Implication of Construction Activities towards Environment

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A project report submitted in partial fulfilment of the requirements for the award of masters in Master of Project Management

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DECLARATION

I hereby state that this project report is based on my own efforts and it is an original work except for citations and quotations which have been duly acknowledged. I also would like to declare that it has not been previously and in the same time submitted for any other graduate, postgraduate or doctorate submission at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

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Signature : _____

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Date : _____

Specially dedicated to my beloved wife and parents.

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IMPLICATION OF CONSTRUCTION ACTIVITIES TOWARDS ENVIRONMENT

ABSTRACT

Construction in the world is moving rapidly to improve the quality of life. The rapid movement of construction to better the living standards has taken a toll on the environment. Environmental and political mobilization to address the impacts construction has risen in recent years. There are various industries that are redefining their goals and perspectives and making their operations socially more acceptable and resource-wise sustainable. At the same time, they are trying to retain and reinforce their identity as vehicle of economic growth and national development. The objectives of this research is to highlight the implications of construction activities towards the environment and to find possible resolution to reduce the impact of construction towards Mother Nature. A questionnaire survey was carried out and 109 out of 150 sets of questionnaire were collected from the targeted respondent to understand the implications towards the environment faced during construction phase as well as possible mitigation methods to reduce impacts from construction activity towards environment. A comprehensive analysis was carried out to further understand the data collected. It was found out that noise was a primary contributor as an impact towards the environment from construction. Construction sites also polluted water due to soil erosion from construction sites and was found as one of the major factors towards endangering the environment. From this research also, it was found that by imposing sustainable policies and guidelines to ensure sustainable construction was the best way to help mitigate the impacts of construction towards the environment. By recognising the major factors that causes impact to the environment and possible mitigation methods to reduce impact towards the environment from a more sustainable construction perspective is what this research can contribute to the construction industry.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Recently, environmental issue is on the rise and has become an important issue (Tse and Raymond, 2001). Environment is defined as "external physical surroundings and conditions, especially as influencing people's livelihood; conditions or circumstances of living and external circumstances which affects growth of plants and animals". Other terms to describe environment area surroundings, atmosphere, climate, habitat, territory, biosphere, ecosystem, and nature (A. Balasubramaniam, 2008). There are many industries that contribute to pollution but when compared among all, construction has been the main source of environmental pollution (Shen et al., 2005). Construction that mainly involves building and operations have a huge direct and indirect effect on the environment (Szafranko, 2019). Environmental pollution from construction produces harmful gases, noise, solid and liquid waste as well as dust (Chen et al., 2005). The environment is constantly affected by the construction life cycle development. The construction life cycle development consists of a few stages which begins with initial work on-site through the construction period, operational period and to the final demolition when a building comes to end of its life. Even if the construction period of a building has a shorter period when compared to the other stages, it has a huge and significant impact to the environment. Construction has indeed contributed to the economic growth and social development, and has enhanced the standard of living and the quality of life but is has often been associated with the deterioration of the environment (Hitam and Borhan, 2012). This arising issue has prompted many construction personnel to attempt to control the impacts of

their activities by instilling environmental management systems (Lam et al., 2011). Knowledge and awareness are the key factors that elevate and intensify the sustainability movement (Zainul Abidin, 2010). Professional bodies and various private organizations have kick started several programs in order to enhance the application of sustainable principles within construction projects (Zainul Abidin, 2010).

1.2 Importance of the Research

The implications of construction activities towards environment needs to be investigated and studied. There are various studies done on the impacts that is caused by construction sector. However, there is no solid way to ensure the impacts of constructions can be reduced or controlled. Thus, this research aims to understand the causes of environmental pollution from the construction sector and methods to reduce or to control the side effects of construction towards the environment.

1.3 Problem Statement

Construction has played an important role in ensuring physical infrastructure to meet the ever growing social need (Md. Asrul et al. 2015). Construction is growing at a rapid pace all over the world and has consume many parts of the environment. In order to meet the growing demand of construction be it building or infrastructure, the environment is being affected and damaged. There are many kinds of destruction brought upon the environment as urbanization takes place. According to Simon & Samuel (2015), the environmental consequences generated from the construction industry relate to many aspects. One of the consequence is that large amount of energy is consumed during the processing of materials, construction processes and in the use of constructed structures. The other consequence is that dust and gas emission released during the transportation of materials and in some construction operations is high. It will also disrupt the living hood of people in the affected area of construction projects through traffic diversion, noise pollution, and air pollution. Another consequence is that construction waste material which are hazardous will significantly be apparent and high. There are cases where waste water discharge is discharged into living areas and is hazardous to the surrounding area and will affect the health of the people near the construction area. An increase in pollution of air and sound due to construction will increase exponentially. During construction phase,

usage of water resources will increase. Another impact is that the geological surroundings will be affected as there will be clearing of land, reduction of oxygen and endangering of species within the construction area. It will also increase the consumption of renewable and non-renewable resources to complete the construction project.

As reported in TheStar (2006), resident in Air Panas, Setapak was facing difficulty of breathing since there is construction of DUKE Highway (Duta-Ulu Kelang Highway) nearby to the housing area. This construction also causes cracks on wall as well as clogs in drain at the area. Therefore, it is important to understand the implication of construction activity nearby towards environment and the solution to reduce the issue.

Thus, this study is to carry out on the implication of construction activities towards environment. Previous researcher had discussed the implication of this topic and some of the information are obsolete with limited to the resolution for the issue. This is depicted that the research gap for this study is about the implication of the construction activities and the solution taken according to the current issue where sustainability construction is the one of the actions to take for consideration.

1.4 Report Aims and Objectives

1.4.1 Report Aims

The aim of this research is to study the possible causes to pollution from construction sector as well as to investigate the possible mitigation methods to reduce or eliminate the impacts caused by construction towards the environment.

1.4.2 Research Objectives

i. To identify the implications from construction sector towards the environment.
ii. To identify possible mitigation methods to reduce or eliminate the impacts from construction towards the environment.

1.5 Contribution of the Research

This research provides a reference to all parties participated in the same industry on the possible impact that may occur towards the environment during construction stage. Therefore, the inputs obtained from the parties from the same discipline is

critical as their inputs may directly or indirectly provide potential mitigation measures to reduce the impact construction has on the environment. Furthermore, this research will encourage the construction organisation to be more involved in the industry to implement mitigation measures to reduce its impacts towards the environment.

1.6 Research Methodology

The purpose of the research methodology is to provide a guideline for this study to achieve the research objectives that are identified in the earlier stage. The flowchart in Figure 1-1 shows the steps taken in the research methodology.

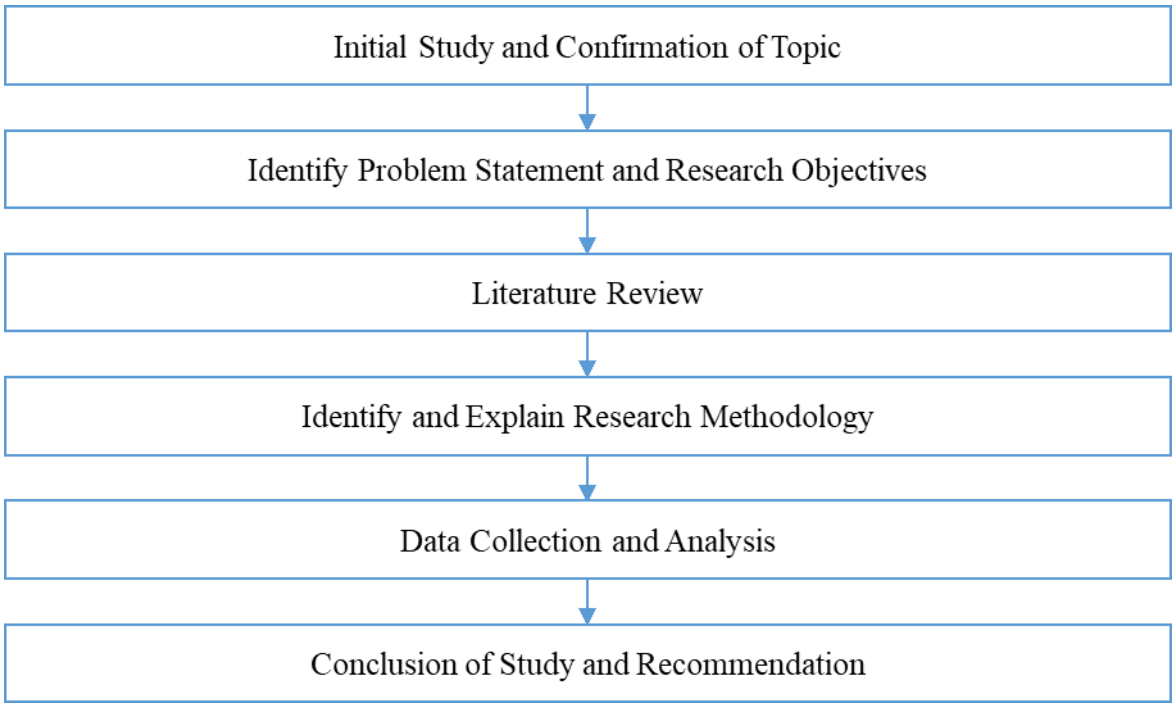

Figure 1-1: Research Methodology Flowchart

In the beginning stage of the research methodology, an initial study was carried out to understand the research topic before selecting it. The reason for an initial study to be carried out is to research and to narrow the scope so that the objectives of the research topic can be identified.

The following stage is to identify the problem statement and research objectives. This chapter provides an outline of the limitation and scope of study the research topic.

Upon identifying the problem statements and confirming the research objectives, the next stage is to summarize a literature review of pass research that have been carried out in regard to the research topic. Journals and books are the main sources that assist in preparing the literature review and will be classified as secondary data and help to prepare the questionnaire survey's questions.

The subsequent stage is to identify and to explain the research method being used. This stage will explain the purpose of a questionnaire survey. The questionnaire survey will be adapted for this research topic and to be sent to targeted groups so that the results will be based on people's direct involvement or experience towards the research topic.

In the next stage, data from the questionnaire replies are collected and analysed. Relative Importance Index will be used to convert the qualitative data to quantitative data.

In the final stage, a conclusion and recommendation will be identified based on the research carried out. In this stage, it explains the major outcome of this research and recommends suggestions for future research development.

1.7 Report Structure

The structure of this report is as presented below:

Chapter 1: Introduction

This chapter included brief introduction, importance of research, problem statement, research aims, research objectives, scope, limitation and contribution of this research. This is for the readers to understand the intention of this research and the expectation at the end of the research.

Chapter 2: Literature Review

This chapter provided the review of other related and relevant research works or studies on the similar topic. The outcome of the literature review from published journals, articles, book and others presented in here. This chapter is critical as it helps toward the formation of the research methodology.

Chapter 3: Research Methodology

This chapter spelled out the research methodology that applied in this research to achieve the research aims and objectives set in Chapter 1. The data collection method

and techniques used for data analyses detailed in this chapter. Justification provided for selection of the method and techniques.

Chapter 4: Results

This chapter of the research presented the analysis and discussion on the collected data through the method stated in Chapter 3. The results derived from data analysis were discussed here to confirm whether the research aim and objectives are achieved.

Chapter 5: Discussion

This chapter of the research presents the discussion on the data collected and derived from Chapter 4.

Chapter 6: Conclusion and Recommendation

The conclusion of the research stated in this chapter after the evaluation on the achievement of the objectives. Recommendations were provided for future researcher for further research on this topic.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This study explores the impact of construction towards the environment. Construction is defined as the process of making something such as the occupation of a building or the way something is assembled (YourDictionary, 2020). In the context of this research, construction refers to the process of developing buildings, infrastructure, and facilities for various industries. The environment is defined as all things which occur naturally on the earth which are living non-living such as the natural world of flora, fauna, land, air and sea. The environment is also defined as the combination of external physical conditions which affects and directly influences the development, behaviour, growth and survival of organisms (American Heritage Dictionaries, 2011).

As an impact from globalization and modernization, there is a rise in the demand in construction activities to cater to economic and societal requirements. As a result, there is an inadvertent impact towards the environment due to a number of factors. Construction activities influence the environment in terms of the increasing reliance on natural resources to ensure there is a sufficient supply of materials for construction projects. Besides that, the lifecycle of the construction project also involves the processing and production of objects and products which also relies on natural resources such as fossil fuels, electricity and raw material. Although construction activities contribute to economic and societal development, it cannot be denied that the rise is the standard of living also deteriorates the environment (Wathern, 2013).

Based on market studies, it is projected that the construction industry in Asia will reach a Compound Annual Growth Rate of 8.9% hitting US$ 4,622.3 billion by the year 2023 (Laura Wood, 2020). This projection translates to a risk of detrimental effects to the environment if construction is not managed sustainably.

2.2 Stages in Construction

There are mainly six stages in a construction project. The six stages of construction are the development of project concept, the design of the project, pre-construction, procurement, construction and post construction (Klinger & Susong, 2006). The construction project: phases, people, terms, paperwork, processes. It is imperative for sustainable construction guidelines to be adhered to during all stages of a construction project. Impact to the environment can be minimized or avoided if sustainable practices are embedded into each stage of construction.

The conception of a project begins when the brainchild for the project is developed by an owner of the construction project. The project owner has the greatest amount of input during this stage to conceptualize the project. Depending on the scale and urgency of the project, the conception of the project can take anytime between a few days, months or years.

The second stage of construction is in the design of the project. With an engineer or architect taking the lead, project designs, drawings and calculations are developed at this point while ensuring that the relevant construction standards and guidelines are complied with. The bidding process also begins at this stage. During this stage, there are four phases which includes, feasibility and programming, schematic design plan, development of designs and contractual documents.

The third stage of construction project is the pre-construction stage. During this stage, the bidding process is completed, and the suitable contractors are hired to be part of the project team (Lee, 2010). The project team includes suppliers, project owner representatives, engineers, and health and safety personnel. During this stage a technical site survey is conducted to test site and soil conditions to examine feasibility to proceed with the construction process. The words that occur during this

stage also include clearing and demolition of site, setting out the building, establishing datum level and corresponding earthworks (Teng, 2011)

The fourth stage of the construction process is the procurement stage. This stage involves the procurement of materials, labourers and equipment to facilitate the construction process. The fifth stage is the construction stage itself. The construction stage consists of eight different phases which are the construction of foundations, substructure, superstructure, and roofing, first fix electrical fittings, second fix electrical fittings, surface finishing, external works paving and driveways. Sub-structure is known as the structure which forms the building's foundation or columns, foundation, abutments and other constructions on which the building is set upon. Super-structure is referring to the structure built as a vertical extension of the entire building from the basement upwards or ground floor footings and slab. Finishes refer to the final touches to the surface of the construction which may be a trowelled concrete surface or an applied finish such as tiles.

The sixth and final stage of a construction project is the post construction stage. This stage prepares the project to be handed over to the owner. A few processes take place such as the commissioning of the building, occupancy of the building by owners and contractual closure of the project.

2.3 Impact towards the Environment

The impact from hazards and pollution which are caused by construction related activities can be categorized into seven forms of impacts which are fallen objects, harmful gases, dust, noises, liquid and solid wastes, ground impact and others (Chen et al., 2000). Studied by Cole (2000). It was noted that these impacts can be divided into three namely, human health issues, loadings on the ecology and usage of resources. Research by Chen et al. (2005) has characterized the effects of construction to the environment under eight different types which are vibration and noise, soil and ground contamination, dust, odours and hazardous emissions, underground water contamination, waste from construction and demolition, archaeological impact and impacts to flora and fauna.

According to Ametepey (2014), there are ten categories for environmental impact of construction activities which are water, noise, dust, health and safety hazards, ecology, usage of timber, traffic, landscape, energy and sewage. Other research papers categorize the impact of construction on the environment differently.

With reference to Cardoso (2005), the characterization of the impact of construction on the environment includes water and soil pollution, flora and fauna damage, production of waste, soil and dust, impact towards the local drainage and sewage systems, and other physical impacts such as traffic, noise, space limitation for parking and public use. It can be clearly noted that there is no one single way of assessing the impacts on the environment as a result of construction activities from the literature above.

In a study by Cole (2000), it was noted that these impacts can be divided into three namely, human health issues, loadings on the ecology and usage of resources. The classification on the environmental impacts as conducted by Shen and Tam (2002) were mainly focused on the consumption of natural resources. The classification consisted of air, land, water, energy, minerals and fossil fuels. Other than that, the other categories stated in the same study were sanitary and solid waste production, waste resulting from construction activities which require landfills for disposal, odours, noise, vibrations, and emissions which are particulate and chemical in nature.

However, the most established guidelines are as contained in the Eco-Management and Audit Scheme (EMAS) regulation (Gangollels, n.d.). Environmental impact can be categorized in a standardized format under 8 different categories (Testa et al, 2014). These categories give a comprehensive coverage of all the different types of environmental pollution which have been defined in the previously referred to literature. The categories employed in the EMAS guidelines are as follows which are (1) air pollution and emissions, (2) water pollution and emissions, (3) recycling, reusing, reducing and disposing all waste in general, (4) land contamination, (5) use of natural resources such as fossil fuels and also raw materials, (6) issues such as vibration and noise, dust, smell, and odour, (7) environmental impact from

transportation, (8) risks from environmental accidents and emergency situations, (9) impact on biodiversity.

When it comes to air pollution and emissions, the extraction of raw materials from the natural environment for the purpose of construction generates an accumulation of pollutants in the air (Ametepey, 2014). In the USA alone, the air pollutants from site construction contributes to 40% of emissions in the atmosphere, 20% of emissions into the water and 13% of effluents into other sinks. While they may not be identified by the human eye, dust and other emissions consists of harmful substances which are sulphur oxides and also nitrogen. These atmospheric emissions are usually generated during the production of raw materials, the transportation of raw materials to site and site construction activities. They also pose a harmful threat to humankind and the natural environment (Rohracher, 2001). According to Tjoe Nij et al. (2003 stated that the air pollution from construction activities is caused by two culprits which are the Particulate Matter 10 (PM10) and Particulate Matter 2.5 (PM2.5). When these particulates are found to be at levels above the guidelines, it can cause respiratory diseases among workers and residents who lives nearby.

There are many ways in which construction contribute to water pollution and emissions. For construction, there is transportation involved where heavy diesel vehicle transport materials to the construction sites. Besides that, for the finishing of the construction site, solvents and paints, weather coating and solvents are used. During the process of construction, waste is also produced on site. In some cases, the waste is illegally disposed at areas which are not landfills. Due to these activities, elements leech into the water sinks such as rivers, lakes and seas when it mixes with rainwater. When it contacts the aquatic ecosystem, the eco toxicity of water increases. This makes the aquatic environment less safe and harmful to the underwater ecosystem (Heinonen et al., 2016).

Besides that, water sources can also be contaminated by the washing water from construction sites. This water which originated from the housekeeping at construction sites constitute a significant amount of suspension matter which prove to be a nuisance to sewage treatment processes and plants. The elements from the wash water are usually high in mineral content. The permissible level for treatment

plants for mineral content is 200mgl-1. However, the minerals from washing water when leeched into water sources exceed these allowable amounts. The alkaline form of these minerals also causes the matter to precipitate. This is an issue which can clog treatment plants and systems (Oliveira, 2000).

Referring to recycling, reusing, reducing and disposing all construction waste in general, project owners of construction sites globally contribute to one of the highest types of wastes worldwide. However, methods to overcome this has not been aggressively implemented by the project owners. The construction industry generates a wide variety of construction wastes. The type of waste produced differs for each stage of the construction process. Studies by researchers have shown that construction contributes severely to the impact on the environment especially in terms of the waste generated at construction sites (Muhwezi, 2012). Around 40% to 60% of salvage from site construction activities directly generates waste as there is a high consumption of material. However, it is vital to note that approximately 80% of waste used on site are recyclable and can be reused again at another site. Examples of these material are sawn formwork and Portland cement (Cole, 2000).

According to Macozoma (2012), the high generation of waste from construction sites are due to the high consumption of raw material which are 30-40% of the total consumed energy, 25% of harvested wood, 40% of virgin materials from the natural environment, 12% - 16% of total consumed fresh water and 20-30% of greenhouse gasses emitted. In China alone, the similar research shows that the solid waste from urban areas in China are made up of 30-40% waste from construction sites alone. Material selection itself can determine the high amount of waste from construction sites. Material that are non-recyclable and non-reusable have a higher tendency of being disposed and ending up in the landfills. Due to the limited knowledge and effort by project owners to use more sustainable material, the composition of waste from construction sites in landfills remain as a higher percentage compared to waste from other sources.

Based on a research conducted by Galitskova & Murzayeva (2016), construction activities also contribute to land contamination. For the purpose of construction activities, machinery, materials and various equipment are used which inadvertently

affect the quality of the natural urban environment. The high increase in manufacturing plants for construction materials and buildings greatly contribute to contamination of the topsoil layer. As a result, of construction and materials used for it, the accumulation of pollutants on topsoil deteriorates its quality for other uses like vegetation. According to the same study, a research on the topsoil quality in Novokuybyshevsk, Russia found that the quality of soil is very poor in the central part of this city where construction and urbanization is most dense. This can be attributed to the manufacturing industry and construction activities which make the areas highly unsuitable as a living area.

Additionally, the use of natural resources such as fossil fuels and also raw materials are also under threat due to construction activities. The various natural resources such as land, energy, water and raw material are unavoidably used to facilitate the construction process. The operations of machinery and construction equipment also lead to the usage of energy in the form of fossil fuels; diesel and electricity. This industry is accountable for the consumption of a high volume of these forms of natural resources. As a result, the generated amount of pollution is also high as a result of material extraction, transportation and processing (Zolfagharian et al., 2012). If not sustainably managed, the scarcity of natural resources may occur in the future.
Issues such as vibration and noise, dust, smell, and odour also occur as a consequence of construction activities. In urban areas, there is an increase in construction activities due to the demand in industrial and corporate activities. Because of this, there is an increase in the amounts of heavy vehicles used to transport construction materials. As a result, there is a high amount of noise around construction sites (Jain et al., 2016)

Construction activities also have an impact due to the transportation systems related to construction activities. In construction, the transportation of materials such as from manufacturing plant or quarry to site constitutes one of the greatest environmental impact. It was found that studies on the environmental impact of transportation at a construction site is scarce. From existing studies, it was found that the replacement of diesel with biodiesel as a fuel for transportation in construction activities lead to a reduction in the amount of hydrocarbon, particulate matter emissions and CO emissions. However, there was no notable decrease in CO_2 and NO emissions (Frey

& Kin, 2009). A lifecycle assessment for construction related transportation showed that if a vehicle's engine has a higher capacity, the emissions of CO and non-methane volatile organic compound emitted into the atmosphere is higher (Huang et al., 2009). From the perspective of raw material transportation carbon emissions, the materials which were found to contribute the highest amount of carbon in relation to its transportation process are glass, aluminium, gypsum, concrete roofing and cement.

These carbon emissions are contributed by vehicle efficiency, vehicle type and the distance of transportation from manufacturing plant or quarry to the construction site. Besides that, the carbon emissions are also accounted for by the transportation process of secondary construction materials like concrete blocks (Utama et al., 2011). The impact on biodiversity because of construction activities cannot be denied. The importance of trees and vegetation for carbon sequestration and other benefits have been highly regarded of late. Due to the importance of these greeneries, it is imperative to give proper care and attention to preserving them in the natural environment. The wellbeing of trees translates directly to the wellbeing of the population around them. When the population of trees diminish around the area, complaints from residents are inevitable. Damage to these greeneries are only more obvious a few years after the damage has taken place and when the effects are irreversible. Construction activities downplay the importance of greeneries and its impact towards biodiversity Activities at a construction site give rise to plenty of biodiversity impacts. Firstly, land is cleared for construction whereby trees and vegetation and cleared off. This means that not only a carbon sink is removed but the habitat of various fauna also disappears. Hence, this reduces the population of flora and fauna in the natural environment and affects natural biodiversity at the locality where it occurs (Cardoso, 2005).

2.4 Mitigation Methods through Sustainable Construction

There are many mitigation methods to address the impact of construction towards construction and one of them is through sustainable construction. The United Nations Framework Convention on Climate Change (UNFCC) had introduced the Kyoto Protocol which was signed and ratified on 16th February 2005 by 37 countries around the world which have been industrialized. Between the years of 2008 and 2012, these countries have given their commitment to ensure that their overall carbon emission

levels reach the levels they were before 1990.While it was noted that most of the developing countries such as India, Brazil and China emit a substantial amount of carbon emissions, it was not required of these countries to oblige to the reductions in carbon emissions (Santili et al., 2005). Following the Kyoto protocol, the Doha amendment was established which reinforced the GHG emission reduction commitments for the period between 2013 and 2020 which have received a significant number of ratifications by countries throughout the world. This amendment involved GHG reduction commitments from countries which are developing nations and also countries which have economies in transition (EIT) (Loynes, 2016). Towards this end, it is vital to ensure that the construction sector employs the necessary measures to reduce the environmental impact from its activities.

There are various definitions when it comes to sustainable development and construction. In essence, it refers to ensuring that the implementation of developmental activities does not put at risk the rights of the generations to come to have sufficient resources for sustenance. Besides that, sustainable development also refers to the improvement and enhancement of the quality of life within the capability of the ecosystem we live in. According to Elliot (2012), sustainable development defines the provision of basic economic, social and economic needs to a society without compromising the natural built ecosystem upon which the development depends on. It can also be synonymized with community social and economic development aligned with sustainable practises in the context of international market penetration and cooperation among nations while protecting the environment with policies and guidelines for the economy (Huovila & Koskela, 1998).

There are many strategies for ensuring that construction is carried out in a sustainable manner to reduce impact towards the environment. Firstly, it is advisable to use material which are renewable and recyclable. Firstly and foremost, it is vital to use material which are made from renewable or recyclable source to make up the building material. Recycled material is known to have lower embodied carbon compared to material made from virgin raw material. This is because the embodied carbon to remanufacture the material is omitted. The embodied carbon that is

considered for recycled material are from other processes such as collecting, recycling process and transforming into a new item. By recycling the material, the lifespan of the material is substantially extended beyond its normal shelf life. However, it is worthy to note that a majority of these items which are recyclable are made of natural resources which are not renewable in nature such as steel or plastic which is made from fossil fuels (Lawrence, 2015).

Besides that, another approach to reduce the embodied carbon used for construction is by using bio-based materials. There are many benefits from using bio-based construction material. Firstly, since they are made by crops, they utilize less energy for production. If they are sourced close to the construction site, then there is a significant reduction is the carbon emissions used for transportation of these materials. The carbon embodiment in plant happens during the photosynthesis process where CO_2 is absorbed from the atmosphere. While the carbon elements are retrieved and stored in the chlorophyll of the plant, oxygen is then absorbed. Compared to other materials of non-renewable materials, bio-based material embodies less carbon. The plant removes 44kg of CO_2 from the atmosphere for every 12kg of plants. This translated to a conversion ratio of 3.67. Besides that, bio based material has another benefit in terms of its heat storage capacity of 2.0 kJ.kg-1.K-1 whereas materials made from minerals have a heat storage capacity of 1.0 kJ.kg-1.K-. The higher the heat capacity of a material, the less it responds to changes in temperature. This makes bio-based material highly suitable as insulation material to stabilize interior environments of buildings (Lawrence, 2015).

To minimize the effects of construction waste on the environment, there are a few measures that can be implemented. This can be done in the form of legislative controls. In Hong Kong, the Waste Disposal Ordinance (WDO) was introduced to provide a proper guideline from controlling waste generated on construction sites. This document serves as a framework for construction project owners and teams for the end to end management of waste from its generation, disposal or recycling. In this case, the project owners or project team is not allowed to dispose any waste until it receives the relevant permission from the authorities especially from the Director of Environmental protection. This also gives construction teams guidelines on the proper disposal of all waste including hazardous material. Besides that, controlling

landfill areas is another way to reduce construction waste. There are non-inert materials such as wood and bamboo which cannot be recycled and can only be disposed of at landfills. Recently, Hong Kong has introduced charges for the usage of landfills by construction project owners in the hopes to reduce waste to landfills. Thirdly, the provision of facilities on construction sites to sort waste also proves to be a suitable method to reduce construction waste. These facilities have the capacity to sort around 2000kgs of waste per day for recycling and disposal. Additionally, the establishment of an environmental management system can reduce waste generation on site. The components of an environment management system include the setting of the environmental policy, planning, implementation and operation, checking and correction and review by the management team. Finally, reduction of waste from a construction site can be done by ensuring that a recycling scheme is introduced. The government can introduce incentives for the setting up of recycling plants nearby construction sites to ensure that minimal waste ends up at landfills. In Hong Kong, the government had introduced a Demonstration Scheme (DEMOS) on recycling to ensure that people have the knowledge for this purpose (Tam et al., 2007).

There are measures which can be employed to reduce the impact of construction on vibration and noise in the environment. Firstly, machinery and equipment use for the construction process can be installed with silencers of mufflers to reduce the noise generated to the external environment. Secondly, equipment technicians or engineers are to ensure that all machinery parts are maintained regularly while defected parts are replaced and repaired. This will reduce the amount of vibration produced which will then reduce the amount of noise produced. Towards the similar objective, running machine parts have to be oiled regularly to minimize friction which will also lead to noise in the long run. During the construction process, it is advisable to ensure that soundproof materials are installed to reduce noise to the environment. For machinery like generators, acoustic containment units can be used to reduce the impact of sound (Hajah, 2004).

According to Matar (2008), there are a few methods which can be adopted to ensure construction is sustainable and good for the environment. Firstly, value management is imperative. This means that a top down approach is essential in ensuring that green practices are instilled into construction practises. When imposed by the management,

it is more effective for implementation. Besides that, it is important for building architects and engineers to make sure that the design of the building itself is green an environment friendly. Health, safety and environment engineers need to take the responsibility to conduct a life cycle assessment of the proposed building design. By doing this, they will be able to help architects and engineers to optimize the design and ensuring that the construction activities are sustainable. On top of that, it is vital to practice lean construction methods by using less material, resources, energy and labour. Nano technological advancements can also be utilized for construction. By using nanotechnology, higher strength to wait ratio materials can be derived for use as construction material. This leads to lower overall carbon emissions as less material is used to achieve the desired strength. Biomimicry is also a concept that can be used to achieve sustainable construction. Biomimicry is using the design found in nature to advance existing solutions. An example of biomimicry is by using the design of termite nests to build buildings which have passive cooling. This in turn reduces the energy consumption needed to cool down the building (Oke et al., 2019).

Based on a research conducted in Australia, a proposed mechanism to ensure sustainable construction is to ensure that recycled aggregate or concrete is used. By using recycled concrete aggregate, the environmental impact from remanufacturing new concrete aggregate is omitted. For recycled aggregate to be used, its strength properties have to be similar to natural concrete aggregates. Many researches has been put into improving the quality of recycled aggregates. Some of the methods recommended are the addition of steel fibres, addition of limestone fillers, water reducing approaches, two stage and three stage mixing methods, polymer additives, mineral admixtures and additional cement (Senaratne et al., 2017).

Lean construction is one of the highly recommended methods to ensure sustainable construction. In lean construction, the basic principles are lean design, lean supply, lean assembly and lean usage. For lean design, the architect or engineer is to ensure that the design, concept and process for the construction project utilizes an optimal amount of material and resources. For lean supply, the fabrication and logistics of the material or product to construction site has to be carefully ensures to ensure minimal use of material and sources close as possible to the construction site. In line with lean usage, the commissioning of site, operations and maintenance and alternation and

decommissioning of construction site has to be done with minimal energy consumption when utilities such as electricity and diesel is used. With lean construction, the environmental impact is reduced as the cradle to cradle GHG emissions are reduced resulting from less material and energy consumption (Koskela et al., 2002).

In a study conducted in Sri Lanka by Athapaththu (2008), more sustainable construction practises have been identified. Firstly, it is recommended to have a legal framework and enforcement for sustainable construction. This legal framework is to detail out the social and environmental responsibility of the project owner during the construction phase to enhance development. On top of that, it is vital to have sustainable construction policies and guidelines. With these in place, risks associated to the society and environment can be reduced as employees have a clear-cut guide to clearly adhere to. Thirdly, architects and engineers are encouraged to adopt sustainable design for the construction project. Some of which include improving the value of a project by ensuring minimal raw material and energy usage, minimal waste generation, and optimal use of utilities such as water. Fourthly, an organization should ensure that sustainable procurement policies are implemented. This ensures that the entire supply chain of the material or product is as green as possible in this way, organizations can impose requirements to their suppliers to ensure that the environmental requirements are adhered to such as the limit for carbon emissions per kg of material, the usage of recyclable and renewable material and recycling capabilities. Fifthly, the adoption of sustainable innovations, technologies and processes can also help to ensure that the cradle to cradle environmental impact of a construction site is minimized. In terms of organizational structure, it is imperative to ensure that knowledge and awareness of green construction practises is given to all employees within the project or the organization to ensure commitment from each individual. To encourage employees, training and education should be given to the project team to ensure construction activities are done right. Through training and education such as green building practises, employees can increase their depth of knowledge to then inject sustainability into their project. It is also important for construction projects to ensure that sound reporting is maintained. This allows project owners to compare their achievement against benchmark levels and then

work towards optimizing their operations and construction activities (Athapaththu & Karunasena, 2018).

From a construction project management perspective, there are four phases for which sustainability is to be ensured which are feasibility, design, implementation and closeout. For the purpose of feasibility, project managers need to ensure that the projects meet the need of the market and the environment. And environmental manger has to be appointed to advice on matters relating to the sustainability index of the project. At the same time, community input is vital to ensure the societal and environmental impact of the project is carefully scrutinized. In the design phases, it is imperative to ensure that the design team introduces best practice solutions for the project which prioritize efficiency and the optimal use of resources. The procurement team is to ensure that suppliers recruited for this project are aligned with the green policies of the project. During the implementation phases, the construction has to be implemented with components of sustainability. This can be done by ensuring that green building certification indices are complied with such as LEEDs. For the final closeout phase, the commissioning of the project must involve the clear understanding of the sustainability goals and investment by the project owner (Robichaud & Anantatmula, 2011).

Separately, five aspects were identified to catapult construction projects more efficiently. The first one is to ensure compliance with the sustainability policies followed by design concept and procurement policies. Other than that, developers should leverage on innovation and technology to introduce new solutions which will not only optimize the usage of raw materials and energy but also the way employees work at site. Fourthly, the reinforcement of the organizational structure and process plays a key role to ensure that a top down awareness for sustainability is present. Lastly, education and training for the project team is important in order for everyone to be aware of each opportunity into which sustainability can be injected into construction activities (Tan et al., 2011).

Based on these, the study of the various mechanisms to ensure efficient construction practices can help nations to establish policies towards reducing GHG emissions in

line with their commitment in the Kyoto Protocol which was reinforced by the Doha Amendment.

2.5 Conceptual Framework

Hence, Figure 2-1 show the conceptual framework for the research study, where the implication of construction industry towards environment which consist noise, dust, water, health, human living and plant. This impact should take the mitigation by sustainable construction which are recycling scheme, green practice in design, construction and maintenance, waste management, procurement and construction system.

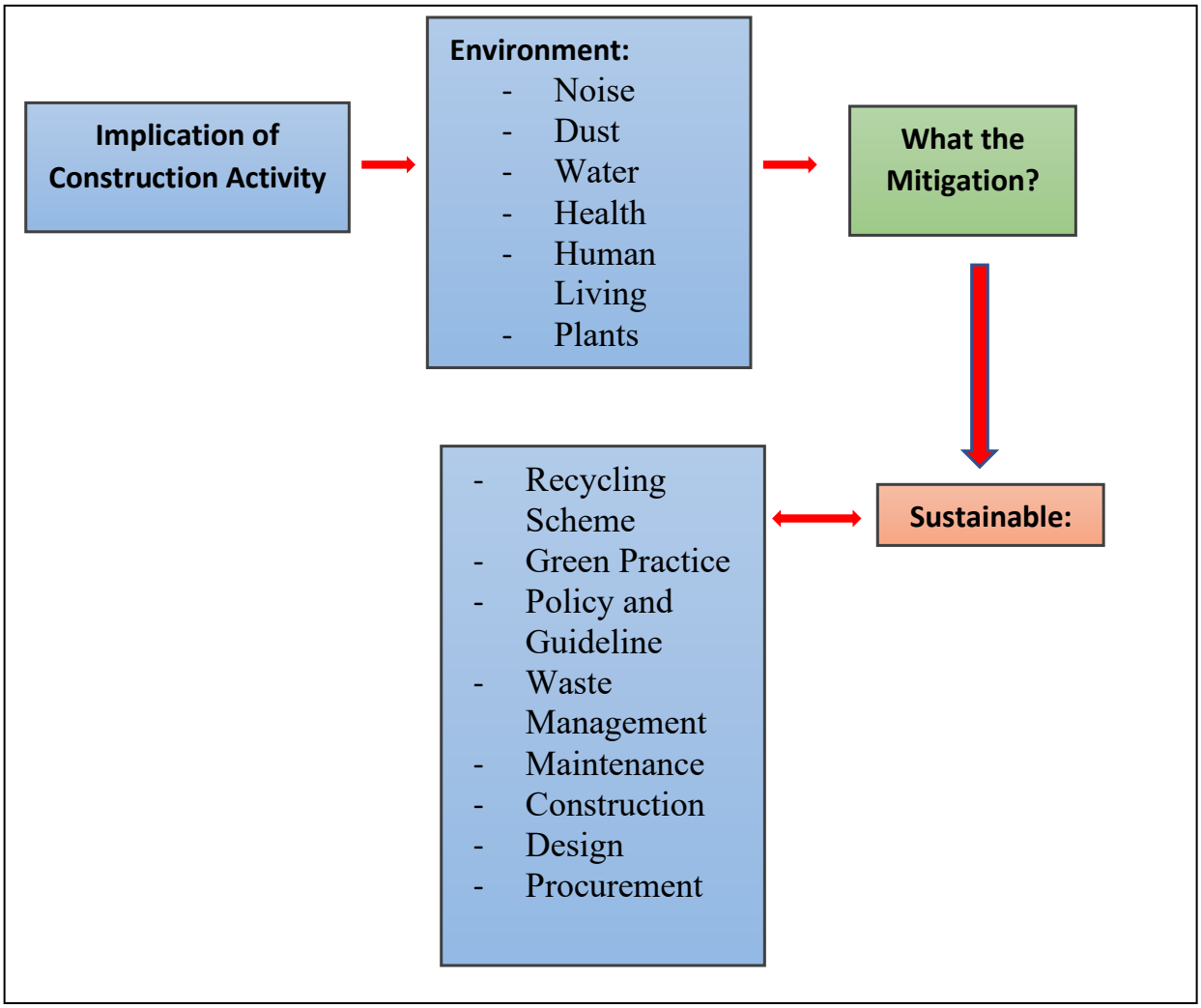

Figure 2-1: Conceptual Framework for Implication of Construction Industry towards Environment

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology followed to address the research objectives set in the Chapter 1. The concepts, process and techniques applied to complete this research are detailed in this chapter. The following are the contents will be discussed in subsequent sections:

i. Research framework and design;
ii. Population and sampling;
iii. Data collection; and
iv. Analysis of Data.

3.2 Research Framework and Design

To outline the research method, a framework is needed where the technique for data collection and analysis is used to confirm the research objectives is able to be achieved. Therefore, a research framework as illustrated in Figure 3-1 is adopted and use as a guideline for this research. The research techniques for the framework is based around the research techniques describe in Creswell (2014).

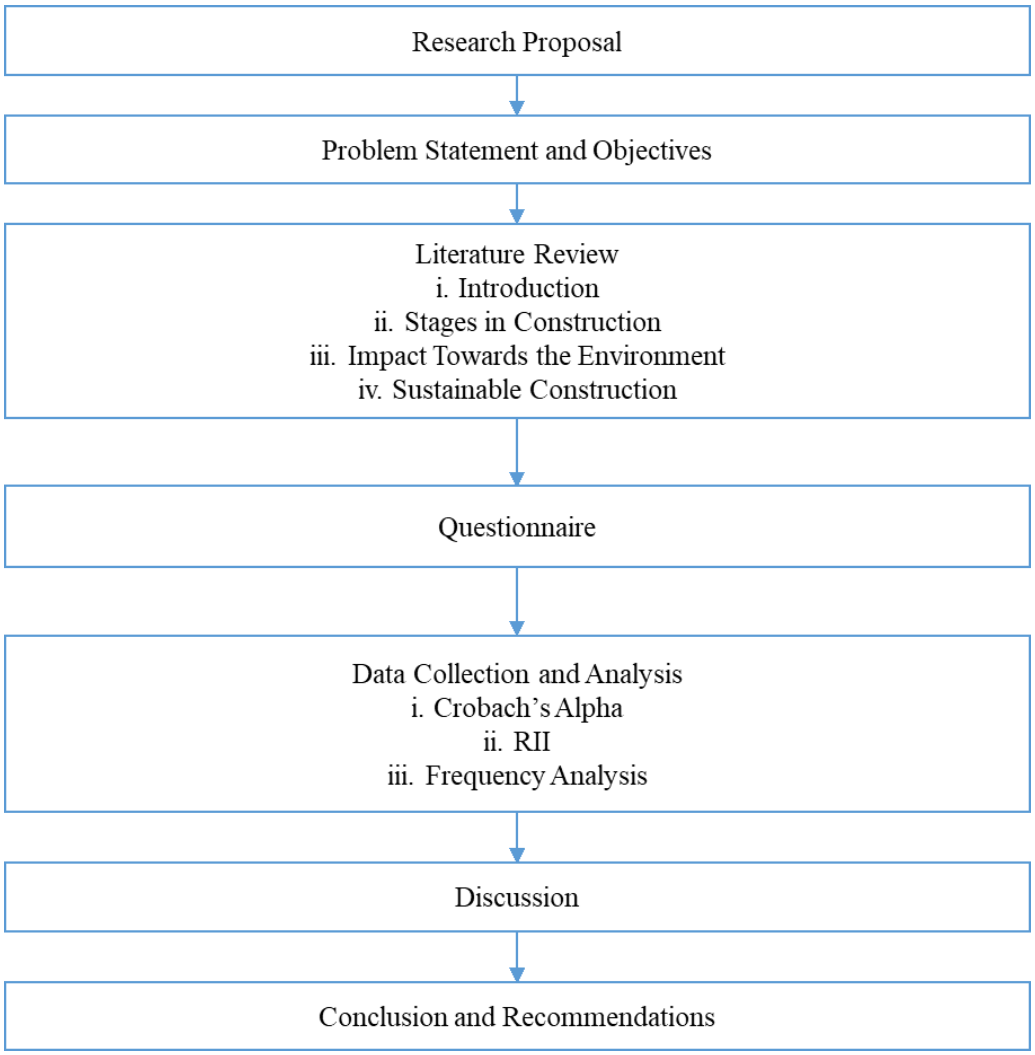

Figure 3-1: Research Framework Guideline according to Creswell (2014)

3.2.1 Research Design

The aim of research methodology is to provide a work plan of research (Chinnathambi, 2013). Research is referred to as a study that is carried out by any individual or a group of people (C.R. Kothari, 2004). It is mentioned in the oxford dictionary that the purpose of research is to create certain facts and to reach new conclusions through carrying out studies based on existing sources and to follow a systematic investigation approach.

There are various research methods that can be used in order to conduct a research. The various research methods are all bound to their own specific procedures and systematic ways in order how the research is to be carried out. According to Chinnathambi (2013), research methods are used in order to assist the researcher to

gather information, data, and samples and to find a possible solution to a specific problem. There are three research method that can be adopted which are quantitative, qualitative and mixed method. A quantitative research includes a systematic investigation through the process of collecting, analysing and interpreting the collected data to obtain the outcome of the research (Creswell, 2014). A qualitative research method involves collecting and analysing non-numerical data to understand concepts, opinions or experiences. Qualitative studies are used to gather in-depth studies of an issue or to produce new research ideas. According to Creswell (2014), mixed mode research integrates both quantitative and qualitative method into one research.

In this paper, quantitative research method is used as it is suitable for the research topic. The main purpose of using the quantitative research is so that a large research sample size can be collected in a short amount of time frame though an organized survey via questionnaire.

3.3 Population and Sampling

3.3.1 Sampling Design

Sampling is a technique used in order to gather information from a controllable group size. Sampling technique is choosing as it fits best and gives the researcher the ability to estimate and to obtain the required information from a specific target group. In order to ensure that the data obtained is good, restriction of time and location were enforced.

There are two types of sampling according to Saunders et al, (2008), the first is probability sampling and the other is called non-probability sampling. In order to reduce cost, money and effort, non-probability sampling was adopted in this research. Further to acquire the data needed, convenience sampling was chosen due to the short time frame. Convenience sampling method allowed the researcher to obtain data based on the chosen proximity and accessibility to the researcher. This technique was adopted as it is inexpensive and provides data fast as the respondents are either colleagues or knew the researcher.

3.3.2 Sampling Size

Kumar Ranjit (2019) has mentioned that, the sampling is the process to select some portion from the great number of populations as a foundation for estimating the prevalence of information which related to the research topic. An appropriate sample size according to pervious researchers such as Roscoe (1975), Gorsuch (1983), Kline (1984) and MacCallum et al. (1999) is between a ranges of 30 to 500 numbers. This is supported by Fellows & Liu (2008), where a sample size greater than 30 and less than 500 is adequate and factor analysis needs at least 100 numbers. However, according Meng (2013), it was found out that the simple random sampling is defined as sampling model, where x dissimilar items was selected from the y in population item. It is believed that each of possible union of x item is equivalent to the selected sample. This is to show that the simple random sampling is allowed to choose for each sample given.

3.3.3 Target Population

The target population in accordance with this research has to be personnel that works either in the construction industry or is directly involved with the construction industry. The main target of the study was client/owner, consultant, contractor and subcontractor. The questionnaire was distributed through email to the respective respond in order to answer the questions in google form provided.

3.4 Data Collection

The objective of collecting data is to allow the researcher to collect enough evidence and to later proceed to come up with an inference that is required to make decisions about the findings generated (Vian Ahmed, 1997; Syed Muhammad, 2016). In quantitative research methodology, there is a couple of research data-collection methods that can be adopted, but for this research a questionnaire approach was adopted. According to Vian Ahmed (1997) and Nigel Mathers et al., (2009), the questionnaire method is good because it provides flexibility, has low cost and is easy to administrate. In this research, the questionnaire was generated via Google forms that is readily available on the internet. The generated online Google form questionnaire then was distributed to specific personnel that is related to the construction industry via the share link from the Google form.

3.4.1 Questionnaires Design

In this research, the questionnaire generated in Google forms, was developed based on close-ended questions. The respondents were required to address all questions that were in the questionnaire which required their inputs based on the scale from "Strongly Disagree" to "Strongly Agree".

The developed questionnaire was divided into three sections. Section 1 of the developed questionnaire is in regard to the respondent demographic background which includes the respondent's current position, years of experience in the current position, project sector involved and their role in their current project. Section 2 of the questionnaire is to gauge what are the respondent's thoughts on implications towards the environment encountered during construction phase. This section was further broken down to air, water, land and noise pollution caused by construction activities. In this section, respondents are required to provide a feedback based on the scale set which ranges from 1 to 5 where 1 is "Strongly Disagree" and 5 is "Strongly Agree". Section 3 of the questionnaire is to gather feedback from the respondents on their thoughts of mitigation methods to reduce the impact of construction towards the environment. They were question on building materials used in construction, waste disposal at construction site, machinery used at construction site, green practices implementation in regard to project perspective and on construction framework and practices.

3.5 Analysis of Data

A software tool called Statistical Package for Social Science (SPSS) is used to analyse the data collected via the questionnaire survey. The analysis carried out on the data is to achieve the objective of this research via the help of the SPSS software. The tests used were Cronbach's Alpha, Ranking Test and Frequency Analysis.

3.5.1 Frequency Analysis

Frequency analysis is descriptive statistical method to display the frequency of each response selected by the respondent in this research through the questionnaire survey. The results was tabulated in order to provide a clearer understanding.

3.5.2 Relative Importance Index (RII) Analysis

A five-point Likert scale which ranges from 1 to 5 was adopted in this questionnaire and the RII analysis was used to measure the Likert scale in this research. The RII was obtained by using the formula below:

$$RII = \frac{\sum_{i=1}^{5} Wi \cdot Xi}{A \times N}$$

Where:

RII – Relative Important Index

W– Scale selected by the respondents (ranges from 1 to 5)

X – Frequency of *i*-th response given

A – Highest weight (5 is the highest for five point Likert scale)

N – Total number of respondents

3.5.3 Cronbach's Alpha Test

The Cronbach's Alpha reliability test was selected to measure internal consistency reliability from the keyed in data. The main purpose the Cronbach's Alpha test is conducted is to determine the reliability of the scale used in the questionnaire. The Cronbach's Alpha coefficient ranges from a scale of 0.00 to 1.00. The higher the alpha value states that the internal data obtained is more consistent. According to (Pallant, 2011), Cronbach's Alpha coefficient above 0.70 is acceptable.

Cronbach's Alpha	Level of Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Preferable
$0.7 > \alpha \geq 0.8$	Acceptable
$0.7 > \alpha$	Poor

Table 3-1: Cronbach's Alpha Value according to (Pallant, 2011)

3.6 Summary

In a nut shell, Chapter 3 presents the research methodology that acts a guideline for both data collection and data analysis. The results obtained from the questionnaire and from data analysis is state in Chapter 4. The discussion of the results is provided in Chapter 5.

CHAPTER 4

RESULTS

4.1 Introduction

As stated in Chapter 3, a minimum of 100 responses to the questionnaire survey is necessary for this research. The questionnaire was sent out to 150 targeted respondents. All 150 questionnaires were share to respondent via Google form link. A total number of 109 sets of responded questionnaire received at the end of data collection activity with a response rate of 72.67%. Table 4-1 below states the number of targeted respondents and the number of replies obtained.

Target of Respondents	150
Questionnaire Replies Obtained	109
Rate of Responded Questionnaire	72.67%

Table 4-1: Data Distribution and Collection

4.2 Respondent Background

The respondent's background data obtained from the questionnaire was analysed using frequency analysis and is summarised in Table 4-2, Table 4-3, Table 4-4 and Table 4-5 as follows with regards to frequency and percentage.

i. Current Position in Company

Position	Frequency	Percentage (%)	Rank
Engineer	66	60.6	1
Manager	26	23.9	2
Safety Officer	4	3.7	4
Site Supervisor	3	2.8	5
Skill Worker	4	3.7	4
Technician	6	5.5	3

Table 4-2: Respondents Current Position

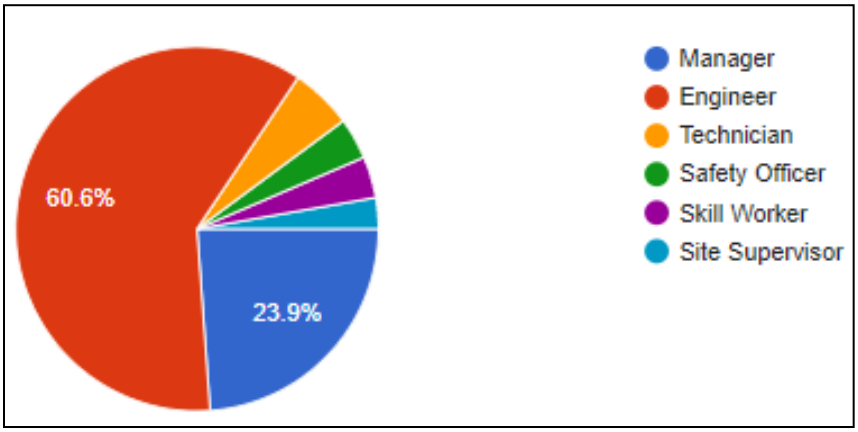

Figure 4-1: Pie Chart on Respondents Current Position

There is a total of 109 respondents which participated in this research and as shown in Figure 4-1, the majority of the respondents are executive levels. At 60.6%, the respondents were engineers followed by 23.9% who were managers, 5.5% were technicians, 3.7% were skill workers, and safety officers and 2.7% were site supervisors. Majority of the questionnaire survey reveals that the respondents are from executive levels and are directly involved in the construction phase at the construction site.

ii. Years of Experience in Current Position

Years of Experience	Frequency	Percentage (%)	Rank
<5 Years	55	50.5	1
⩾5 to 10 years	38	34.9	2
⩾10 to 15 years	13	11.9	3
⩾15 to 20 years	2	1.8	4
>20 years	1	0.9	5

Table 4-3: Respondents Year of Experience in Current Position

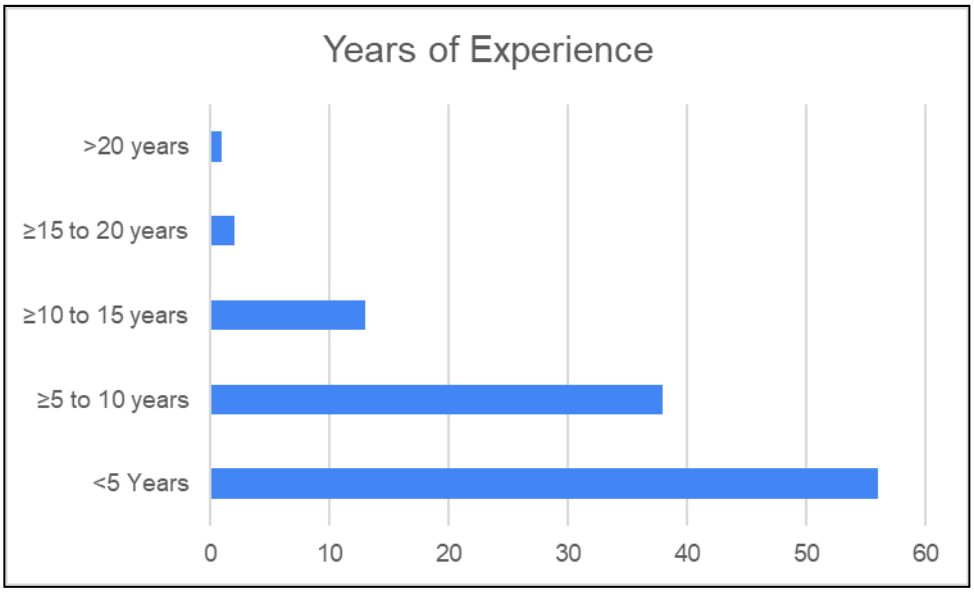

Figure 4-2: Respondents Current Experience Bar Chart

From the bar chart in Figure 4-2, it can be seen that most of the respondents are in their first few years of working life. A total of 55 respondents which makes up of 50.5% has experience less than 5 years, 38 respondents which makes up of 34.9% has been working between 5 to 10 years, 13 respondents which makes up of 11.9% has experience between 10 to 15 years, 2 respondents which makes up of 1.8% has 15 to 20 years working experience and only 1 respondent which makes up of 0.9% has working experience for more than 20 years. Majority of the respondents have around 5 years of working experience which makes the data collected reliable.

iii. Project Sector Involved

Project Sector	Frequency	Percentage (%)	Rank
Railway	65	59.6	1
Building	14	12.8	2
Highway	12	11	3
Oil & Gas	9	8.3	4
Energy	5	4.6	5
Waste Management	2	1.8	6
Road	1	0.9	7
Water	1	0.9	7

Table 4-4: Respondents Project Sector Involvement

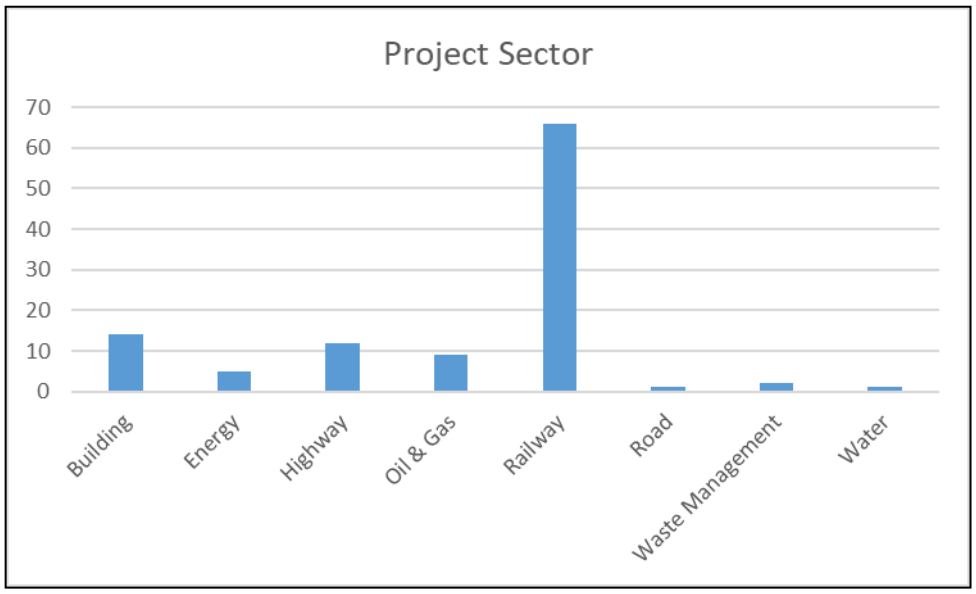

Figure 4-3: Respondents Project Sector Bar Chart

From the bar chart in Figure 4-3, majority of the respondents are from the railway industry with 65 over 109 are from the industry, this makes up for 59.6% of the respondents. 14 of the respondents which makes up of 12.8% are from the building sector, 12 of the respondents which makes up of 11% are from the highway sector, 9 of the respondents which makes up of 8.3% are from the oil and gas sector, 5 respondents which makes up of 4.6% are from the energy sector, 2 respondents which makes up of 1.8% are from the waste management sector where as there are 1 respondent which makes up of 0.9% from both water and road sector.

iv. Role in Project

Role	Frequency	Percentage (%)	Rank
Contractor	54	49.5	1
Sub-Contractor	27	24.8	2
Consultant	17	15.6	3
Owner/Client	11	10.1	4

Table 4-5: Respondents Role in Project

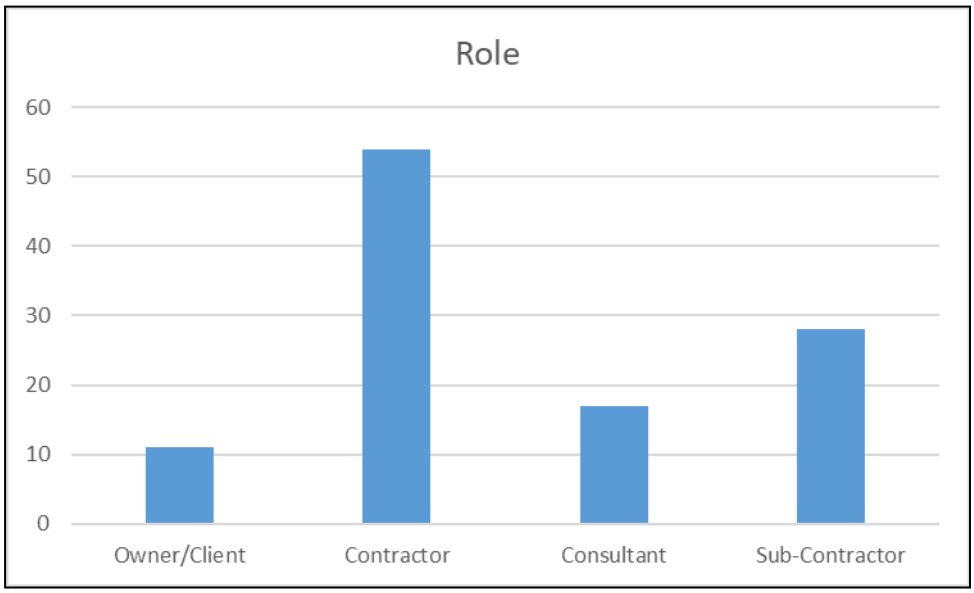

Figure 4-4: Respondents Role Bar Chart

From the bar chart, majority of the respondents are contractors, followed by sub-contractors, consultant to owner/client. 54 respondents were contractors in various construction projects which made up of 49.5% and 27 subcontractors hired by the contractors which made up of 24.8%. Next were the 17 consultants who advices the owner/client which made up of 15.6% of the overall respond. Lastly was owner/client which made up of 10.1% of the respondents equalling to 11 responds. As majority of the feedback was from respondents who were directly involved with the construction works, it is clear that this questionnaire survey is legit and reliable.

4.3 Cronbach's Alpha Test

The objective of the Cronbach's Alpha Test is to obtain and to measure the internal consistency reliability of the data obtained from the questionnaire survey. The acceptable alpha value to be obtained from Cronbach's Alpha test must be above 0.70 as the low values reflects a low degree of internal consistency (Pallant, 2011).

4.3.1 Cronbach's Alpha Test for Implications from Construction Activity towards the Environment

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.881	.883	13

Table 4-6: Cronbach's Alpha for Implication Construction Activity towards The Environment

4.3.2 Cronbach's Alpha on Mitigation Methods to Reduce the Impact of Construction towards the Environment

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.947	.951	20

Table 4-7: Cronbach's Alpha on Mitigation Methods to Reduce the Impact towards the Environment

4.4 Relative Importance Index (RII) and Frequency Analysis

4.4.1 Implications from Construction Activity towards the Environment.

Table 4-8 show the implications towards the environment encountered during construction phase in various construction sectors.

Implications	Number of Respondents	Mean	Rank	RII
Living areas are polluted by construction noises during day time? Please choose one.	109	4.16	1	0.831
Living areas are affected by heavy machinery (Piling, Excavating, Crane and etc.).	109	4.05	2	0.809
Muddy water due to soil erosion?	109	3.97	3	0.794
Dust in the air is visible around construction area?	109	3.96	4	0.793
Flash floods caused by clogged drains?	109	3.87	5	0.774
Dust in the air affects breathing?	109	3.83	6	0.767
Heavy smoke odours from heavy vehicles?	109	3.79	7	0.758
Health of people living around construction area deteriorate.	109	3.76	8	0.752
Water contaminated by construction waste being flowed into public drainage?	109	3.70	9	0.739
Chemicals (Paint, Weather coating, Solvents and etc.) vapors from various substances used from construction?	109	3.51	10	0.703
Plants around the construction area destroyed by contaminated water source?	109	3.50	11	0.699
Living areas are polluted by system test noises during night time?	109	3.40	12	0.681
Dust in the air affects visibility?	109	3.37	13	0.673

Table 4-8: Ranking of Implication from Construction Activity towards the Environment

4.4.2 Mitigation Methods to Reduce the Impact towards the Environment

Table 4-9 show the mitigation methods to reduce the impact towards the environment.

Mitigation Methods	Number of Respondents	Mean	Rank	RII
Impose sustainable policies and guidelines to ensure sustainable construction?	109	4.413	1	0.883
Construction site should have facilities on site to dispose of waste efficiently and accordingly?	109	4.404	2	0.881
Scheduled maintenance of machinery and vehicles used on construction site?	109	4.394	3	0.879
Health, safety and environment engineer to conduct life cycle assessment on proposed construction design?	109	4.376	4	0.875
Imposed stricter guidelines on how to dispose waste on construction sites?	109	4.367	5	0.873
Impose legal framework and enforcement for sustainable construction?	109	4.321	6	0.864
Provide employees training and education on sustainability to encourage green practices?	109	4.303	7	0.861
Encourage designers/architects to adopt sustainable design?	109	4.294	8	0.859
Architect and Engineers to ensure design is environment friendly?	109	4.284	9	0.857
Implement sustainable procurement policies to ensure supply chain is as green as possible?	109	4.266	10	0.853
Propose recycling scheme with incentives by government?	109	4.257	11	0.851
Management impose a top down approach to ensure green practices?	109	4.257	12	0.851
Practice lean construction method in order to reduce less material, resource, energy and labor?	109	4.257	13	0.851
Adopt sustainable innovations, technologies and processes to ensure cradle to cradle environment impact is minimized?	109	4.174	14	0.835
Installation of mufflers on to machines to reduce noise pollution?	109	4.128	15	0.826
Usage of acoustic containment units to reduce impact of sound?	109	4.110	16	0.822
Impose charges on waste disposal to landfills for waste that can't be recycled or disposed?	109	4.083	17	0.817

Continue Table.

Sustainable Construction	Number of Respondents	Mean	Rank	RII
Installation of mufflers on to machines to reduce noise pollution?	109	4.128	15	0.826
Usage of acoustic containment units to reduce impact of sound?	109	4.110	16	0.822
Impose charges on waste disposal to landfills for waste that can't be recycled or disposed?	109	4.083	17	0.817
Use bio-based material sourced at processing plants near construction sites to reduce carbon emission?	109	3.697	18	0.739
Use renewable or recycled source as building material?	109	3.633	19	0.727
Renewable or recycled material has longer lifespan?	109	3.248	20	0.650

Table 4-9: Ranking of Mitigation Methods to Reduce the Impact of Construction towards the Environment

CHAPTER 5

DISCUSSIONS

5.1 Introduction

This chapter will discuss the findings from the data tabulated in Chapter 4. It will be explained from Cronbach's Alpha, Frequency Analysis and Relative Important Index (RII).

5.2 Cronbach's Alpha

5.2.1 Cronbach's Alpha Test for Implications from Construction Activity towards the Environment

In Section 2 of the questionnaire, a total of 13 possible implications were put forth that is encountered during construction phase towards the environment for respondents to provide their inputs. The respondents was asked to rate the implications based on their inputs on what they think based on five-point Likert scale. Cronbach's Alpha Test was carried out on the scale using the SPSS software. It was deduced that the coefficient alpha value is more than 0.80. Hence, this value is within the acceptable range of 0.70 to 1.00, which clearly states that the scale has a good internal consistency as stated by (Pallant, 2011).

5.2.2 Cronbach's Alpha on Mitigation Method to Reduce the Impact of Construction towards the Environment

In Section 3 of the questionnaire, a total of 20 mitigation method approaches were put forth for the respondent's inputs. The respondents was asked to rate the questions based on a five-point Likert scale. Test was carried out on the scale using the SPSS software. It was deduced that the coefficient alpha value is more than 0.90. Hence, this value is within the acceptable range of 0.70 to 1.00, which clearly states that the scale has a good internal consistency as stated by (Pallant, 2011).

5.3 Relative Importance Index (RII) and Frequency Analysis

5.3.1 Implications from Construction Activity towards the Environment.

Data populated in the table above presents the opinions of the respondents on what implications of construction towards the environment that they noticed. The Relative Importance Index (RII) is used to calculate the importance of the factors and to find out the ranking of the factors among them. According to the RII obtained which is 0.831 and ranked first, it is evident that respondents are most affected by living areas polluted by construction noises during the day time. This states that noise caused by construction activities have affected the environment and people's daily routine. Living areas polluted by construction noises during the day time has a mean of 4.16 and is ranked first. Most of the respondents selected 5 on the Likert scale in the questionnaire. The second highest on the RII which is 0.809 is living areas are affected by heavy machinery. Living areas affected by heavy machinery has a mean of 4.05 and is ranked second. Most of the respondents selected 5 on the Likert scale in the questionnaire. Respondents may be concerned with the usage of heavy machinery and heavy vehicles at construction site. The noise from vehicles could be from pilling, excavating, bulldozing, crane and etc. It has shown that it is not only affecting the environment through noise pollution but also the daily living of people around the area. The first and second highest on the RII is both related to noise which shows that noise pollution is affecting the environment and can could lead to hearing problems, stress, poor concentration, communication difficulties and fatigue from lack of sleep. Noise are only noticeable during the day time and the respondents has note this as the key factor at the construction site and how it is affecting both the environment and the living hood of the people around the site. During night time, construction noises are not apparent and not noticeable as respondents has provided a reply in regards to living areas are polluted by system test noise during night time as not a major effect. The RII for this is 0.681 and is ranked twelfth with a mean of 3.40. The majority of the respondents voted four on the Likert scale on the questionnaire.

According to the RII populated and ranked thirteenth, the lowest ranking that affects respondents at construction sites were dust in the air affect visibility. The RII calculated was only 0.673. Dust in the air affect visibility has a mean of 3.37 and is also ranked thirteenth. Most of the respondents' selected three in the Likert scale on

the questionnaire. This shows that dust in the air is not a major factor and doesn't affect the well-being of the respondents. Nowadays dust control at construction sites are more efficient and not apparent. This is because at every construction site, the construction safety engineers as well as environmental engineers have guidelines on how to reduce air pollution. Most construction sites have to clean the outgoing vehicles from the construction site to ensure that no soil is carried from the site to the public areas. Some construction sites have large vacuums to filter the dust entering the atmosphere which help reduce particles into the air. Even with enforcing this few steps, respondents do think that dust is still visible in the air around construction area with an RII of 0.793 and ranked fourth. Dust visible around construction site has a mean of 3.96 and is ranked fourth. Most of the respondents has chosen five on the Likert scale on the questionnaire. They also think that dust in the air affects breathing with an RII of 0.767 and ranked sixth. It has a mean of 3.83 and is ranked sixth. Most of the respondents noted down five on the Likert scale in the questionnaire. No matter how many preventions and precautions that are implemented by safety and environmental engineers, a construction site is always going to be dusty as it involves moulding, mixing, grinding, pilling and etc. Ranked seventh and related to air pollution was heavy smokes odours from heavy vehicles with a RII of 0.758 and a mean of 3.79. Majority of the respondents marked four in the Likert scale on the questionnaire. Heavy smoke may cause difficulty in breathing to young ones and to elderly. It is also bad to the environment where it can cause greenhouse gases (GHG). Greenhouse gases will then cause environmental and health effects where GHG will cause trapping of heat and it will cause respiratory diseases.

Respondents noted down that chemical vapours from various substances from construction are not a major concerned at is ranked tenth based on the RII of 0.703 and a mean of 3.51. Majority of the respondent answered a four in the Likert scale on the questionnaire distributed.

According to the RII obtained, water contamination or pollution was the next factor they noticed around construction sites. At an RII of 0.794 and ranked third, respondents has stated that muddy water due to soil erosion was one of the top three implications encountered at construction site. Muddy water caused by soil erosion has a mean of 3.97 and is also ranked third. Most of the respondents has selected four

on the Likert scale on the questionnaire. Soil erosion is possibly caused by over excavation, heavy rain falls around construction site or by excessive deforestation. Flash flood caused by clogged drains was also one of the factors identified from the respondents in the questionnaire. It ranked fifth with an RII of 0.774 and a mean of 3.87. At construction sites, it is clear that you can see waste and rubbish everywhere and there cleanliness is not something that is being looked into every minute at the site. Waste from the construction sites will eventually make its way into drainage system and clogged the flow of water and can cause flash floods. In the greater part of Klang Valley where construction is evident, flash floods are also evident during major rain fall. When investigations are made, the common findings are that major drainage systems are clogged with waste from nearby construction areas. In regards to water pollution, responds from respondents on water is contaminated by construction waste ranked number nine with a RII of 0.739 and a mean of 3.70. Most respondents selected 4 on the Likert scale of the questionnaire. Waste management is critical at construction site and needs proper planning, certain construction site closes a blind eye to this and only deals with waste at the end of the project. Proper waste management has its own measures of ensuring waste is dispose in a more systematic manner and not to contaminate the environment. Plants being destroyed by contaminated water source at construction site has an RII of 0.699 and is ranked eleventh with a mean of 3.50. Majority of the respondents has given an input of three on the Likert scale on the questionnaire.

At number eighth according to the ranked RII was the responds of respondents on health of people living around construction area has deteriorated with an RII of 0.752. This responds has a mean of 3.76 and most of the respondents noted down a four on the Likert scale on the questionnaire. As most projects are not so close to living areas, people around the area can still go about their daily business without being affected by construction activities. Nevertheless, there are construction sites in regards to building and railway which are in close proximity of people living space. This may cause a nuisance to people’s daily routine and health.

5.3.2 Mitigation Methods to Reduce the Impact towards the Environment

Table 4-9 shows the RII, mean and mode of the responds obtained from the respondents from section three of the questionnaire which is in regards to mitigation methods to reduce the impact of construction towards the environment. The Relative Importance Index (RII) and mean are used to calculate and to find out the ranking of the possible mitigation methods to reduce the impact of construction towards the environment among them.

The highest scored RII was to impose sustainable policies and guidelines to ensure sustainable construction. RII was calculated at 0.883 and has a mean of 4.413. Most of the respondents scored 5 on the Likert scale on the questionnaire. Sustainable policies and guidelines are key aspects to any construction sites to ensure that the environment is taken care of. More and more stringent policies are being placed in order to ensure than construction is done right and pollution levels are kept to its low. There are a lot of studies that has pinned urbanization as one of the key factors disintegrating the environment. Respondents has rated a majority of 5 on the Likert scale in regards to provide employees training and education on sustainability to encourage green practices. The RII obtained was 0.861 and mean was calculated at 4.303. The RII calculated ranked this particular question as the seventh important to the respondents. Without education and training, site employees will not know what is right from wrong. It's best to allow them to learn from environmental engineers or safety inspectors on the Do's and Don'ts at construction sites.

Under the same category of framework and practices, respondents gave a majority of five to encourage designers /architects to adopt sustainable design and is ranked eighth in RII based on the Likert scale in the questionnaire. Sustainable construction is not in the top five most probably because sustainable construction or green construction is more expensive. Green design uses material that has longer lifespan, has more durability, lower maintenance, and requires expert handling for best installation. At tenth ranked with an RII of 0.853 and a mean of 4.266 was the respond to implement sustainable procurement policies to ensure supply chain is as green as possible. Most of the respondents have "Strongly Agree" on this as having a green supply chain for procurement will ensure the environment is a greener place. Procurement team in a company will be able to approach suppliers with either

recycle materials or more durable materials. To adopt sustainable innovations, technologies and process to ensure cradle to cradle impact is minimized has an RII of 0.835 and a mean of 4.174. Most of the respondents have mark a 5 on the Likert scale in the questionnaire. This question is ranked fourteenth in both RII and mean. To implement the cradle to cradle is important but its ranked fourteenth due to some respondents has mark one or two on the Likert scale and has tipped the scale to be lower and be ranked fourteenth. To ensure materials used are cradle to cradle is hard in a construction site as the term cradle to cradle is not fully possible such as concrete and metal.

The second ranked was construction sites should have facilities to dispose of waste accordingly with RII of 0.881 and a mean of 4.404. Many respondents graded 5 on Likert scale of the questionnaire. In order to ensure sustainability of the environment and to not let the waste being scattered or to be disposed by wind or water during floods, it's best to have a waste disposal system on every construction site. This will encourage site employees to dispose waste better such as by learning what is recyclable and what hazardous waste is. This will also teach all construction related employees on the benefits of having a cleaner site. Diseases such as Aides and Malaria can be avoided or reduced once they is no way for mosquitoes to breed in stagnant water such as containers, bottles, cans and etc. Under waste disposal, the respondents access that it is important to impose stricter guidelines on how to dispose water on construction sites. It obtained an RII of 0.873 and has a mean of 4.367. Majority of the respondents marked 5 on the Likert scale of the questionnaire. By imposing more stringent guidelines on waste disposal, site employees will feel obliged to carry out the tasks set to them by their employers. This will indirectly help the environment to be more plausible. The RII for imposing charges on waste disposal landfills for waste that can't be recycled or disposed was at 0.817 and has a mean of 4.083. Most of the responds was a 5 but there were still respondents that disagree with it. Many developers of a construction site wouldn't mind disposing the waste at a landfill but wouldn't want to pay for waste that cannot be disposed of. For an example, disposing asbestos is expensive and hazardous. Developers would not want to pay more to dispose something that has no significant importance or value to them.

In regards to machinery category of mitigation methods to reduce the impact of construction towards the environment, scheduled maintenance of machinery is ranked at third with a RII of 0.879 and a mean of 4.394. From this we can see how important maintenance of both heavy vehicles and machinery used at site is important. This is because by maintaining vehicles and machinery, it can reduce both sound and air pollution that comes from an unmaintained vehicle or machine. By implementing schedule maintenance, greenhouse gasses (GHG) can be reduced and sound levels can be reduced to allow a healthier environment. The next under machinery category is to propose recycling scheme with incentives to construction sites. It is ranked eleventh with an RRI of 0.851 and a mean of 4.257. Most of the respondents choose five. By having recycling machinery on site, it will help reduce the transportation of waste to landfill and reduce transportation which indirectly will reduce air pollution from heavy vehicle. Some might not agree as recycling machine will need to be handle by experience personnel and the machine will cost more than to just send waste to landfills. Installation of muffles on to machines to reduce noise pollution has an RII of 0.826 and a mean of 4.128 whereas usage of acoustic containment units to reduce impact of sound has an RII of 0.822 and a mean of 4.110. Both are ranked fifteenth and sixteenth respectively. Respondents feel that with installation of both mufflers or acoustic containment will not help reduce sound pollution to its best. In Malaysia, both acoustic containment and mufflers are rarely used and it is not well known to Malaysia personnel.

At ranking number four is that health, safety and environment to conduct a life cycle assessment on proposed construction design with an RII of 0.875 and a mean of 4.376. This was ranked high and voted as important to ensure the life cycle of the materials chosen for a specific construction project. By doing so, the life span of the constructed building or architecture will be longer and more acceptable. Less maintenance will be needed if the life cycle assessment is carried out in the beginning and at the end of a construction project. To impose legal framework and enforcement for mitigation methods to reduce the impact of construction towards the environment was ranked sixth with an RII of 0.864 and a mean score of 4.321. A lot of the respondents scored this question high or “Strongly Agree” is because if the framework is imposed at the beginning of the framework is much easier to execute compared at the middle of the project or at the end of the project. If the entire project

practices green framework or are working towards one goal of green construction, it will definitely help reduce pollution caused by construction and evidently better the environment. Respondents input for architect and engineer to ensure is environment friendly ranked ninth overall and has a RII of 0.857 and a mean score of 4.284. Most of the responses were 5 on the Likert scale of the questionnaire. For architects and engineers to ensure the design they come up with is as green as possible will cost the budget to be more than planned and therefore is not agreed by project managers who wants to keep everything under cost price. Green features or energy saving facilities or equipment do save the environment but it is costly to procure and implement in a large scale project. Respondents inputs on whether management to impose a top down approach to ensure green practices was ranked twelfth with an RII of 0.851 and a mean score of 4.257. The inputs given were mostly scored 5 on the Likert scale of the survey but it is not the highest ranked most probably due to skill workers and subcontractors did not agree on this statement. To impose something form the top is an instruction and not a management step. To make everyone be on the same page, management level employees should practice what needs to be passed down to allow employees at site to follow the correct green practices. Respondents inputs on practicing lean construction methods in order to reduce less material, resource, energy and labour came in at rank thirteenth with a mean score of 4.257 and a RII of 0.851.

The three lowest score ranking eighteenth, nineteenth and twentieth were using bio-based material sourced at processing plants near construction sites to reduce carbon emission with an RII of 0.739 and a mean score of 3.697, followed by use renewable source as building material with RII of 0.727 and mean score of 3.633 where as to use renewable or recycled material has longer lifespan came in last with RII of 0.650 and a mean score of 3.248. Many respondents' inputs for this three questions on reusable material were scored lowest. They most probably believed that in the construction sector no renewable materials should be used to ensure its quality and longevity. By using new and enforced material will provide a more secure and strong structure and will be best for the long run. This helps ensure the lifespan of the civil structure being constructed.

5.4 Summary

To recap Chapter 5, a total of 109 responded set of distributed questionnaire was analysed. Every question in the three sections of the questionnaire was thoroughly analysed. Frequency analysis was used to analyse the demographic of the respondents' background and projects' information. The reliability of the collected data was assured and confirmed with Cronbach's Alpha Test. The scales used in questionnaire were found to be statistically reliable as the alpha value, α of at least more than 0.7. The first objective of this project which was to address the implications of construction towards the environment during construction phase was addressed in Section 4.4.1

Rank	Implications
1	Living areas are polluted by construction noises during day time?
2	Living areas are affected by heavy machinery (Piling, Excavating, Crane and etc.).
3	Muddy water due to soil erosion?

Table 5-1: Ranking of Implications from Construction Activity towards the Environment

The second objective which was on mitigation methods to reduce the impact of construction towards the environment of this project was addressed in Section 4.4.2.

Rank	Mitigation Methods
1	Impose sustainable policies and guidelines to ensure sustainable construction?
2	Construction site should have facilities on site to dispose of waste efficiently and accordingly?
3	Scheduled maintenance of machinery and vehicles used on construction site?

Table 5-2: Ranking of Mitigation Methods to Reduce the Impact of Construction towards the Environment

CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

Chapter 6 is to conclude the findings from the questionnaire survey that was used for this research. It was beneficial and useful to understand the implications from construction phase towards the environment and the possible mitigation methods to reduce the impact towards the environment that could be implemented. The contractors and sub-contractors play a major role in this part to encourage feasible construction to improve the existing environmental pollutions with effective solutions.

6.2 Conclusion

The primary objective of this project was to identify the environmental implications and factors that may cause environmental pollution to the surrounding environment in regards to construction from different project sectors. Based on the questionnaire survey, the gathered data from respondents were useful in the data analysis. The relative important index (RII) was used to identify the most important factors that caused environmental impacts at construction sites. According to the questionnaire survey results based on 5 point Likert scale, noise pollution was the biggest contributor as an impact towards the environment. Heavy machinery works such as pilling and excavating was one of the major contributors to noise pollution around the construction area. This makes is evident that noise pollution greatly affects the surrounding environment and the quality of people's life. Nevertheless, they were many possible mitigation methods to reduce the impact of construction towards the environment put forth for respondents to ensure construction will not harm the environment.

The second objective of the study was to identify possible mitigation methods to reduce or to eliminate impacts from construction towards the environment. Imposing sustainable policies and guidelines to ensure noteworthy construction has the highest relative important index (RII). Respondents strongly believe if policies and guidelines were made to be in place since the start of the project, construction sites will reduce the implications of construction towards the environment further. Sustainable policies will enforce how construction should be carried out and at the same time ensuring Mother Nature is not damage by urbanization. It is also strongly agreed that waste disposing facilities on site will further reduce the damage to the environment. If waste disposal facilities were made available on construction sites, waste do not have to be collected and stagnant till it is transported to landfills for further process. It will also reduce transportation of waste from one location to the landfill and indirectly reduce the usage of heavy vehicles which emits greenhouse gases (GHG). Waste disposal facilities on site will also encourage zero waste policy on site, where all or most waste can be either eliminated or recycled to other materials.

6.3 Limitations of Research

Time constraint was the primary limitation of this research. Convenience sampling of non-probability technique was adopted for this study due to the limited time frame. Hence, the respondents were more from railway projects compared to the other project sectors, this is because of the nature of work I as the researcher was in. Due to time constraint, the data obtained was from respondents involved in projects across Malaysia only and was more focused towards Klang Valley. Data for the entire Malaysia projects was unable to be obtained and the data obtained through the questionnaire survey hardly represents all the projects being carried out in Malaysia. Therefore, the findings in Chapter 4 may not represent the overall Malaysian construction projects, its implications towards the environment and the possible mitigation methods to reduce the impact of construction towards the environment.

6.4 Implications of Research

Implications of constructions towards the environment is unavoidable if not managed properly. Pollution from every aspect can be seen coming from construction towards the environment such as water, air and sound. By identifying the possible impacts from construction towards the environment, project personnel can better their construction management and environmental process to impact the environment further.

Also from this research, it was able to identify the possible best ways to reduce the impacts of construction towards the environment. By enforcing sustainable policies based on best practices from various projects, impact of construction can be contained and eliminated if handle properly. Therefore, this research promotes the use of legal measures and to have green frameworks to ensure construction activates do not impact the environment.

6.5 Recommendations

From the companies' perspective, it is best if the company involving construction takes sustainable construction seriously to reduce the burden construction has on the environment. The best way is to enforce sustainable policies and green framework so that the entire company works towards the similar goal. The company has to take charge and to guide its employees to better the standard of living. Companies can also provide training to employee's especially foreign worker on housekeeping at site and on recycling. Every construction company is advised to prepare a small area for waste disposal facilities. To get everyone on board with ensuring feasible construction, maybe companies could introduce an incentive measure or an appreciation for employees that adhere best to the sustainable policies and green framework by doing their part for the betterment of the environment.

From the governments' perspective, they can reduce charges towards construction companies of waste disposal to the landfill. By reducing the charges, it helps promote construction companies to actually dispose of their waste correctly and not by letting the waste rot at site and creating diseases. Another method is to work together with construction sectors on how to reuse what is considered as waste. There are a lot of waste at major construction sites that involves wood, metal and concrete. It's best if

construction companies can work with the government on how to reuse this instead of just burying it underground which could lead to soil pollution.

6.6 Recommendation for Future Work

Implications are always look from a negative perspective and not a positive one. There are a lot of studies done in regards to how impacts of construction is bad for the environment. There are very few studies stating on how the environment may be better from construction activities. There are almost no study on how green engineering can better the environment and on how green policies may bring construction to the next level. As a suggestion for the researcher who is interested on this topic, a further research in qualitative approach is needed to validate the result. For future studies, in order to get a obtain a more precise result, it is recommended to use another sampling method for data collection to look into same topic by including more sample from other project sectors besides railway.

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APPENDICES

APPENDIX A: Questionnaire

Implication of Construction Activities towards Environment

Dear Sir/Madam,

Sincere greetings and best regards to you.

I am a postgraduate student of Masters of Project Management from Lee Kong Chian Faculty of Engineering and Science (LKC FES) at University Tunku Abdul Rahman (UTAR). I am currently doing a research on “Implication of Construction Activities towards Environment”. The purpose if this research is to investigate the impacts construction has made towards the environment and the possible mitigations to reduce the impacts construction has on the environment.

It will be much appreciated if you could participate in this research by filling up this questionnaire. The questionnaire is designed to be completed within 15 minutes.

Please be assured that your participation will be anonymous and all information will be kept confidential and for academic purpose only. Should you require any clarification, please do not hesitate to contact me at ashvin.32.naidu@gmail.com or 016-4406302.

Your precious time and effort in participating the survey is deeply appreciated.

Thank you.

Yours faithfully,
Ashvin Naidu

Section 1 : Demographic Background

Personal Background

1. 1. What is your current position in your company? Please select one.

   Mark only one oval.

   - ◯ Manager
   - ◯ Engineer
   - ◯ Technician
   - ◯ Safety Officer
   - ◯ Skill Worker
   - ◯ Site Supervisor

2. 2. How long have you been working in your current position? Please select one.

   Mark only one oval.

   - ◯ <5 years
   - ◯ ≥5 to 10 years
   - ◯ ≥10 to 15 years
   - ◯ ≥15 to 20 years
   - ◯ >20 years

3. 3. Which project sector are you involved in for this infrastructure project? Please select one.

Mark only one oval.

- Road
- Water
- Railway
- Highway
- Building
- Energy
- Mining
- Oil and Gas
- Waste Management

4. 4. What is your role in this project? Please select one.

Mark only one oval.

- Owner/Client
- Consultant
- Contractor
- Subcontractor

Section 2 : Implications from Construction Activity towards the Environment.

The following questions are in regards to the possible impacts caused by construction activities and how it affects the environment.

5. 1. Dust in the air is visible around construction area? Please select one.

Dust Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

6. 2. Dust in the air affects visibility? Please chose one.

Dust Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

7. 3. Dust in the air affects breathing? Please chose one.

Dust Poluttion

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. 4. Heavy smoke odors from heavy vehicles? Please chose one.

Air Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. 5. Chemicals (Paint, Weather coating, Solvents and etc.) vapors from various substances used from construction? Please chose one.

Air Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. 6. Flash floods caused by clogged drains? Please choose one.

Water Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

11. 7. Muddy water due to soil erosion? Please choose one.

Water Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. 8. Water contaminated by construction waste being flowed into public drainage? Please choose one.

Water Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

13. 9. Plants around the construction area destroyed by contaminated water source? Please choose one.

Water Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

14. 10. Living areas are polluted by construction noises during day time? Please choose one.

Noise Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. 11. Living areas are polluted by system test noises during night time? Please choose one.

Noise Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. 12. Living areas are affected by heavy machinery (Piling, Excavating, Crane and etc.). Please choose one.

Noise Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. 13. Health of people living around construction area deteriorate. Please choose one.

Noise Pollution

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section 3 : Mitigation Methods to Reduce the Impact of Construction towards the Environment.

The following questions are in regards to the possible sustainable approaches towards helping the environment.

18. 1. Use renewable or recycled source as building material?

Building Materials

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

19. 2. Renewable or recycled material has longer lifespan?

Building Materials

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

20. 3. Use bio-based material sourced at processing plants near construction sites to reduce carbon emission?

Building Materials

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. 4. Imposed stricter guidelines on how to dispose waste on construction sites?

Waste Disposal

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. 5. Impose charges on waste disposal to landfills for waste that can't be recycled or disposed?

Waste Disposal

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. 6. Construction site should have facilities on site to dispose of waste efficiently and accordingly?

Waste Disposal

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. 7. Propose recycling scheme with incentives by government?

Machinery

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

25. 8. Installation of mufflers on to machines to reduce noise pollution?

Machinery

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. 9. Usage of acoustic containment units to reduce impact of sound?

Machinery

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. 10. Scheduled maintenance of machinery and vehicles used on construction site?

Machinery

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

28. 11. Management impose a top down approach to ensure green practices?

Green Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

29. 12. Architect and Engineers to ensure design is environment friendly?

Green Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

30. 13. Health, safety and environment engineer to conduct life cycle assessment on proposed construction design?

Green Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

31. 14. Practice lean construction method in order to reduce less material, resource, energy and labor?

Green Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

32. 15. Impose legal framework and enforcement for sustainable construction?

Framework and Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

33. 16. Impose sustainable policies and guidelines to ensure sustainable construction?

Framework and Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

34. 17. Encourage designers/architects to adopt sustainable design?

Framework and Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

35. 18. Implement sustainable procurement policies to ensure supply chain is as green as possible?

Framework and Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

36. 19. Adopt sustainable innovations, technologies and processes to ensure cradle to cradle environment impact is minimized?

Framework and Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

37. 20. Provide employees training and education on sustainability to encourage green practices?

Framework and Practices

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree