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ANALYSIS OF CONSTRUCTION AND DEMOLITION WASTE GENERATION AT KUANTAN, PAHANG

ADVEIN A/L AMI

Thesis submitted in fulfillment of the requirements
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ABSTRAK

Sisa pembinaan adalah satu masalah yang semakin meningkat di kedua-dua negara yang sudah maju dan sedang membangun. Negara-negara membangun sedang berusaha ke arah pengurusan sisa pembinaan yang lebih baik. Bagaimanapun masih ada sistem pengutipan yang tidak mencukupi dan sistem pelupusan sisa yang tidak betul. Sisa pembinaan secara amnya merujuk kepada perkata yang berkaitan dengan pembinaan, perobohan, pengubahsuaian, pembangunan hartanah, pembinaan infrastruktur, kerja tanah dan operasi pembersihan tanah (US EPA 1998, Tang, Soon & Larsen 2003). Ia terdiri daripada kayu, konkrit, logam, batu-bata, drywall, bumbung, bahan pembungkusan, plastik, kertas, kadbod dan lain-lain. Dalam pembinaan bangunan, penggunaan konkrit, kaca, keluli, bata, aluminium dan plastik yang biasa digunakan dalam kuantiti yang besar yang boleh menyebabkan sisa kepada bahan-bahan.

Objektif kajian ini adalah untuk mengenal pasti sisa pembinaan dan sisa perobohan di tapak pembinaan. Selain daripada itu, kajian ini juga mengenal pasti strategi yang diambil oleh syarikat dalam menguruskan sisa pembinaan di Kuantan, Pahang. Kaedah kuantitatif digunakan dalam pengambilan data untuk kajian ini. Ini berkaitan dengan mengambil sampel daripada populasi tertentu. Untuk kajian ini, soal selidik telah diperoleh dari 32 sampel daripada 36 syarikat pembinaan di Kuantan, Pahang.

Soal selidik ini berkaitan tentang jenis dan jumlah sisa yang dihasilkan, kaedah melupuskan dan strategi untuk mengurangkan sisa pembinaan. Segala maklumat kajian yang diperoleh adalah melalui maklum balas daripada responden dan semua maklumat ini kekal sulit. Statistik deskriptif digunakan untuk menganalisis data. Hasil kajian ini menunjukkan bahawa konkrit, keluli dan aluminium, batu bata dan kayu dan papan lapis adalah 100% dijana sebagai sisa di setiap tapak pembinaan. Ini diikuti oleh kaca 71,88%, plastik 43.75%, dan lain-lain bahan 6.25%. 32 daripada 32 responden menyatakan bahawa kaedah pelupusan adalah kaedah yang biasa digunakan di tapak pembinaan. Tapak pelupusan yang sah terdapat di Kuantan terletak di Pusat Pelupusan Sampah Jerangau-Jabor. Kebanyakan responden juga bersetuju bahawa pengendalian dan penggunaan bahan-bahan dengan betul adalah strategi terbaik untuk mengurangkan sisa pembinaan dengan skor purata yang tertinggi iaitu 4.62 daripada 5. Ia adalah penting untuk kontraktor untuk mengikuti laman Pelan Pengurusan Sisa (SWMPs) untuk menguruskan sisa pembinaan dengan lebih berkesan.

ABSTRACT

Construction waste is a growing problem in both developed and developing countries. Developing countries are moving towards better management of construction waste however there is still inadequate collection and improper disposal of construction waste. Construction waste broadly refers to waste arising from construction, demolition, renovation, property development, infrastructure construction, earthworks and land clearing operations (US EPA 1998, Tang, Soon & Larsen 2003). It consists of wood, concrete, metal, brick, drywall, roofing, packaging materials, plastic, paper, cardboard and others. In construction building, the usage of concrete, glass, steel, brick, aluminium, and plastics are commonly use in large quantities that can causes the waste to the materials.

This study objective is to characterise the construction and demolition waste at construction site. Other than that, this study also investigate strategy taken by company in managing construction waste in Kuantan, Pahang. Quantitative method is used as a data collections for this study. This is related with taken a sampling from a certain population. For this study, questionnaire had been given to the 32 sample from 36 construction companies in Kuantan, Pahang.

The reviewers responded to questionnaire about type and total waste generated, method of disposing and strategies to minimize the construction waste. Survey information was obtained through the respond from reviewer and all responses remained confidential. Descriptive statistics were used to analyse the data. The result of this study shows that concrete, steel and aluminium, bricks and wood and plywood is 100% available and generated as waste at every construction sites. This is followed by glass 71.88%, plastics 43.75%, and others material 6.25%. 32 out of 32 reviewer stated that the disposal method is the commonly used method at construction site. The legal landfill in Kuantan is located at Pusat Pelupusan Sampah Jerangau–Jabor. Most of reviewer also agreed that proper handling and usage of materials is the best strategies to reducing construction waste with the highest mean score of 4.62 out of 5. It is essential for the contractor to follow Site Waste Management Plans (SWMPs) in order to manage the construction waste more effectively.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Construction waste is a growing problem in both developed and developing countries. Developing countries are moving towards better management of construction waste however there is still inadequate collection and improper disposal of construction waste. Construction waste broadly refers to waste arising from construction, demolition, renovation, property development, infrastructure construction, earthworks and land clearing operations (US EPA 1998, Tang, Soon & Larsen 2003). It consists of wood, concrete, metal, brick, drywall, roofing, packaging materials, plastic, paper, cardboard and others. In construction building, the usage of cement, glass, steel, brick, aluminium, and plastics are commonly use in large quantities that can causes the waste to the materials.

The construction sector in the countries accounted for most of total waste generation. The construction industry produces large amounts of waste, which is about four times generated in households and thus contribute more than 50 percent of waste deposited in normal landfills (Ferguson et al, 1995;. Coventry and Guthrie, 1998). This is because of the high amount of waste generated from construction, demolition, renovation and activities that related to the construction. The rapid growth in the construction industry has increased the problem of construction waste in the entire world. Construction, remodelling, repair, renovation or demolition work of buildings and other infrastructure generate a large amount of construction waste. An estimated 13-30% of all solid waste deposited in landfills around the world is made up of construction and demolition waste at a ratio of 1: 2 for construction to demolition waste. In the Netherlands, for example, is estimated at 4250 million tonnes construction waste every year (O D Wilson, R M Skitmore and A Seydel, n.d.).

Before the construction waste become the big problem to the countries, the immediate improvement of the construction waste disposal practices is need to be taken quickly in order to improved construction waste management. The countries need to know the main root of this problem so that the legal action can be taken.

1.2 Background of Study

Previous studies on the causes of waste in construction projects shows that the waste can be occur at every stage of the construction process, whether at the beginning, construction and operation of the built facility (Faniran and Caban, 1998; Craven *et al.*, 1994; Gavilan and Bernold, 1994; Spivey, 1974). According to Polat and Ballard (2004), it is generally acknowledged that very high levels of waste present in construction. Since construction has a great influence with many other industries in purchasing inputs and providing the products to all other industries, eliminating or reducing waste in the construction industry can generate substantial cost savings to society. In recent years, the waste of the construction industry has been the subject of several research projects around the world.

Management of waste materials is a worldwide problem. In developing countries, waste management becomes an acute problems due to the increasing urbanization and economic development that leads to a larger amount of wastes that require management in countries. In Asia, the management of waste should be given attention and need to be considered, especially in countries like China, Korea and Malaysia which have been categorized as emerging industrialized countries.

Malaysia, like most developing countries, face increasing waste generation and have a problem with waste disposal. Malaysia has undergone rapid infrastructure development over the last decade when Malaysia is undergoing a process of transformation. Therefore, in order to prepare the site for construction of new buildings, they need to carry out the demolition project to get the landsite. A comparative study between new construction and renovations show that construction activity will generate more than 80% of waste than refurbishment. For some of the historic city, there are more

waste being produced because of demolition and new construction projects (Teixeira and Couto, 2000). The aim of this study was to provide background information on the construction waste in term of composition of waste generated which might leads to problems in Malaysia and propose a practical guide for building professionals on how to manage and reduce the construction waste.

1.3 Problem Statement

The construction sector in Malaysia at present produce a lot of waste materials at the construction site. The wastes are from surplus of excavation work, building construction, land clearing, the destruction of buildings, road construction and building renewal. Most contractor in Malaysia do not take this issue seriously. They just ignore the wastage occurs at construction site and not try to solve the problem of this issues.

1.3.1 Statistic about Construction Waste in Malaysia

Construction waste generation in Malaysia is becoming a demanding issues (Begum Et. al, 2007; Begum Et. al., 2010). Rapid development in the construction industry scar a lot of construction waste in this country. The building of major infrastructure projects and the high demand of house make the total of construction waste become higher (Nasaruddin et. al., 2008; Siti and Noor, 2008). A study in Malaysia shown the percentages of materials waste: Soil 27%, wood 5%, brick and blocks 1.16%, metal product 1%, roofing material 0.20%, plastic and packaging materials 0.05%, concrete and aggregate 65.80% (Begum et al., 2006). Jones and greenwood (2003) obtained percentage of waste in ten materials as plaster board 36%, packaging 23%, cardboard 20%, insulation 10%, timber 4%, chipboard 2%, plastic 1%, electric cable 1%, and rubber 1% (Yahya and Boussabaine, 2006). In Peninsular Malaysia, the measure of solid waste created every day expanded from an expected 23, 000 tons in 2010 to 25, 000 tons in 2012, averaging around 0.9 kilograms for each individual every day. Solid waste in Malaysia by an average of 45.0% of food waste, 24.0% plastic, paper 7.0%, 6.0% iron, and glass 3.0% and other (Ahmed, 2010). The research has been carried out on 30 construction site and they found there are six famous types of waste which include

concrete (12.32%), metals (9.62%), bricks (6.54%), plastics (0.43%), woods (69.10%) and others waste (2%). From this research, it can be concluded that wood is the most material waste than others (Faridah et. al., 2004).

1.3.2 Weakness of Malaysian Contractor in Minimizing Construction Waste

The statistic shown us that Malaysia have the trouble in order to minimize construction waste. This is due to the weakness among the contractor in Malaysia. The contractor do not know the specific quantity that needed in completing the project. They cannot estimate the right quantity of materials. The materials and store is in bad condition. This will cause the damage, broken, and loss of materials. The material should keep arrange and neatly to make it easier to find what it's need. The contractor also do not check first the materials or products that delivered. Sometimes the materials or products are already damaged and broken due to the journey. The materials become useless if it is exposed to the weather. The contractor not close the materials. The contractor will always buy the new materials in order to replace the damage one. They only think fast way in order to replace it. They do not want to try reuse or recycle the material first. All of these weakness in managing the materials on site make the construction waste become more increase.

1.4 Research Objectives

1. To identify the composition of construction and demolition waste at construction site

2. To investigate strategy taken by company in managing construction waste.

1.5 Research Questions

1. What are the construction and demolition waste of construction materials at construction site?

2. What are the strategies implemented by construction company in managing construction waste?

1.6 Scope of Study

The scope of research is one of the first to establish what, why, where, who and how the investigation is going on. This research will focus on the situation and practices of Malaysian contractors in reducing waste during construction. Next, a problem in reducing construction waste will be identified. Since the research will involve the construction of waste minimization practices among contractors, the main target group will be the contractor class A. This study will focus on the current status of waste minimization practices made by the contractor on a construction site. The target group consists of contractors registered in the state of Pahang. In addition, only selected sites within the Kuantan, Pahang has been selected by the considered of the highest percentage of development there. The study will cover all types of construction site. In others, the relevant agencies such as the Construction Industry Development Board (CIDB), and Solid Waste and Public Cleansing Management Corporation and Department of Environment (DOE), which is among the most important agencies relating to wastage in Malaysia was also selected as the target group to find out details about these issues. Limitations of this study was limited to individuals who play an important role in the reduction of construction waste in Malaysia.

1.7 Significant of Study

Currently in Malaysia, there is very limited research have been done on the issue of construction waste. The importance of this study is to highlight the key issues of waste and the waste reduction practices among contractors. This study will highlight the gaps in terms of existing policies and practices and the main problems in reducing construction waste. This study will add to the existing knowledge on the issues of waste minimization and policies. This study is to emphasize the importance of effective implementation of waste reduction towards sustainable development in construction in the future. In general, the issues of waste in the construction industry is not seriously taken by others. So,

evidence and research is needed to provide information on this issue and the actions to be taken. This study is aimed to contribute certain data on waste composition and provides the basic elements in reducing waste at the construction site, and it is expected to be of interest to many parties, especially development researchers and related agencies.

1.8 Definition of Terms

- **Waste**

  Waste means unwanted or unusable materials. Any materials which is no use, rejected, worthless, or deflective after the use of it. Waste Management Act of 2001 define waste as "any substances or object which the owner intends or requires that materials to be removed or disposed shall be presumed as a waste" (Torgal and Jalali, 2011).

- **Construction Waste**

  Construction waste means any substances, matter, or thing used or generated as a result of the construction work. In other words, any materials which is processed or stored abandoned after the project completed. It includes the surplus materials resulting from excavation, renovation, demolition, site clearance, and other works. (Choudhary, Venkata, and Bhargav, 2015)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Construction waste is something that consists of unwanted material or waste produced or occur either directly or indirectly by the construction or industries. This include building materials such as sand, nails, water, and rubbish. During site preparation a lot of waste generated like big rock and tree stumps during the process of dredging. There are certain construction waste may contains any of hazardous substances. Most of the construction waste consists of materials such as cement, sand, brick, concrete, and wood damaged or unused during construction. A research by Nagapan and Asmi (2013) has shown that 10% to 15% of this materials is used in the building. Certain components of construction waste that consists of chemical materials are dangerous when inappropriate disposed. It can be hazardous because it release a toxic gas. Construction waste is not the new issues in the construction sites but it is already exist in the past. Every development country have this problem on their construction project. A rough estimation of the quantity of construction waste is ~7.5 million tons a year, which is well-matched with values reported by Chini (2005) for industrialized countries. An increase in the standards of living in developing countries has increase the amount of waste significantly due to many developments.

2.1.1 Construction Waste in The Countries

Most of the nations have the difficulties time dealing with waste. For the fast developing world, managing waste is the challenging issues for them due to the

inadequate manpower, financial resources, implements, and machinery which result in environment pollution (Kartam et al., 2004).

In United Kingdom (UK), construction sector is one of the fastest growing sector. 32% of the total waste generated in that country and most of the waste from this sector goes to landfill sites (Defra, 2004). In the USA, construction activities generate an enormous amount of waste over 29% of the total number of landfills (Ferguson et al., 1995). Research in Hong Kong showed that about 5-10% of building materials end up as waste on the building site. There are many factors that contribute to this figure like human, and other mechanical (Poon and Jailon, 2004).

According Formoso et al. (2002), one of the first studies on waste material in Brazil carried out by Pinto (1989). The study based on data from the project 18-storey residential buildings that are selected. The amount of waste is 18% of concern for all materials purchased, which represent an additional cost of 6%.

According to Datta (2000), about 20-25% of materials are wasted on the construction site in Tanzania, Zambia, Zimbabwe and Botswana. Fatta et al., (2003) also noted that in Greece, every 1000 m^2 building activities involving the generation of waste 50 m^3. In Ghana, report from Ayarkwa and Adinyira (n.d.) show the wide variations in wastage rates between 5% and 27% from the amount purchased for construction projects.

2.1.2 Construction Waste in Malaysia

The construction industry is considered as a major fillip to the Malaysia economy. However, it also produces waste from construction activities. In recent years, the number of construction projects have increased dramatically in order to achieve 'Malaysia Plan 2020'. Unfortunately, due to the rapid development, a lot of negative impact were occurs. Waste management in the building industry in Malaysia has become a major issue in recent years. Population growth has led to an increase in solid waste generation in

Malaysia and it has become an important issue to be resolved. Yahaya and Larsen, 2008 report that the issue of illegal dumping has increased rapidly in this country. A study conducted in Johor indicates that 42% of the 46% illegal landfills is construction waste (Blessings and Ibrahim, 2007). Furthermore, a study in Seberang Perai, Penang also found more illegal dump site along the road near (Faridah et. Al., 2004). Recent news has been confirmed that almost 30 tons of construction waste were dumped illegally in tropical mangrove swamps near Bandar Hilir, Melaka and construction waste problem in Selangor.

2.2 Landfills in Malaysia

Malaysia have many landfills but not all of the landfills are operating. Table 2.1 below show the number of operating landfills and non- operating landfills.

Table 2.1: The Number of Operating Landfills and Non-Operating Landfills.

State	Number of operating landfills	Number of non-operating landfills	Total
Johor	14	23	37
Kedah	8	7	15
Kelantan	13	6	19
Melaka	2	5	7
Negeri Sembilan	7	11	18
Pahang	16	16	32
Perak	17	12	29
Perlis	1	1	2
Pulau Pinang	2	1	3
Sabah	19	2	21
Sarawak	49	14	63
Selangor	8	14	22
Terengganu	8	12	20
WP Kuala Lumpur	0	7	7
WP Labuan	1	0	1
Total	165	131	296

Source: National Solid Waste Management Department, Ministry of Urban Wellbeing, Housing and Local Government, (2015)

2.3 Definition of Waste

Waste in construction can be define as different way due to the different study. Referring to the new production philosophy, waste can be understood as any inefficiency in the use of equipment, materials, labour, or capital in larger quantities than those considered as necessary in the production of a building. According to (Alwi et al., 2002; Formoso et al., 1999), waste should be defined as any losses produced by activities that generate direct or indirect cost but do not add any value to the product from the point of view of the client. In a simple way, waste means "that which can be eliminated without reducing customer value" (Polat and Ballard, 2004).

The Environmental Protection Department (EPD) of Hong Kong (2000) defined that C&D waste consists of unwanted materials produced during construction, including rejected structures and materials, materials which have been over-ordered or are surplus to requirements, and materials which have been used and discarded.

2.4 Types of Wastes

Construction waste can be classified into 2 types:

- Direct waste
- Indirect waste

2.4.1 Direct Waste

This is waste that could have been avoided and involve the actual costs. Most of the time, the cost of direct waste does not end up in the cost of material, but it is followed by the cost of removing and disposing. Thus, by preventing waste direct financial benefit can be obtained easily. According to the (Kulatunga et al, 2006; Formoso et al, 2002; Shen et al, 2002), direct waste can occur at any stage of the construction process before the delivery of materials to the site, and after incorporating the building materials.

Table 2.2: Categories of Direct Waste

Category	Explanation	examples
Transport waste	Transport waste mean breakable materials during transportation and placing materials into the initial storage.	Bricks, tiles, glazing, roofing sheets
Cutting waste	Cutting waste occurs when materials cut into various sizes and uneconomical shapes.	Plywood, formwood, tiles
Application waste	Application waste occurs with most wet building materials.	Plaster,paint,glue
Residue waste	Waste occurs with materials normally delivered in containers. Waste occurs when completely not used and when not properly sealed.	Paint, glue
Stockpile waste	Occurs when most loose materials are dispersed on the site because of poor storage.	Sand, cause aggregate
Criminal waste	Occur due to the theft and vandalism	Tiles, cement bags
Waste caused by other trades	Occurs due to succeeding trades such as plumbing, electrical etc.	Damages to wall, plaster etc.
Management waste	Occurs due to lack of supervision or incorrect decisions of the management.	Throwing away extra materials
Waste due to wrong use	Occurs due to wrong selection	Rejection of inferior

Source: Kulatunga et al., (2006); Skyoles and Skyoles, (1987)

2.4.2 Indirect Waste

Indirect means materials that are not physically lost but indirectly. For example, waste due to concrete slab thickness larger than that specified by the structural design

(Kulatunga et al., 2006; Formoso et al., 2002). Indirect waste arising from the replacement of materials, over allocation, quantities of materials used are not clearly stated in the contract documents, error mistakes, and waste cause by contractor's own carelessness.

Table 2.3: Categories of Indirect Waste

Categories	Explanation	Examples
Substitution waste	Substitution of materials in work, which will incur losses to either contractor or client	Use of high strength concrete instead of weak mix. Use of facing bricks instead of common bricks.
Production waste	Contractor does not receive any payments for the works he has carried out	Use of extra plastering to rectify the uneven surfaces of the brick walls
Operational waste	Occurs due to the unavailability of proper quantities in the contract document and when the materials are left in the building.	Left form work
Negligence waste	Occurs when more materials are used than specified, due to the use of unfit machineries etc.	Use of extra concrete when over excavate.

Source: Waste Prevention on Site (Skoyles and Skoyles 1987).

2.5 The Common Waste of Construction Materials At Construction Site

2.5.1 Concrete

Concrete is the most commonly used man-made material on earth. It is an important construction material used extensively in buildings, bridges, roads and dams. Its uses range from structural applications, to paviours, kerbs, pipes and drains. Concrete is a composite material, consisting mainly of Portland cement, water and aggregate (gravel, sand or rock). When these materials are mixed together, they form a workable paste which then gradually hardens over time.

2.5.2 Bricks

Bricks are mostly used to form the internal walls, fixtures and partitions of a building. Study conducted by Poon (2004) shows that the generation of bricks during construction process begins from the transportation to the site until its point of use.

2.5.3 Timber/Wood/Plywood

The majority of timber waste was generated during the formwork process. Primarily, waste occurred from work undertaken on the materials to make them suit the required shape and size of the formed concrete, and due to rough stripping methods. Good planning by the sub-contractor to make formwork 'fit' with minimal modification and better care during the stripping of formwork would have contributed to reducing waste. Waste timber products generated by formwork were deposited into bins at the work area since there was easy crane access to place bins onto the working platform. Thus a high proportion of material was able to be separated for recycling. Problems included the careless contamination of timber with foreign substances such as masonry or other waste at the ground floor level. The whole load of timber then became non-recyclable and forced the waste contractor to dispose of large quantities of timber waste as general waste.

2.5.4 Steel

Metal waste was mainly derived from reinforcement, steel partition framing and roofing off-cuts. Reinforcement waste was minimal and primarily resulted from miscellaneous spare items left after the completion of the works. Metal roofing waste was due to off-cuts and modifications made to sheeting materials and flashings to suit roof penetrations and geometry. Metal stud waste was attributed to the requirement of size modifications to suit the application. The metal scrap bin was centrally located at the ground floor level between the two apartment buildings. At rubbish collection time, all refuse was collected into one suspended container at each floor level by the crane. Consequently loading work was hurried in order to minimise crane time, and various waste streams could not be sorted prior to placing in bins. Therefore, only large and easily

separable metal waste was placed in the scrap metal waste bin. Valuable waste such as copper and aluminium was retrieved and taken off-site by the subcontractors and did not contribute significantly to metal waste. The remainder was disposed of in the general refuse bin.

2.5.5 Glass

Glass is a hard substance which may be transparent or translucent and brittle in nature. It is manufactured by fusion process. In this process sand is fused with lime, soda and some other admixtures and then cooled rapidly. Glass is used in construction purpose and architectural purpose in engineering.

2.5.6 Others

Other materials such as nails, glue, string, plastic, paint, wire, etc. will also be wasted if not managed or used properly. Even minor uses of this material, but it also affects managers in terms of cost. These materials are neglected and ignored because they assume these materials is not as important as the main ingredients of the others. In other words, these materials are used with in excess. Besides that, these materials are also left scattered on the ground.

2.6 The Factors of Construction Waste

There are several causes of construction waste:

- Wrong material storage
- Poor materials handling
- Poor quality of materials
- Ordering errors

- Mistakes in quantity surveys
- Poor attitudes of workers
- Poor supervision
- Lack of waste management plans

These factors also supported by researches in many studies.

2.6.1 Wrong Material Storage

In the construction site, the storage is use to keep the materials when the project is done. Nowadays, at the construction site, there is only one material storage. The contractors take this thing easily. One is not enough to keep the larger quantities of materials. In the storage, the materials are mixed each other. It is not neatly arrange. In other hand, it is difficult for the workers to find the materials that they need. When the desired material cannot be found, the contractors will automatically will buy the new one even though that materials is there in the storage. This will cause the waste of materials. The storage also not in the good condition. It is too small and leak. The materials will be exposed to the weather either in hot or rainy day. Some of materials cannot be exposed to the rain or it will be useless. This will cause a loss of material due to the weather. There are a lot of materials that need to be store in the good place. The contractors need to store the materials neatly in other to keep the materials in the good condition. If this issues is not taken seriously, then there will be more waste at the construction site.

2.6.2 Poor Materials Handling

In the construction site, the manager do not teach their workers perfectly on how to use or handle some materials. There is no proper instruction on how to handle the materials properly. This will make the workers handle the materials carelessly. The result is that the materials are handling in the poor condition and incapability in managing the

materials perfectly. The materials is not use in correct terms means they use or handle the material wrongly. The workers not focus on handling the materials. The materials will broke if not manage perfectly. This will causes the loss for the materials. It is wastage after all.

2.6.3 Poor Quality of Materials

Some of the managers order a poor quality of materials in order to reduce their cost in project. It is okay for them to purchase it but the quality of the materials is the important thing. Poor quality will cause a poor product in the end of the project. The risks for purchasing poor materials is it easy to broke and non-durable. If the material is broken, the manager need to buy a new one in order to replace it. It actually increase their cost of project because they need to buy a same thing or material all over again. The old ones will be unwanted and unused. So, the construction site will full with the wastage of the material.

2.6.4 Ordering Errors

Sometimes the materials is already broken because of the transportation of the material to the construction site. During the process of ordering the materials, the materials is already in the position to be harmful during the transportation. The transportation that is used cannot guarantee the material inside it is safe or not. Sometimes the condition of street in way to the construction site is not in good condition. This will cause the materials inside the lorry will move and crash each other's. The materials will be damaged before reaching the construction site. The contractor cannot be expected this thing to be happen. Even they order the good materials but with some reasons or condition during the process of delivery, the materials become not good. This is an ordering errors. So, the errors materials will be throw and become the waste. The contractor need to buy the materials again to replace it.

2.6.5 Mistakes in Quantity Surveys

The contractor need to know the quantity of materials that need in completing the project. They need to surveys and look how much the quantities of materials that they need to buy. This is to avoid them from buying an exceed quantities of materials. They must do a correct calculation about the quantities of materials. The bigger the project, the larger the quantities of materials that needed. The quantities of materials must be enough to complete the project. They need to surveys what quantity of the materials that is need. If they make a wrong calculation or survey, than it will become a waste for that materials. This is because there are still a materials even though the project is already done. They make the mistakes in quantity surveys.

2.6.6 Poor Attitudes of Workers

Some workers in the construction site have their bad habits or attitude. They play around while doing the job and did not take it the job seriously. The workers do not care about the materials in the construction site. If any materials are scattered in the construction site and they are lazy to tidy and clean up, they will disregard the fact that the materials still can be used if they pick it up. One more thing, some worker are stealing the materials for the purpose of themselves. They feel that thing is interesting for them so they take it out. That's why the materials is always not enough for the project. Another thing for the bad attitudes among the workers are they are ready to go back early after they done do the work for the day. After they finish do some workers, they will go back. They do not clean up or tidy up the materials first before they back home. They just let the materials that has been used abandoned. They do not keep the materials or machine to their storage. So, the waste will happen due to the bad attitudes of workers in the construction site.

2.6.7 Poor Supervision

Poor supervision in the construction site will cause the building project become slow and stop. The supervision not take the project seriously. They do the project not

according to the planning and schedule. They just do what they want to do in that day without referring to what have been planning early. The supervision are not good in handling and purchasing the materials. They do not know when and how much to buy the quantities of the materials for the project. They wait until the materials are finish or run out first, then only they will order the new one to the construction site. This is bad because when they just order the materials, the materials will come late. As a supervision, they need to check out what materials are already to run out so that they can order it faster. They cannot wait for the materials to run out first. It will cause the waste for the project.

2.6.8 Lack of Waste Management Plans

The manager do not have the plans how to manage the waste. They do not have the expertise in managing the waste. They just throw and burn the waste in the construction site. They just dispose it. The waste is keep or throw in one place and will idle for the long time. They do not just want to try to recycle its. Day by day the waste will become more. Even though the materials is already the waste but it still can be used for some purpose in building project. But the manager cannot see it, they just only think waste is waste. They will purchase the new one for the project. They are so bad in handling the waste. Even though there are policies about the waste management but the manager is neglect follow it. They just do what they can do and easy to them for manage it. So, the only way is they just throw and burn the waste. This is lack of waste management plans. This will cause the loss for the company.

2.7 The Impact of Construction Waste

Construction waste give the negative effect if it did not manage efficiently. The impact not only to the environment but also to the parties involved in the project.

2.7.1 Contractors

Contractors will suffer losses as a result of the waste that occurred. Contractors had to bear the cost of this waste. Contractors had to use his own money to buy new materials to replace materials that are wasted. This led to the profits earned by the contractor will be reduced. The higher the wastage of the higher costs incurred.

2.7.2 Workers

This material waste also affects the workers at the site. A scattered and accumulate wastes may affect the safety of workers on site. For example, fragments of brick, broken glassware, iron or wood will make it difficult for workers to walk safely. When the condition of site not very safe, they have to be careful. Otherwise it will harm or injure workers. When there is an injured worker, the employee will undoubtedly give a break. This will reduce the workforce at the construction site.

2.7.3 Materials Resource

Materials such as wood, sand, aggregates and cement may be reduced in the future. If it has been used by many, regardless of wastage that occurs, it is possible one day these materials will be discharged and reduced. So this will make it difficult for contractors to find the spare parts more quickly. They had to order from somewhere else and had to wait for quite some time. This will necessarily increase the cost of construction.

2.7.4 Environment

Of course, residual waste that occurs will cause pollution to the environment. Workers take it easy the rest of the material that occurs at the site. They remove and burn the rest of the material as they like. River, drain, and forest waste is usually to be a place they throw or damaged their construction waste. The waste material will cause water pollution, air pollution and soil pollution. River becomes dirty, clogged drains, and soil

eroded. This will cause bad smell in the vicinity of the site. Flora and fauna will also be affected by the disposal of residual waste that is not managed.

2.8 Waste Management

Waste management means the control of the waste either in terms of the generation, recovery, processing, and disposal of waste in the correct way in accordance with human health, economic, and other environmental considerations (Tchobanoglous, 1993/ 2003). In order to ensure that waste is managed well, it is important to identify the type of waste first. Different waste treatment requires different handling and disposal. According to Woolley (2000), reducing, reusing and recycling seem profitable alternative that will increase the lifespan of landfills and reducing the discovery of natural resources. In addition, some European countries' practice of waste management is based on prevention (reduction), recovery and sanctions (reuse and recycling).

2.8.1 Waste Management Hierarchy

Construction waste should not dispose directly but it must go through several processes before disposal. Waste material cannot be disposed of or written off. It can be managed by either using or referring to the waste hierarchy. The waste management hierarchy is the order or sequence of action to be followed in reducing and managing waste. Waste management hierarchy shows that the waste should be reduced, reused, recycled and disposed to proper dumpsite like landfill. It is usually expressed in the form of a pyramid. This hierarchy reflects on how the process of substance or product is managed at every level of waste management hierarchy. This hierarchy purpose is to provide the advantages and benefits to the material itself, in other hand to aims fatherly reduce the amount of waste that occurred on site.

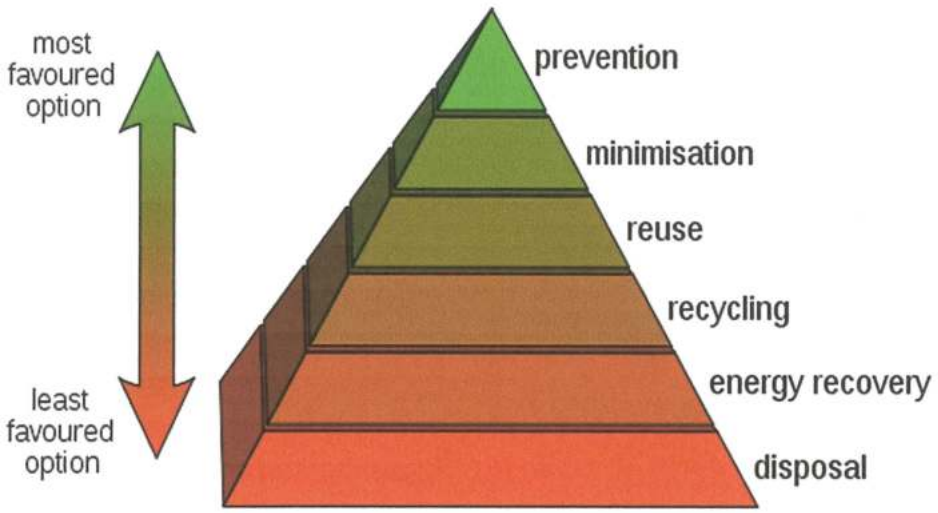

Figure 2.1: Waste Management Hierarchy

Sources: Wikipedia Waste Hierarchy (2017)

Waste prevention is the most preferred option in the hierarchy. This concept lies in the principles do not generate waste during the company's activities, in other words it can be said to be a 'Zero Waste'. Next, is to reduce the waste generated. This can be achieved by using good project management practices, using materials that will generate less waste during the production phase.

Principle 3 'R' is to reduce, reuse and recycle waste generated during the company's activities. This will reduce the company's impact on the environment. The last option should be preferred waste disposal. Sometimes not all waste can be handled with the above options, in which case disposal can be chosen, but this should be done in an appropriate manner.

2.9 Challenges in Achieving Sustainable Waste Management

To solve a problem, it is very important to identify the cause of the problems faced. So also in this case, there are many challenges that prevent the company from

achieving sustainable waste management. The challenges are shown in the table 2.4 below:

Table 2.4: Challenges in Achieving Sustainable Waste Management

Challenges	Description
Lack of technology and facilities	The current technology is not able to accommodate the ever increasing waste generation.
Lack of a well recycling market	Recycling requires aggressive marketing efforts to find market and sell with higher prices. Disadvantages would impede effective in implementing waste recycling.
Insufficient fund	Waste require a higher cost. So the incentive or the fund could be their motivation to apply waste reduction as one method of waste management.
Regulations inadequate	The regulations are needed for industry practitioners to follow and apply in their way of waste management. However, it is a challenging to produce a comprehensive waste management system.
Lacking of awareness	Even though many policies have created but the industry still does not realize the importance of managing waste by waste management hierarchy that prioritizes waste reduction through the 3R.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter basically discuss and explain the research methods that been used to carry out this study. By choosing the right research methods, it is a priority in order to achieve the goals and objectives of the study. Data collection method and tools for data analysis will be described in this chapter. Tool for the analysis of the relevant data will be selected precisely to show all the relevant information. All information will be gathered, arranged and compiled before start of analysis. In quantitative research, the steps involved in conducting the investigation are fairly standard (Al-Moghany, 2006).

3.2 Data Collection Method

Quantitative method was used as a data collections for this research. Data sources are available in two categories as follows.

3.2.1 Primary Data

Primary data mean first-hand information obtained by researchers at the variables of interest for the specific purpose of the study. For example, individuals, focus group and panels. To get the data from the targeted sample, the quantitative research, the questionnaire method is use. The questionnaire is a set of written questions that have been formulated which is distributed to the selected respondents. The selected respondents

were from the construction companies and their personnel including engineer, site supervisor and site admin.

3.2.2 Secondary Data

Secondary data is an information or available data gathered from an available sources. The data can be collect from website, internet, media, company, article and journal and so on. These can give a broader picture about an issue or topic being studied.

3.3 Population and Sampling

Population refers to the entire group of people, events, or things of interest that the researcher wishes to investigate (John Wiley and Son Ltd, 2012). The target population for this study is the contractor with a class A licensed in Kuantan, Pahang and the others relevant agencies. While, according to John Wiley and Son Ltd, (2012), sampling means a subset of the population. It consists of a number of selected members from it. The process was involving a selection of sample from certain population. By doing this, the results that are analyses from the samples were generalized and can be describe about the population. The questionnaire had been given to the 32 sample from 35 construction companies with class A licensed in Kuantan, Pahang. The table below show the sample size for a given population size.

Table 3.1: Sample Size for A Given Population

N	S	N	S	N	S
10	10	60	52	120	92
15	14	65	56	130	97
20	19	70	59	140	103
25	24	75	63	150	108
30	28	80	66	160	113
35	32	85	70	170	118
40	36	90	73	180	123
45	40	95	76	190	127
50	44	100	80	200	132
55	48	110	86	210	136

Sources: Sample size determination (Krejcie and Morgan 1970)

N= population size

S= sample size

3.4 Design of Questionnaire

For this study, the data of construction and demolition waste has been collected by using the method of questionnaire. This method is use in order to get the real data and information direct from the targeted people. In designing the questionnaire, there were many factors that have been taken into account such as the content of the questionnaire, form of the reaction and the use of the correct word and vocabulary in question. The questionnaire will be given to the selected samples based on the relevant agencies in managing and minimization of construction waste. The questionnaire form consisted of the followings section:

3.4.1 Section A: Background of projects

Respondents were asked to provide information about the type of project and overall cost of the project about the construction site.

3.4.2 Section B: Waste of Construction Materials

By using a rate of 0-20 tonnes, 21-40 tonnes, 41-60 tonnes, 61-80 tonnes, 81-100 tonnes and none waste, respondents were asked to rate the waste of construction materials.

3.4.3 Section C: Minimizing Construction Waste

By using a Likert scale of 1-5 (where 1 = strongly agree and 5 = strongly disagree), respondents were asked to rate several strategies to reduce construction waste materials.

3.5 Data Analysis

After all the data from questionnaire were collected, the data analysis will be conducted in order to get the result. The data will be analysed based on the data collections method use which is questionnaire method.

For example, the data responses from the questionnaire will manually transfer into a spreadsheet. As a column heading, put the questions number while the row column for the answers from the respondents. Then, assign the possible answer in a number or code. Go through each data collected from the questionnaire that given to the respondents and enter the data to the spreadsheet. The spreadsheet below show the example what this might look like.

Table 3.2: Example of Respondent's Questionnaire

Respondents Questionnaire	Q1	Q2	Q3
Respondent A	4	4	5
Respondent B	1	1	2
Respondent C	1	2	3
Respondent D	1	1	1

In this example, the code are:

Strongly agree=1, Agree=2, Neither Agree or Disagree=3, Disagree=4, Strongly Disagree=5

Once the data have already been done enter to the spreadsheet, it is good to check again the data for accuracy. When satisfy with the data collect, calculate how many respondent selected for each response. Once finish calculate the how many respondent selected for each response, the data can be set up into the table and display the data by graph. For example:

Table 3.3: Example of Data Analysis

Response	**No of Respondent**
Strongly agree	3
Agree	0
Neither agree or disagree	1
Disagree	0
Strongly disagree	0

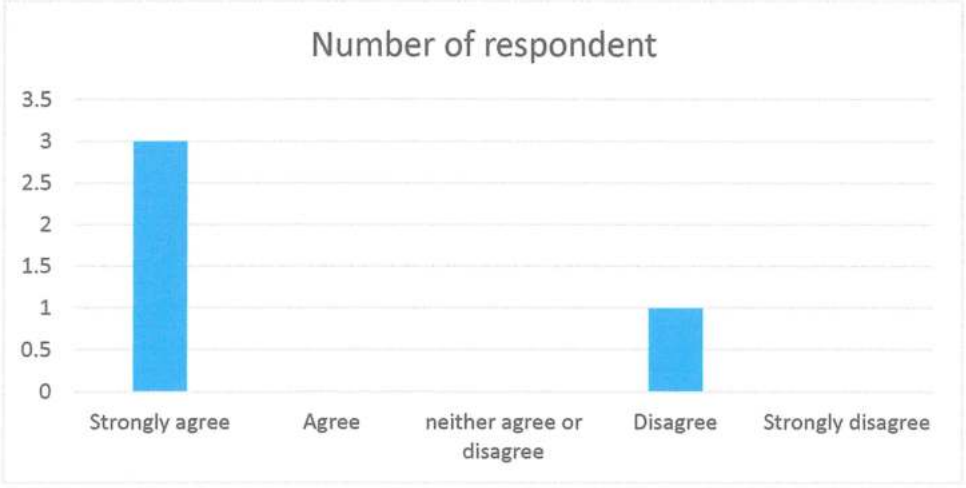

Figure 3.2: Example of Graph Data Analysis

The tools that will be use to analyse the data is Statistical Package for Social Science version 22.0 (SPSS) as well as Microsoft Excel 2010 as an assist because sometime SPSS were difficult and complex. Microsoft Excel 2010 will help to construct the graph, chart or graphic of data. When all the data have been analysed, the discussion and conclusion will be made to tell what the data is about.

3.6 On-site Sampling (C&D waste)

Samples were selected randomly with high density and variation of C&D wastes at construction site. Next, a perimeter was establish around the C&D wastes to prepare a sample with size of 100 kg each. Then, the C&D waste is collected and placed in a container. The collected C&D wastes waste is separated and sorted according to its respective type.

The sampling is being done 2 times at different construction sites to get an average. Then, the data obtained from the C&D waste is converted in term of percentage of each type of C&D wastes.

3.7 Step By Step Procedure

Sample = 100 kg

Apparatus

Separation/segregation

Weighing sample

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The collected data of questionnaire that obtained from the total of 32 respondents out of 35 population, was analysed by using SPSS and Microsoft Excel. The data was analysed to comprehend the mean and the percentage of each categories. This chapter divided into several parts as the objectives of the study are to identify the waste of construction materials at construction site and the strategy taken by company in managing construction waste at construction site.

4.2 Respondent's Demographic Information

The demographic analysis was to determine gender, age, position, experience and the knowledge of the respondents about the construction site.

4.2.1 Type of Project

Table 4.1 Type of Project

Type of project	Frequency	Percent
Construction	31	96.9
Demolition	1	3.1
Total	32	100

Based on the Table 4.1, most of projects are construction rather than demolition. It shows that the construction project are 31 out of 32 projects with 96.9%. While the demolition project are only 1 out of 32 with 3.1 %. This happen because the projects are more likely to develop on a new land rather than old settlement.

4.2.2 Overall Cost of Project

Table 4.2 Overall Cost of Project

Overall cost of project	Frequency	Percent
Kurang daripada RM 1,000,000	1	3.1
RM 1,000,000 - RM 5,000,000	3	9.4
RM 5,000,000 - RM10,000,000	6	18.8
RM10,000,000 - RM20,000,000	6	18.8
RM20,000,000 - RM50,000,000	10	31.3
RM50,000,000-RM100,000,000	4	12.5
Others	2	6.3
Total	32	100.0

Table 4.2 shows that the majority of projects are from the range of "RM 20,000,000 - RM 50,000,000" with the highest percentage, 31.3% or 10 out of 32. While the least is from the range of "kurang daripada RM 1,000,000" with the lowest percentage, 3.1% or 1 out of 32. This is because most of the project is involving residential area with high number of unit per project.

4.2.3 Type of Waste Generated

Table 4.3 Type of Waste Generated

Type of waste generated	Frequency	N	Percent
Concrete	32	32	100
Steel & Aluminium	32	32	100
Bricks	32	32	100
Glass	23	32	71.88
Plastics	14	32	43.75
Wood & Plywood	32	32	100
Others	2	32	6.25

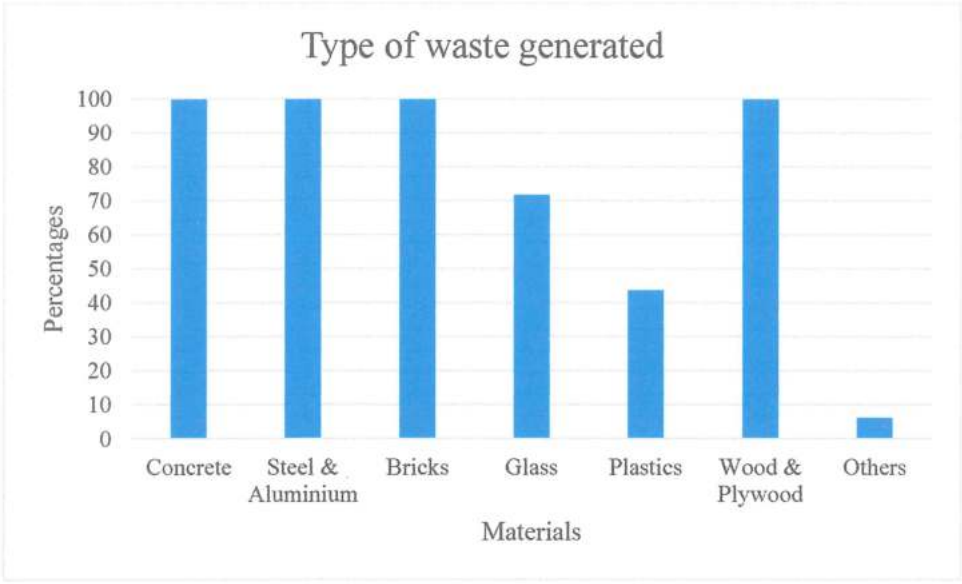

Figure 4.1: The Percentage of Construction Waste

From the Figure 4.1, it shows that the concrete, steel and aluminium, bricks and wood and plywood contributed the highest percentage to the waste generation with 100%. Six types of waste produce on the three sites which are wood, steel, concrete, mortar, packaging waste and bricks (Nagapan, Rahman, Asmi 2013). It means that the concrete, steel and aluminium, bricks and wood and plywood is the most common waste at construction site. This is followed by glass 71.88%, plastics 43.75%, and others material 6.25%.

4.3 Total Waste Generated

The first objective of this research is to identify the construction and demolition waste of construction materials at construction site. In this section, there are six common waste of construction materials which include concrete, steel and aluminium, bricks, glass, plastics, wood, and plywood. Construction waste with highest percentage can be considered as the most common waste can be found at construction site.

4.3.1 The Frequency of Construction Waste

4.3.1.1 Concrete

Table 4.4 Concrete

Rate (tonne)	Frequency
1-20	9
21-40	5
41-60	10
61-80	4
81-100	4
Total	32

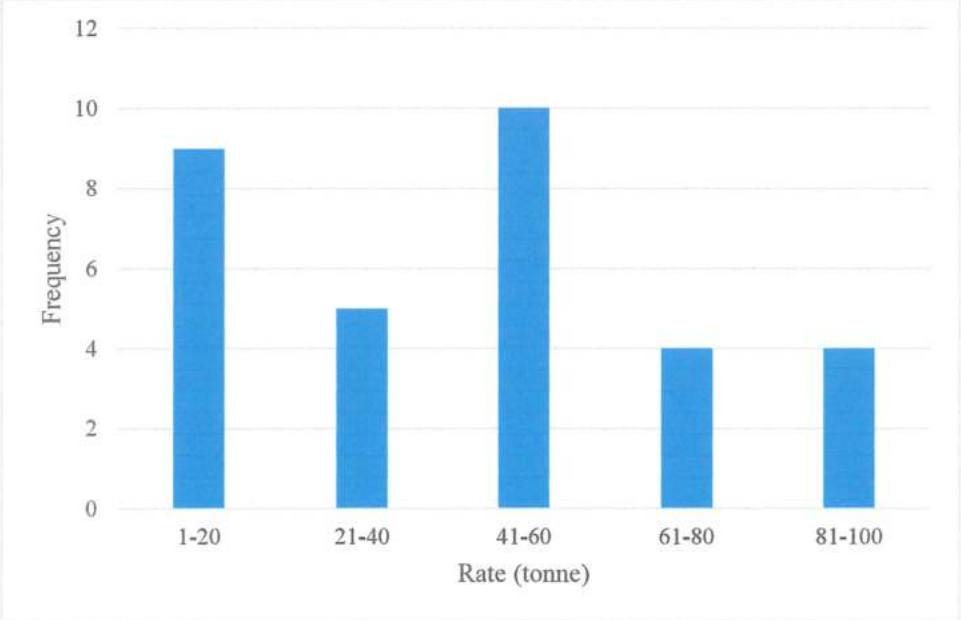

Figure 4.2: The Rate Waste of Concrete

From the figure 4.2, 10 respondents believe that the rate waste of concrete at construction site around 41-60 tonnes. Concrete's versatility, durability and economy have made it the world's most used construction material (Sudipta Roy 2015). By according to it properties and advantages, concrete is one of the common material that

been used in construction. Once the concrete is mixed, it is exposed to the air and water, and then will cause it to be hardened. Thus, it cannot be store for long term and lead to a wastage.

4.3.1.2 Steel & Aluminium

Table 4.5 Steel & Aluminium

Rate	Frequency
1-20	19
21-40	0
41-60	13
61-80	0
81-100	0
Total	32

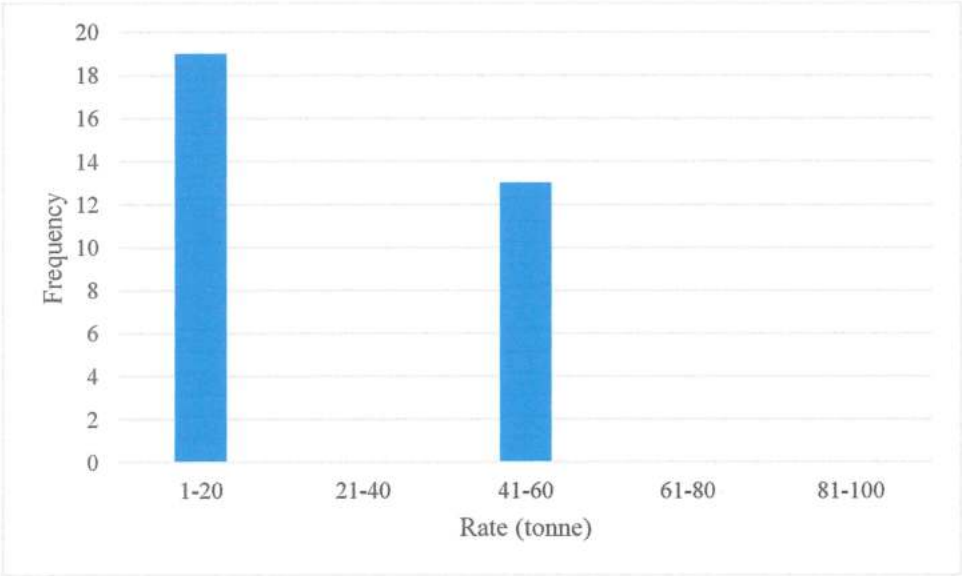

Figure 4.3: The Rate Waste of Steel and Aluminium

Figure 4.3 shows that majority of total respondents agree that the rate waste for steel and aluminium is around 1-20 tonnes. Steel is also commonly used because it is versatile, durable, and affordable (Wasatch 2013). The waste of steel occurs during the inappropriate method of cutting and storage. Although it is commonly used, the amount of steel

is less compare to concrete which result in less wastage. This is because steel is more expensive and only used in certain part of project.

4.3.1.3 Bricks

Table 4.6 Bricks

Rate (tonne)	Frequency
1-20	13
21-40	10
41-60	0
61-80	4
None	5
Total	32

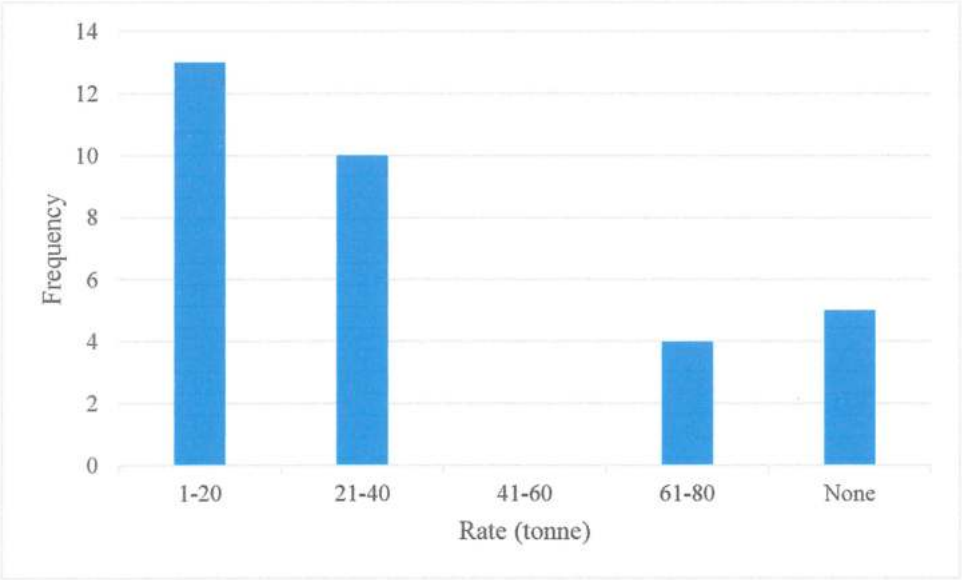

Figure 4.4: The Rate Waste of Bricks

From the figure 4.4, 13 respondents believe that the rate waste of bricks at construction site around 1-20 tonnes. Brick is building material used to make walls, pavements and other elements in masonry construction (Stevens 2009). The usage of

brick in masonry and partition wall made it commonly used in construction. The wastage occurred during the shipment, where it is poured directly from the truck and deposited a location. Brick can be damaged due to poor handling during the transportation.

4.3.1.4 Glass

Table 4.7 Glass

Rate (tonne)	Frequency
1-20	5
21-40	4
41-60	0
61-80	5
None	18
Total	32

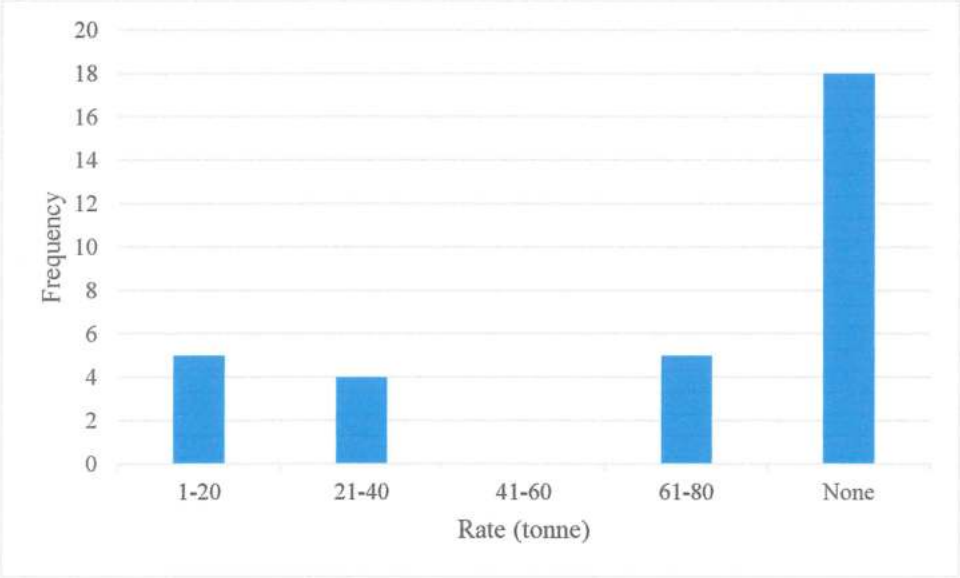

Figure 4.5: The Rate Waste of Glass

Figure 4.5 shows that majority of total respondents agree that the rate waste of glass is none. The factories are now with better and more easily controlled technology

to allow flexible production of varying large glass sizes and wide thickness of variation (Leponen 2001). By this information, the glass nowadays in already being properly shaped and sized at the factory. Besides that, the delivery of glass also is handle with care since the material is fragile. Thus, wastage of glass can be totally minimized.

4.3.1.5 Plastics

Table 4.8 Plastics

Rate (tonne)	Frequency
1-20	14
21-40	4
41-60	5
61-80	0
None	9
Total	32

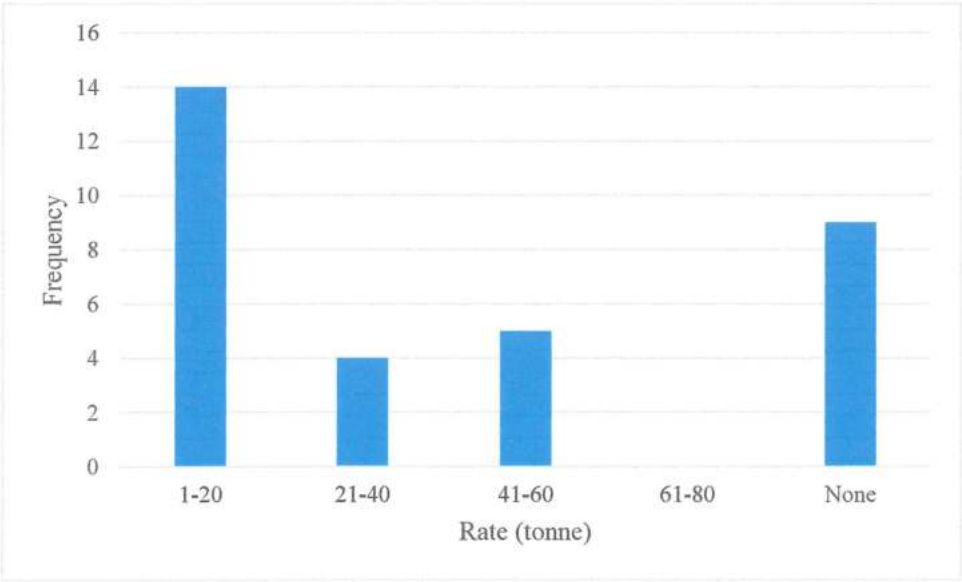

Figure 4.6: The Rate Waste of Plastics

From the figure 4.6, 14 respondents believe that the rate waste of plastics at construction site around 1-20 tonnes. Plastic materials used in new construction. This included PVC plumbing pipe, PVC siding, Styrofoam insulation, and plastic sheet. Thus, the wastage of plastic also minimum since it is being properly shaped and sized at the factory. The wastage only occurred during the inappropriate cutting method and installation.

4.3.1.6 Wood & plywood

Table 4.9 Wood & plywood

Rate (tonne)	Frequency
1-20	14
21-40	0
41-60	5
61-80	4
None	9
Total	32

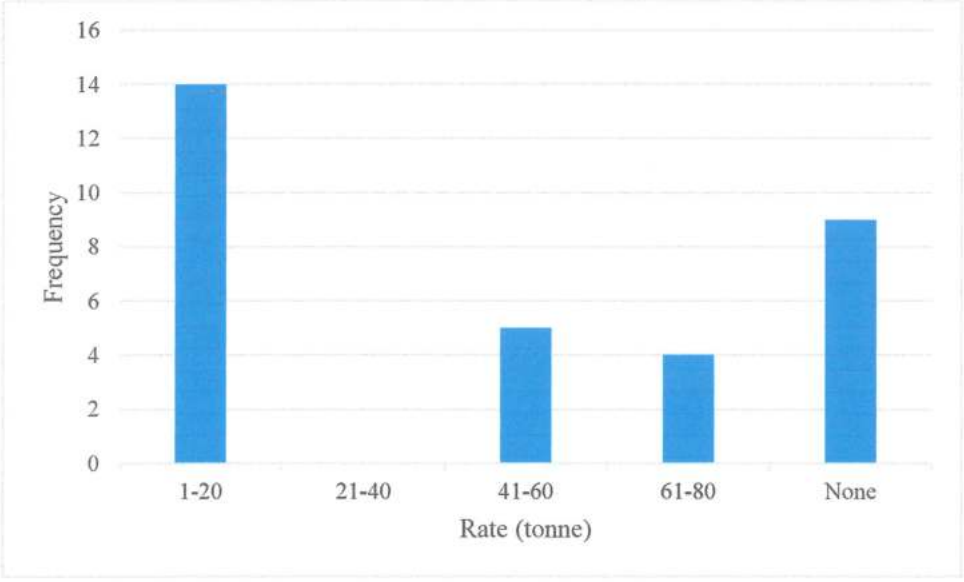

Figure 4.7: The Rate Waste of Wood & plywood

Figure 4.7 shows that majority of total respondents agree that the rate waste of wood and plywood is 1-20 tonnes. Wood is used for formwork, sprung floors, flooring, cladding, fencing and other landscaping uses (Hunt 2014). Thus, the wastage of wood in formwork process is not much since the wood can be used all over again. For flooring, decorative and landscaping uses, the wood will be cut according to the specific size and lead to a small amount of wastage.

4.4 Method of Disposal

Table 4.10 Method of Disposal

Method of disposing	Frequency
Incineration	0
Disposal	32
Recycle	18
Buried	1
Others	0

From the Table 4.10, it shows that the disposal method is the highest frequency of 32 out of 32. It means that the disposal is the most common method at construction site. This is followed by recycle 18 out of 32 and buried 1 out of 32.

Disposal is the common method because it is easy, safe and legal way in Malaysia. Other than that, it does not cause too much pollution to the environment. Recycle is also an option because it does not pollute the environment and can save up space. Incineration is less favour because lack of technology in the country and the method can pollute the environment.

Most of the waste are disposed at landfill which are located at Tapak Pelupusan Sampah Jerangau-Jabor, Kuantan, Pahang. Besides that, there are also temporary disposal site such as site located in Felda Panching Timur and Seri Damai.

4.5 Estimated Cost for Waste Disposal

Table 4.11 Estimated Cost for Waste Disposal

Cost	Frequency	Percentage (%)
Kurang daripada RM1,000	4	12.5
RM 1,000 - RM 5,000	9	28.1
RM 5000 - RM 10,000	10	31.3
RM 10,000 - RM 20,000	5	15.6
RM 20,000 - RM 50,000	4	12.5
Total	32	100.0

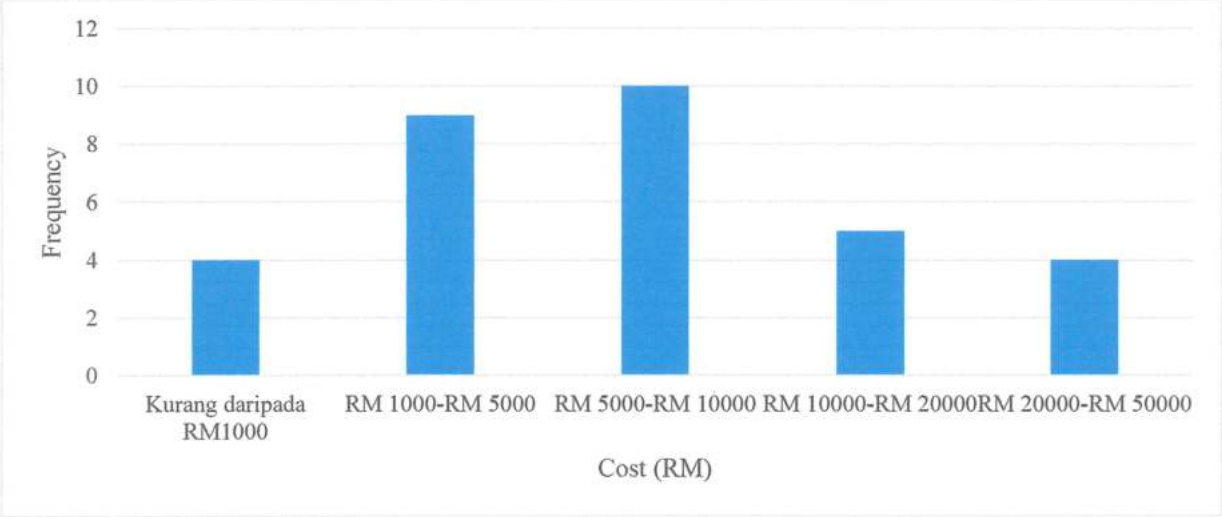

Figure 4.8 Estimated Cost for Waste Disposal

Figure 4.8 shows that majority of total respondents agreed that the frequency of estimated cost for waste disposal is between RM 5,000-RM 10,000

4.6 On-site Sampling (C&D Waste)

Table 4.12 On-site Sampling (C&D Waste)

SAMPLE	1	2	AVERAGE	PERCENTAGE (%)
Concrete	35.99	31.24	33.62	33.62
Steel & Aluminium	18.67	20.94	19.81	19.81
Brick	27.88	26.47	27.18	27.18
Glass	0	0	0	0
Plastic	8.64	9.31	8.98	8.98
Wood & Plywood	8.92	11.33	10.13	10.13
Others	0	0.71	0.36	0.36
TOTAL	**100**	**100**	**100**	**100**

Based on Table 4.12, the highest percentage is concrete (33.62%) and brick (27.18%). The lowest percentage is glass (0%) and other materials (0.38%). Once the concrete is mixed at construction site, it will be hardened if not quickly casted and lead to a wastage. The bricks was not stored properly and caused it to be damaged. Glass is being used during the finishing process and it is rarely being a waste as it is being properly sized and shaped at the factory. The others material such as nail, plaster and dust can be found in small amount when it is being dumped after completing certain process.

4.7 Strategies to minimize the construction waste

The second objectives is to ranking the strategies taken by company in managing construction waste at construction site. There are 8 strategies in order to minimize the construction waste. The collected data from the total of respondent, 32 was analyse to see the frequency of each strategies as shown in the Table 4.16. The ranking of the most common strategies will be determined by looking at the mean of each strategies. The

strategies which with higher percentage is the most common strategies of reducing construction waste at construction site. Scale used was 1-5 as shown in the Table 4.13.

Table 4.13: Scale Used

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

Table 4.14: The Frequency of the Strategies to Minimize the Construction Waste

	Strategies	Frequency					Mean
		1	2	3	4	5	
1	Good storage	0	0	0	22	10	4.31
2	Cut the materials appropriately	0	0	0	20	12	4.38
3	Accuracy in take-off quantities	0	0	0	20	12	4.38
4	Proper implementation of materials management plan	0	0	2	21	9	4.22
5	Arrange the material appropriately	0	0	0	16	16	4.50
6	Handle and use the materials appropriately	0	0	0	12	20	4.63
7	Provide convenient containers for materials storage and retrieval	0	0	7	14	11	4.13
8	The delivery of the materials are in good condition	0	0	6	18	8	4.06

Table 4.15: The Ranking of the Strategies to Minimize the Construction Waste

	Strategies	Mean	Ranking
1	Handle and use the materials appropriately	4.63	1
2	Arrange the material appropriately	4.50	2
3	Cut the materials appropriately	4.38	3
4	Accuracy in take-off quantities	4.38	4
5	Good storage	4.31	5
6	Proper implementation of materials management plan	4.22	6
7	Provide convenient containers for materials storage and retrieval	4.13	7
8	The delivery of the materials are in good condition	4.06	8

From the research, the result can be seen as the Table 4.15 which it is already arranged according to the highest mean to the lowest mean.

Proper handling and usage of materials is the best strategies to reducing construction waste with the highest the highest mean score of 4.63 out of 5. The materials need to be use according to the quantities needed. In this way, it can reduce the waste of materials.

Arrange the materials appropriately is in the second place with 4.50 mean. The material arrangement need to be assigned with the task that need to be performed. Contactor also must also ensure that the delivery of building materials must be in accordance with a predetermined time so that there is no delay in the delivery of building materials at the project site

Next is cut the materials appropriately and accuracy in take-off quantities with the same mean 4.38 in ranking third and fourth. Building materials should be cut according to the requirements needed to avoid an overload during cutting.

In fifth ranking is the good storage with 4.31 mean. Stores that are appropriate to the type of construction materials need to be built at the construction site. Building materials usually should be placed on a solid base, a protected area and close to the workplace.

Proper implementation of materials management plan with 4.22 mean is in sixth ranking. Contractors must make a fence around the project site so that no outsiders or animals coming into the project site at night. Each site must have a security guard to keep goods and materials from being stolen by outsiders

Seventh place is provide convenient containers for materials storage and retrieval with 4.13 mean. Materials such as wood, cement and iron are among the materials that can be reused after use. These materials must be stored or placed into the appropriate place after use so that it can be reused for other purposes.

Lastly is the delivery of the materials are in good condition with lowest mean 4.06. The workers at the construction site should ensure the right material come to the right time. List of materials and material submitted by the supplier should be checked and payment can be done after the material received. If wrong materials being send and the material would not be used on construction sites it, will be wastage of construction materials.

CHAPTER 5

CONCLUSION

5.1 Introduction

In this chapter, the conclusion of each of the objectives set at the beginning of the study will be made based on the results of the analysis and interpretation of data.

5.2 Conclusion

The conclusion was based on two objectives as follows:

Under the first objective of the identifying of construction and demolition waste at different construction site, it can be concluded that the most common construction waste is concrete with an average of 41-60 tonne concrete is generated at construction site. It is also the main material for construction. Once the concrete is mixed, it is exposed to the air and water, and then will cause it to be hardened. Thus, it cannot be store for long term and lead to a wastage. Waste of steel, wood and plywood, bricks, and plastic is in range within 1-20 tonne. Waste of steel occurs during the inappropriate method of cutting and storage. For wood, waste occurs during the cutting process. Bricks is damaged during the shipment, where it is poured directly from the truck and deposited a location. Next, most of the responded agreed that the wastage for glass material is none. This is because the glass in already being properly being shape and size at the factory and delivery of glass also is handle with care since the material is fragile.

For the second objectives, the strategy taken in order to minimize the construction waste at construction site, it can be conclude that proper handling and usage of materials

is the best strategies to reduced construction waste with the highest mean score of 4.63 out of 5. The materials need to be use according to the quantities needed. In this way, it can reduce the waste of materials. This is follows by 'Arrange the material appropriately' with the mean score of 4.50. The material arrangement need to be assigned with the task that need to be performed. In this way it will avoid wastage. From the analysis, the 'good storage' practise also can be considered as the important strategies. Stores that are appropriate to the type of construction materials need to be built at the construction site. Building materials usually should be placed on a solid base, a protected area and close to the workplace. Delivery of construction materials also need to be made well and perfect. The workers at the construction site should ensure the right material delivered to the right time. List of materials and material submitted by the supplier should be checked and payment can be done after the material received. If wrong materials being send and the material would not be used on construction sites, it will be wastage of construction materials.

5.3 Recommendation

Architects, authorities, developers, contractors, council staff and building managers need to incorporate better waste management practice into the design, establishment, operation and ongoing management of waste services during the construction process. This can achieve by having better practice guideline for waste management and recycling. Site Waste Management Plans (SWMPs) will help in managing and recycling the construction waste more effectively.

Other than that, Solid Waste and Public Cleansing Management Act 2007 (SWPMA) stated that the waste can only be disposed into approved facilities or landfill sites. It also stated that every stage or point of waste initiation including its travel path, mode of transport, collecting and transporting agency and place of disposal has to be controlled and scheduled. Thus, the authorities need to enforce the law based on this act. Any violation to this act need to be penalized and legal action need to be taken.

5.3.1 Site Waste Management Plans (SWMPs)

A SWMP explain how resources will be managed and waste controlled at all levels during construction projects. A successful of SWMP requires careful planning and preparation. Generally, the larger the project the more work to be done.

The Purpose of SWMPs

- This plan will protect the environment. SWMPs help to manage and reduce the total waste generated by construction project. The waste goes to the landfill is reduce. Other benefits is the environment not damage, lower energy consumption and use of recycled materials.

- It will save money. The costs will be reduced when materials being managed efficiently. Good storage and handling can reduce the waste. Reusing materials on site will also reduce the cost of disposal.

The Benefits of SWMPs

- By following this plan, contractors can save time. Proper handling of material and an efficient waste management system can reduce the time taken to dispose the waste.

- It can help against prosecution. Contractors can ensure all of the waste is disposed legally.

- The plan helps in winning new business. Contractors can prove their environmental performance, which can give an edge in the bidding process.

- It also should reduce waste disposal costs. The personnel will know on to manage the waste. This will result in saving money and cost reduction.

- It can improve the reputation. The client can see the stages where it is environment-friendly.

- It can reduce pollution. The materials and waste on site will be managed more efficiently in order to reduce the pollution of the local environment.

- The plan help to improve future projects. When SWMPs is complete, it can be used it as a references in the future project. The useful information can be used for future projects. This will give general idea on to use the resources and managed the waste properly.

There are 9 steps in order to guide the contractor to create SWMPs:

Step 1: Plan and Prepare

SWMPs should be started at an early stage of project. Make sure to schedule time to prepare the SWMPs during the construction work being planned. Record all decisions regarding project design, construction methods or materials that would reduce the waste generated at the site. Then, record the waste materials produce at site that can be reuse or not. This will prevent the materials from becoming the waste. All the step taken to reduce waste need to be record. This will make it easier to find out the total of reduced waste and cost savings. This initial stage is the best opportunity to reduce the amount of waste produce in the project.

Step 2: Allocate responsibility for the SWMPs

Some people can be involved in the delivery of the plan, but a person must be appointed so he or she that can take overall responsibility of SWMPs. One person should be in charge and responsible to update the plan. That person need to understand clearly the responsibility and authority to ensure that other people will cooperate.

Step 3: Identify the waste

Identify the types and quantities of waste that the project will generate. Think through each stage of the project and identify what materials will be used. Estimate how much waste is generated and set the targets for the amount of waste that can be reuse, recycling or disposal. Next, create the data form to record the waste and regularly update the data form when waste is processed or taken away.

Step 4: Identify how to manage the waste

Working out the best option for recycling and disposing of all types of waste produce. Store and dispose of all waste responsibly. Do not mix different types of waste. It can save time and money if waste is separated.

Step 5: Identify where and how to dispose the waste

Know how and where to dispose the waste. If a waste disposal contractor being hired, make sure that they have done it safely and legally. Confirm that the landfill which the waste being transferred to have appropriate permit, license and registration.

Step 6: Organise the materials and waste

Make significant savings by designing the materials needed for the project carefully. It can save money and reduce waste at sites by not over-ordering the material. At the design stage pre-order the material according to the specification to reduce the waste from cutting process and reduce labour costs. Use the recycled or previous materials in order to cut the costs down and help the environment. When a decision to reduce the waste is being made, record that all the construction methods and materials to be used.

Step 7: Communicate the plan and carry out training

Informed all personnel about the plan. Make sure all employees at the site have the proper training and information to carry out their duties according to the SWMPs. A training program need to be develop in order to make everyone understand how to report waste and material use. For example, requesting and recording the correct paperwork, receipts, and destinations for materials. Train the employees on the importance of not mixing the waste. During the project, carry out spot checks and monitor the staff regularly to ensure they comply with the procedure.

Step 8: Measure the waste and update the SWMPs

The SWMPs need to be updated when waste leaves the site and during the project is ongoing. Keep track the waste within the site. Record the types of waste taken, who removed the waste, and where the waste were brought. Save the related document as an attachment to the plan. Every waste that been handled must be updated in plan. This is being done to check the progress of the project. Make sure that everything goes according to plan and make any necessary changes.

Step 9: Review the success and learn lessons for the future

At the end of the project, SWMPs should provide accurate records on how well materials being managed at the site and how well the waste management goals is being fulfilled. The information in the plan should be useful for future construction projects. Put together a report of the results of the SWMPs and a list an action points for the future. The SWMPs must been keep at least two years after the project done. Save it whether at the project site, or at the contractor's main headquarters.

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APPENDIX A
QUESTIONNAIRE: ANALYSIS OF CONSTRUCTION AND DEMOLITION WASTE GENERATED AT KUANTAN, PAHANG

FACULTY OF CIVIL ENGINEERING & EARTH RESOURCES

UNIVERSITI MALAYSIA PAHANG (UMP)

Dear respondents,
This survey is part of the Final Year Project. We would appreciate it if you could spend time on answering this questionnaire. Hope you can give honest responses. Do not worry, your identity will remain anonymous and all information will be held confidential. Thank you.

Responden yang dihormati,
Kajian ini adalah sebahagian daripada Projek Tahun Akhir. Kami amat menghargai anda sekiranya boleh meluangkan masa untuk menjawab soal selidik ini. Berharap anda dapat memberikan jawapan yang jujur. Jangan khuatir kerana identiti anda dan semua maklumat adalah sulit. Terima Kasih.

Researcher:

Advein A/L Ami

019-9580581

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*(Sila tandakan "✓" pada kotak yang berkenaan)
(Please mark "✓" in the appropriate box)

1. **Nama syarikat:-**
   Company name:-

   .....

2. **Nama projek:-**
   Project title:-

   .....
   .....

3. **Jenis projek:-***
   Type of project:-*

   Pembinaan (*Construction*) ☐

   Runtuhan (*Demolition*) ☐

   Lain-lain (*Others*)
   (Sila nyatakan :.....)

4. **Tarikh Mula Projek:-**
   Date Project Started:-

   .....

5. **Tarikh Projek Siap:-**
   Date Project Completed:-

   .....

6. **Jumlah Kos Keseluruhan Projek:-***
Overall Cost of Project:-*

Kurang daripada RM 1,000,000 ☐
RM 1,000,000 - RM 5,000,000 ☐
RM 5,000,000 - RM 10,000,000 ☐
RM 10,000,000 - RM 20,000,000 ☐
RM 20,000,000 - RM 50,000,000 ☐
RM 50,000,00 - RM 100,000,000 ☐
Lain-lain (*Others*)
(Sila nyatakan :.....)

7. **Jenis Sisa Bahan Binaan Yang Dijanakan:-***
Type of Waste Generated:-*
**(Can "✓" more than one)*

Konkrit (*Concrete*) ☐
Logam & Aluminium (*Steel & Aluminium*) ☐
Bata (*Bricks*) ☐
Kaca (*Glass*) ☐
Plastik (*Plastics*) ☐
Kayu & Papan Lapis (*Wood & Plywood*) ☐
Lain-lain (*Others*)
(Sila nyatakan :.....)

8. **Jumlah Sisa Bahan Binaan Yang Dijanakan (ton):-**
Total Waste Generated (tonne):-

Materials/Bahan	Ton/tonne					
	1-20	21-40	41-60	61-80	81-100	None/*Tiada*
Konkrit(*Concrete*)						
Logam & Aluminium (*Steel & Aluminium*)						
Bata (*Bricks*)						
Kaca (*Glass*)						
Plastik (*Plastics*)						
Kayu & Papan Lapis (*Wood & Plywood*)						

Others/*Bahan lain:*_____

9. Cara Pembuangan/Pelupusan:-*
Method of Disposing

Bakar (*Incineration*) ☐
Buang (*Disposal*) ☐
Simpan/Guna Semula (*Recycle*) ☐
Tanam (B*uried*) ☐
Lain-lain Kaedah (*Others*)
(Sila nyatakan :.....)

10. Adakah sisa bahan buangan ini dibuang di tapak pelupusan?*
Are the construction and demolition waste disposed in landfills?*

Ya (Yes) ☐ Tidak (No) ☐

11. Jika ya, sila nyatakan nama dan lokasi tapak pelupusan berkenaan.
If yes, please state the name and location of the landfill.

.....
.....

12. Jumlah sisa bahan binaan yang dibuang di tapak pelupusan :-
Amount of Construction and Demolition waste disposed in landfill:-

Materials/Bahan	Percentage/Peratusan (%)					
	1-20	21-40	41-60	61-80	81-100	None/*Tiada Pembaziran*
Konkrit(*Concrete*)						
Logam & Aluminium (*Steel & Aluminium*)						
Bata (*Bricks*)						
Kaca (*Glass*)						
Plastik (*Plastics*)						
Kayu & Papan Lapis (*Wood & Plywood*)						

Others/*Bahan lain:*_____

13. Jumlah sisa bahan binaan yang dibakar:-

Amount of Construction and Demolition waste incinerated:-

Materials/Bahan	Percentage/Peratusan (%)					
	1-20	21-40	41-60	61-80	81-100	None/*Tiada Pembaziran*
Konkrit(*Concrete*)						
Logam & Aluminium (*Steel & Aluminium*)						
Bata (*Bricks*)						
Kaca (*Glass*)						
Plastik (*Plastics*)						
Kayu & Papan Lapis (*Wood & Plywood*)						

Others/*Bahan lain:*_____

14. Jumlah sisa bahan binaan yang ditanam:-

Amount of Construction and Demolition waste buried:-

Materials/Bahan	Percentage/Peratusan (%)					
	1-20	21-40	41-60	61-80	81-100	None/*Tiada Pembaziran*
Konkrit(*Concrete*)						
Logam & Aluminium (*Steel & Aluminium*)						
Bata (*Bricks*)						
Kaca (*Glass*)						
Plastik (*Plastics*)						
Kayu & Papan Lapis (*Wood & Plywood*)						

Others/*Bahan lain:*_____

15. Jumlah sisa bahan binaan yang diguna semula :-
Amount of Construction and Demolition waste recycled:-

Materials/Bahan	Percentage/Peratusan (%)					
	1-20	21-40	41-60	61-80	81-100	None/*Tiada Pembaziran*
Konkrit(*Concrete*)						
Logam & Aluminium (*Steel & Aluminium*)						
Bata (*Bricks*)						
Kaca (*Glass*)						
Plastik (*Plastics*)						
Kayu & Papan Lapis (*Wood & Plywood*)						

Others/*Bahan lain:*_____

16. Pada pandangan anda, apakah jenis bahan binaan yang mungkin boleh dikitar semula untuk menghasilkan produk yang sama atau produk yang baru?
In your opinion, which type of waste material that can be recycled to produce the same product or a new product?

**(Can "✓" more than one)*

Materials/Bahan	
Konkrit(*Concrete*)	
Logam & Aluminium (*Steel & Aluminium*)	
Bata (*Bricks*)	
Kaca (*Glass*)	
Plastik (*Plastics*)	
Kayu & Papan Lapis (*Wood & Plywood*)	

Others/*Bahan lain:*_____

17. Berapakah anggaran kos keseluruhan pengangkutan dan tenaga buruh untuk mengangkut bahan buangan binaan ini dari tapak bina?
How much is the estimated overall cost for transportation and manpower for carrying the waste from construction and demolition site?

Kurang daripada RM 1,000	☐
RM 1,000 - RM 5,000	☐
RM 5,000 - RM 10,000	☐
RM 10,000 - RM 20,000	☐
RM 20,000 - RM 50,000	☐
RM 50,000- RM 100,000	☐

Lain-lain (*Others*)
(Sila nyatakan :.....)

18. The strategies in order to minimize the construction waste
Langkah-langkah untuk mengurangkan pembaziran bahan binaan

Please indicate the suitable response for each of statements by tick (/) your answer on a scale as below:

1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.
1 = Sangat tidak setuju, 2 = Tidak setuju, 3 = Neutral, 4 = Setuju, and 5 = Sangat setuju.

Strategies	1	2	3	4	5
Good storage *Tempat penyimpanan yang baik*					
Cutting the materials appropriately *Pemotongan bahan dengan tepat*					
Accuracy in take-off quantities *Menggunakan kuantiti bahan dengan tepat*					
Proper implementation of materials management plan *Pelaksanaan rancangan pengurusan bahan*					
Ordering the material appropriately *Pemesanan bahan dibuat dengan teratur*					
Handle and use the materials appropriately *Kendalikan dan gunakan bahan dengan betul*					
Provide convenient containers for materials storage and retrieval *Menyediakan bekas simpanan untuk penyimpanan bahan dan pengambilan semula*					
The delivery of the materials are in good condition *Penghantaran bahan binaan dibuat dengan baik*					

Others/Lain-lain strategi:_____

----------End of Questionnaire----------

APPENDIX B
GANTT CHART FINAL YEAR PROEJCT

GANTT CHART FINAL YEAR PROEJCT 1

Research activities	Weeks													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Final Years Project briefing with supervisor														
Discussed and revise the title and objective														
Chapter 1														
Background of study														
Problem statement														
Research objective and question														
Scope and significant study														
Chapter 2														
Preparation on literature review and design structure of the research														
Complete on literature review														
Chapter 3														
Prepare research methodology														
Submission draft of proposal														
Correction for the proposal														
Prepare slide for presentation														
Presentation proposal														
Correction for the proposal														
Submit the final proposal														

GANTT CHART FINAL YEAR PROEJCT 2

Research activities	Weeks													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Meet supervisor & discuss on Data Analysis														
Start on Chapter 4 & 5														
Collecting the data of questionnaire from respondent														
Conduct Data Analysis														
Submit draft FYP report and poster to Supervisor														
Supervisor comment and advice for correction action														
- Submit Poster and Turnitin report to Kalam - Student obtain approval form from Supervisor														
Present Poster FYP 2														
Submit corrected report														