THE CRITICAL SUCCESS FACTORS OF RECYCLING CONSTRUCTION WASTE IN SELANGOR, MALAYSIA

BY

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A dissertation submitted in fulfilment of the requirement for the Degree of Master of Science (Asset and Facilities Management)

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ABSTRACT

Construction waste is a serious issue in Malaysia due to the negative impact it puts on the environment, economy and society. Hence, this research is carried out to determine the critical success factors of conducting recycling construction waste in Selangor, Malaysia. Three research objectives has been identified which are to review the current status of construction waste recycling in Malaysia, to identify the type of waste frequently generated at construction sites in Selangor, Malaysia and to determine the critical success factors of construction waste recycling in Selangor, Malaysia. A quantitative method involving questionnaire was used as means of data collection. The data were gathered from 30 construction companies including consultant, contractors and developers in Selangor, Malaysia. The analysis found that the construction waste management in Malaysia is ambiguous and requires major revision in term of policy, awareness and practices. This research also found that the types of waste material that frequently generated at construction site are timber, steel, and concrete due to their vast usage in construction activities. Lastly, nine (9) critical success factors (CSFs) for conducting recycling of construction waste have been identified; (CSF1) establish a recycling law for Construction Waste, (CSF2) higher landfill-charging scheme, (CSF3) On-site sorting practice, (CSF4) Contractual provision for recycling construction waste, (CSF5) establish a standard for recycled construction waste, (CSF6) centralized recycling plant, (CSF7) establish a recycling system for construction waste within companies, (CSF8) location of recycling plant and (CFS9) awareness of recycling benefit.

خلاصة البحث

تعتبر مخلفات البناء قضية خطيرة في ماليزيا بسبب التأثير السلبي الذي تتركه على البيئة والاقتصاد والمجتمع. ومن ثم، يتم إجراء هذا البحث لتحديد عوامل النجاح الحاسمة لإجراء إعادة تدوير نفايات البناء في سلانجور، ماليزيا. لقد تم تحديد ثلاثة أهداف بحثية هي مراجعة الوضع الحالي لإعادة تدوير نفايات البناء في ماليزيا، لتحديد نوع النفايات المتولدة في مواقع البناء في سلانغور بماليزيا، ولتحديد عوامل النجاح الحاسمة لإعادة تدوير نفايات البناء في سلانجور، ماليزيا. تم استخدام طريقة كمية تنطوي على استبيان كوسيلة لجمع البيانات. وتم كذلك جمع البيانات من ٣٠ شركة بناء بما في ذلك الاستشاري والمقاولين والمطورين في سيلانجور، ماليزيا. وجد التحليل أن إدارة نفايات البناء في ماليزيا غامضة وتتطلب تنقيحًا كبيرًا من حيث السياسة والوعي والممارسات. كما وجد هذا البحث أن أنواع النفايات التي يتم توليدها بشكل متكرر في موقع البناء هي الأخشاب، والصلب، والخرسانة بسبب استخدامها الواسع في أنشطة البناء. وأخيرا، تم تحديد تسعة (٩) عوامل نجاح حاسمة (CSFs) لإجراء إعادة تدوير نفايات البناء؛ (CSF1) إنشاء قانون إعادة التدوير لنفايات البناء، (CSF2) مخطط أعلى لمكبس النفايا، (CSF3) ممارسة الفرز في الموقع، (CSF4)توفير التعاقد لإعادة تدوير نفايات البناء، (CSF5)إنشاء معيار لنفايات البناء المعاد تدويره، (CSF6)مصنع إعادة التدوير المركزي، (CSF7) إنشاء نظام إعادة التدوير لنفايات البناء داخل الشركات، (CSF8)موقع مصنع إعادة التدوير و (CFS9) الوعي بمزايا إعادة التدوير.

APPROVAL PAGE

I certified that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science (Asset and Facilities Management).

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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CHAPTER ONE

INTRODUCTION

BACKGROUND OF STUDY

It is well know that the construction industry is one of the most important industries that contribute to the economy of a country (Myers, 2013). In light of this, many countries take various initiatives to foster the growth of this sector from time to time. Nevertheless, the construction industry around the world is dealing with issues of construction waste generation (Tam & Lu, 2016). With a rapid ongoing urbanization, many research indicates that the construction waste generation is likely to intensify in future (Wahi, Joseph, Tawie, & Ikau, 2016). The reason for the high volume of waste generated in the construction industry is the vast usage of material resources. It is stated that construction activities required a large input of construction materials which the cost amounted to be between 50-60% (Ganesan, 2000). However, from the large quantity of materials only a small amount is consumed by the construction industry hence; a lot of the materials emerge as waste. Another evidence shows that approximately 40% of the waste generated globally is produced from construction waste (Muhwezi, Chamuriho, & Lema, 2012).

In Asia, the most common practice to dispose of construction waste is by dumping the waste at the same site as municipal solid waste which is the landfill (Chin, Carmody, & Le Breton, 2011). This practice, unfortunately, affects the capacity

of the landfill to which it reduces the number of available landfills. Due to the fact that construction waste is both dense and massive, they are not desirable for disposal in landfills as it consumes a large amount of space in the landfill (Peng, Scorpio, & Kibert, 1997). Moreover, construction activities produce a different type of waste, which is not just garbage or undesirable materials. There are also includes excavated materials such as rock and soil, waste asphalt, bricks, concrete, plasterboard, timber and vegetation, asbestos, and contaminated soil (Australian Government, 2012). In a difficult case, construction activities also produce waste that may contain hazardous materials, such as asbestos and heavy metals that need to be managed safely and in the environmentally sound system (S. Nagapan, Rahman, & Asmi, 2011). Rising awareness of environmentally sustainable waste management within the construction industry is essential and revising common practices of dumping construction waste at the landfill is another element to be considered as both give great impact to the future of this industry.

Recycling practice in construction waste management is guaranteed to reduce waste generation at construction sites where it minimizes the disposal of waste to the landfill, saving transportation costs and no exploitation of new resource (Ahmad et al., 2014). Also, many of the waste materials produced on construction site have high recycling potential. For instance, concrete waste can be extracted and recycled to produce new concrete, with good technical and cost outcomes (Behera, Bhattacharyya, Minocha, Deoliya, & Maiti, 2014; Bravo, De Brito, Pontes, & Evangelista, 2015; Rao, Jha, & Misra, 2007; Wagih, El-Karmoty, Ebid, & Okba, 2013). Red brick waste can be used to not only make new bricks (Reis, 2007), but also can be an ingredient of mortar (Silva, 2006; Silva, De Brito, & Veiga, 2007). From the previous studies, many researchers come to a solid agreement that recycling

has a lot of benefits to offer and hence, to be considered in any waste management policy (Pierce & Blackwell, 2003; Wilburn & Goonan, 1998).

PROBLEM STATEMENT

Malaysian construction industry reported that the national productivity level is likely to rise 4% in the year 2017 (Malaysia Productivity Corporation, 2017) where the local construction sector will be bolstered. On the one hand, this figure demonstrates the crucial contribution of Malaysian construction sector towards the economy of the country. On the other hand, the generation of construction waste is expected to increase as it has been predicted by many researchers around the world. The continues rising of that construction waste will put a huge pressure on the already overstretched waste management infrastructure of the country (Begum, Satari, & Pereira, 2010). As construction waste generation keeps on increasing, the effect can be seen in the decreasing number of the municipal solid waste landfill (Yu, Poon, Wong, Yip, & Jaillon, 2013). Generally, the total number of municipal solid waste landfills in Malaysia which also included dumpsites is about 289. The number of operational landfills becoming less to only 176 landfills after a total of 113 landfills were closed down because of the complaint from the resident living close by as well as the capacity of the landfills has full (The Ingenieur, 2009).

The serious shortage of landfill is due to the common practice of dumping construction waste at the same disposal site of municipal solid waste. The practice is popular since it does not need proper planning or any new advanced technology (Mahayuddin, Pereira, Badaruzzaman, & Mokhtar, 2008). This can be proofed in a study by Begum et al. (2006) that found about 28.34% of municipal solid waste in Malaysia are originated from industrial and construction waste. As stated earlier, the

landfilling practice for construction waste has not only give an impact to the capacity of landfill but also adding to the cost of the disposal (Ibrahim, 2016). Moreover, this conventional practice of disposal leads to the exhaustion of natural deposits, wasting energy and cost for the production of new materials (Ibrahim, 2016).

Even worse, some of the construction waste is disposed of an illegal dumpsite. Malaysia is dealing with this problem and the problem has become more serious recently. There are many cases reported where construction waste is disposed of at the illegal dumpsite throughout the country (Yahaya & Larsen, 2008). Some cases are along roadsides (Faridah, Hasmanie, & Hasnain, 2004) and tropical mangrove swamp (Murali, 2011; Tan, 2012). The number of illegal dumping cases detected by the Board of Engineering Department in the last five years increases from 3 cases in 2001 to 31 cases in 2005 (Keng, 2007). In Johor district alone, 42% from the total 46 illegal dumping sites consist of construction waste (Rahmat & Ibrahim, 2007). It happened due to the cost of disposal as well as the location (Seow & Mohamad, 2007) as most of the contractor complaint about the charges imposed to the waste producer and location of the landfill which unreasonably far from the construction site. Besides landfilling, illegal dumping is the other serious issue in the Malaysian construction industry since it gives a great impact on safety, property value, and quality of life in the community (Fatta et al., 2003).

Seeing that both landfilling and illegal dumping practices have triggered serious environmental impacts, it is time to revise waste management policy in Malaysia. It appears that sustainable waste management is the best idea that provide alternative such as waste reduction, waste reuse, and waste recycling instead of disposal (Ibrahim, 2016). Many researchers around the world agreed that recycling is one of the sustainable waste management methods due to its potential in reducing

disposal and transportation cost while increasing the life of the landfill sites (Begum et al., 2006; Ibrahim, 2016; H. Yuan, Lu, & Jianli Hao, 2013). Additionally, recycling offers a huge benefits for waste management in terms of economic and ecological due to the concept that modify waste into useful resources for financial, environmental and social (Omran, Mahmood, Abdul Aziz, & Robinson, 2009; US EPA, n.d.). Currently, the rate of recycling in Malaysia is still considered low, about 5% compared to countries such as Singapore (11%), Thailand (14%), Japan (40%), China (13%) and Germany (52.8%) (Ministry of Housing and Local Government, 2011). Therefore, this research is carried out to determine the critical success factors of recycling construction waste in order to help policy maker to formulate a strategy that leads to the increasing rate of construction waste recycling in Malaysia.

For the purpose of this research, Selangor is chosen as the study area because of the rapid construction activities that happened here. According to Department of Statistic Malaysia (2014), construction activities in 2013 was concentrated in the central region with the value of gross output of RM67 billion (51%) compared to the other regions. Moreover, Selangor records the highest illegal dumping activities in 2017 which is a total number of 166 (The Star Online, 2017). Hence, Selangor is the most suitable study area to collect data for this research.

AIM OF RESEARCH

The research aims to determine the critical success factors of recycling construction waste in Selangor, Malaysia.

RESEARCH OBJECTIVES

Particularly, the study has the following sub-objectives:

١. To review the current status of construction waste recycling in Malaysia.

٢. To identify the type of waste frequently generated at construction sites in Selangor, Malaysia.

٣. To determine the critical success factors of construction waste recycling in Selangor, Malaysia.

SCOPE OF RESEARCH

The scope of the study is divided into two parts which are:

i. Subject of research

The researcher will study on a sustainable construction waste management which is known as recycling. The importance of recycling and the needs of sustainable construction waste management that are able to cater environmental problem has led to this research.

ii. Area of research

The area of study limited to the construction industry in Selangor, Malaysia.

RESEARCH QUESTIONS

The following questions may arise during the study:

i. What is construction waste?

ii. What is recycling?

iii. How can recycling be utilized in construction waste management?

iv. What are recyclable waste materials in construction waste?

v. Why is recycling construction waste important?

vi. What is the status of recycling in the construction industry?

vii. What are the critical success factors that promote recycling construction waste?

OUTLINE OF METHODOLOGY

The methodology of the dissertation consist of three key activities, the detail explanation of each activity will be discussed in chapter four:

i. Research strategy

In this research, a quantitative method is deemed to be suitable to use.

ii. Data Collection Technique

Literature review and questionnaire survey are used for collecting the required data. Thirty respondents are deemed to be enough for the collection of the required data.

iii. Data sampling

Respondents are selected purposely by the researcher. The practitioners are selected among the developer, consultant, and contractor that have a major role in Selangor construction industry.

iv. Data analysis

To answer the research objective number one, the researcher used literature review to explore the findings. For research objective number two and three, Statistical Package for Science and Social Software (SPSS) is used to extract the findings.

SIGNIFICANCE OF RESEARCH

This research is expected to emphasize the importance of recycling construction waste towards sustainable construction industry. This research will not only benefit the government but also to the others such as follows:

i. This research will add to the existing body of knowledge on recycling construction waste practices.

ii. The findings should provide potential functional solutions for the implementation of effective construction waste recycling.

iii. The adoption of effective construction waste recycling will give positive impact to sustainable construction practice.

STRUCTURE OF RESEARCH

Chapter 1 Introduction

This chapter presents the research background information and problem. The chapter also determines the aim and objectives, research scope and research design.

Chapter 2 Literature Review

Chapter 2 presents a review of waste management, recycling practice in Malaysia and enablers of construction waste recycling for a sustainable construction industry.

Chapter 3 Methodology

In chapter 3, the available research designs are reviewed and then selected for conducting this research. This chapter explains the chosen method for collecting and analysis the data.

Chapter 4 Analysis & Result

Chapter 4 shows the result from the data analyzed from the questionnaires**.** This chapter also discusses the result obtained to answer the research objectives.

Chapter 5 Conclusion

The last chapter of the research summarized the result of this research. This chapter also highlights the contribution of this research to industrial practices. The limitations of the research and recommendations for further research are stated at the end of this chapter.

SUMMARY

In this chapter, the required foundation of a research is discussed in detail. The research background has been provided to introduce the topic that the researcher wants to study. The problem statement also has been discussed clearly in this chapter. It is then followed by the aim, objectives, the scope of research, methodology outline, significant of research and structure of research.

CHAPTER TWO

LITERATURE REVIEW

2.1 CONSTRUCTION WASTE

In the early year, construction waste is defined as a material which needed to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process (Skoyles & Skoyles, 1987). In a recent study by Lau, Whyte, & Law (2008) construction and demolition waste is defined as waste which arises from construction, renovation and demolition activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation. The definition is similar to a few studies which stated construction waste to be consisted of debris generated during the construction, renovation, and demolition of buildings, roads, bridges and all other works related to civil engineering (Kofoworola & Gheewa, 2009; Huong & Larsen, 2004).

Therefore, construction waste, as its name implies, is waste generated during the course of construction and demolition activities due to damage, excess, and non-compliance with the specification or a by-product of the process. From the definitions, construction waste may be classified into many clusters of physical and non-physical waste and type of materials which are inert and non-inert waste. In the next subtopic, the construction waste composition and the causes of construction waste generation are explored.

2.1.1 **Construction Waste Composition**

Physical & Non-Physical Waste

Generally, construction waste is associated with the loss of material, time and costing. However, the major waste generated from the construction activity is identified to be associated with material losses like concrete leftover, demolished debris, steel scrap and others (Nagapan, Rahman, Asmi, Memon, & Latif, 2012). Hence, the construction waste is clustered into two groups, namely the physical and non-physical waste (Nagapan, Ismail, & Asmi, 2012). Physical waste are mainly concrete, timber, steel, and packaging, whereas the non-physical waste is cost overruns and time delays in construction of projects (Esa, Halog, & Rigamonti, 2016). Based on this view, construction waste can be considered to be both physical and non-physical waste but, in this paper, the researcher refers construction waste to physical and tangible waste.

Type of Materials

Also, there are studies that classify construction waste into a few material categories. The European Waste Catalogue (EWC) classifies construction waste into the following eight categories: (1) concrete, bricks, tiles, and ceramics; (2) wood, glass and plastic; (3) bituminous mixtures, coal tar and tarred products; (4) metals including their alloys), (5) soil (including excavated soil from contaminated sites), stones and dredging spoil; (6) insulation materials and asbestos-containing construction materials; (7) gypsum-based construction material; (8) other construction and demolition waste (Lu et al., 2011).

Inert & Non-Inert Waste

In Hong Kong and the United Kingdom, the composition of construction waste is further divided into the two major categories of inert materials and non-inert waste (Lu et al., 2011; EPD, 1998). The inert materials comprise soft inert materials such as soil, earth, silt, a slurry as well as hard inert materials such as rocks and broken concrete, while the non-inert materials include metals, timber, plastics and packaging waste (Lampris, Lupo, & Cheeseman, 2009; Poon, 2007).

Based on the review of previous studies, it can be concluded that there is inconsistency of classifying construction waste as well as the construction waste composition. Therefore, it is important to have information on waste composition to help in accessing the possible solutions for each and every type of construction waste produced.

2.1.2 **Causes of Construction Waste**

Table 2.1: Sources of construction waste generation (Lau, Whyte, & Law, 2008)

Waste Type	Descriptions	Sources
Wood	Dimensional lumber	Formwork, roof truss
	Plywood	Formwork
	Timber props	Falsework
	Sawn timber	Formwork, roof truss
Concrete	Substructure	Footings, piling
	Superstructure	Beams, columns, floor slabs
Metal	Drains and gutters	Drainage works
	Reinforcement bar	Reinforcement fixing
	Wire mesh	Reinforcement fixing
	Roofing sheet	Roof
	Aluminum frames	Window, false ceiling
Brick	Clay brick	Wall, fencing works, gutters
	Cement brick	Wall, fencing work, partitions
	Cinder block	Wall, fencing works
Others	Packaging	Cement packaging, plastics, cardboard, timber pallets
	Gypsum & cement board	False ceiling
	Plaster	False ceiling, finishing works
	Ceramic	Roofing tiles, floor tiles, wall tiles
	PVC Pipe	Plumbing works
	Conduit & wiring	Electrical works

The generation of construction waste is initiated by multiple caused factors and it is important to identify and understand those causes for controlling waste generation at source. The sources of construction waste generation observed by Lau, Whyte, & Law