to the motivation in the construction industry.

REFERENCES

1) Agenda 21 (1992). *United Nation conference on environment and development*. Rio Je Janeiro, Brazil.

2) Cole R.J. (2000). Building environmental assessment methods: Assessing construction practices. *Construction Management and Economics,* 18(8), pp. 949-957.

3) Mihelcic, J.R, Crittenden, J.C., Small, M.J. (2003). Sustainability science and engineering: Emergence of a new metadiscipline. *Environmental Science and Technology*, 37, 5314 – 5324.

4) Dr. S.G.Naoum. (2007). *Dissertation Research & Writing For Construction Students* (2nd ed.). London: Elsevier Ltd.

5) Nieves, E.N.L., Schaffiner, F.C., Abdelhadi, A.H. and Goosen, M.F.A. (2009). London: CRC Press *Environmental Management, Sustainable Development and Human Health.*

6) Sekaran, U. (2006). *Research methods for business: A skill building approach.* New York: John Wiley & Sons, Inc.

7) Shen L.Y. and Tam V.W.Y. (2002). Implementation of environmental management in the Hong Kong construction industry. *International Journal of Project Management*, 20(7), pp. 535-543.

8) CIDB Malaysia (2008). Compilation of Environmental Acts, Laws and Regulations Related to Construction Industry. Retrieved on February 10, 2011, from http://www.cidb.gov.my/v6/files/Comp_Envi_Acts.pdf

9) DOE (2007). Environmental Noise Limits and Control. Retrieved on June 2, 2011, from http://www.doe.gov.my/files/udara25/Guidelines_book_1.pdf

10) Difference Type of Variable, Retrieved on January 14, 2011, from http://www.oswego.edu/~srp/stats/variable_types.htm

11) Geothermal Energy: Construction Impacts. Retrieved on February 5, 2011, from http://teeic.anl.gov/er/geothermal/impact/construct/index.cfm

12) Hafeezrm. (2009). Types of Research. Retrieved on January 14, 2011, from http://hubpages.com/hub/Types-of-Research

13) How can air pollution hurt my health?. Retrieved on February 3, 2011, from http://www.lbl.gov/Education/ELSI/Frames/pollution-health-effects-f.html

14) Kamarul Anuar Mohamad Kamar, Ir. Elias Ismail, Emasria Ismail, Ir. Dr. Zuhairi Abd. Hamid, Professor Charles Egbu, Dr. Mohamad Arif, et. al. (2010). Industrialised Building System (IBS) Construction Research and Information.*Linking the Industrialised Building System (IBS) with Sustainable and Green Construction.* Retrieved on February 10, 2011 from http://ibsresearch.blogspot.com/2010/04/linking-industrialised-building-system.html

15) Melvin Leong. (2010). The Construction Market in Malaysia. Retrieved on February 10, 2011, from http://www.frost.com/prod/servlet/market-insight-top.pag?docid=196027352

16) Mo Ahmadi (2010). Research Method and Process, Retrieved on January 14, 2011, from http://www.referenceforbusiness.com/management/Pr-Sa/Research-Methods-and-Processes.html

17) Nicks J. (2010-2011). Noise Pollution Effects. Retrieved on February 3, 2011, from http://www.buzzle.com/articles/noise-pollution-effects.html

18) Soil pollution. Retrieved on February 3, 2011, from http://nsdl.niscair.res.in/bitstream/123456789/990/1/Soil_Pollution.pdf

19) Tan Siew Ling's case study (2006). Retrieved on July 7, 2011, from http://www.efka.utm.my/thesis/IMAGES/3PSM/2006/4JKAS/PARTS2/tansiewlingaa010483d06ttt.pdf

20) Land pollution. Retrieved on February 3, 2011, from http://www.earthplatform.com/c/pollution/land

APPENDICES

APPENDIX A: Sample of Questionnaire Survey Form

APPENDIX B: Questionnaire Survey Form Collected

APPENDIX C: Measurement of Data Collection

APPENDIX D: Result of Case Review

APPENDIX E: Record of Supervision/Meeting

APPENDIX F: Permission Sheet