

Sustainable Solutions for Construction Waste Reduction in UAE

دراسة حول إيجاد حلول مستدامة للحد من مخلفات البناء في الإمارات العربية المتحدة

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Abstract

The United Arab Emirates (UAE) is one of the biggest waste producers in the world and it is currently going through the challenge of realizing sustainability in construction and the conservation of the natural environment. The main problem has professed to be the management of waste from construction activities.

The major causes of waste generation in UAE were the poor construction policies along with the lack of knowledge and awareness among all construction professionals and off-cuts resulting from planning and designing, thus; survey questioners were conducted for this research with goal of determining a series of solutions based on respondent's opinion and experience during the construction sites.

This research paper looks also into the current status of UAE waste generation in the construction industry and provides a comprehensive understanding on the current legislations and polices being implemented. This research proposes a sustainable package of solutions that will help to mitigate the amount of waste generated through different steps and actions need to be taken as part of the construction procedure. Interviews then incorporated to ensure the proposed solutions and its effectiveness from their perspective. Case study has been selected for this paper practicing the issue of controlling the waste by achieving the sustainability systems.

It is evident that the presence of construction waste is a menace that needs to be eradicated. The main finding for this research is the lack of awareness that connected to several aspects which are the implementation of waste management plan and the governmental role. Construction companies and government agencies could partner to train them on the benefits of waste prevention and minimization and later offer incentives to construction firms that efficiently apply the acquired procedures in their design and implementation. The survey offers overwhelming positive responses on having a mandatory procedure of controlling the waste by the authority and increase the level of awareness.

Waste minimization should be integrated and effectually implemented starting from the planning phase, design, through preparation, during and after implementation of the project. If all or parts of these solutions are implemented UAE can experience drastic reduction in construction waste thus; economic, social and environmental benefits will be established.

الخلاصة

الإمارات العربية المتحدة هي واحدة من أكبر منتجي النفايات في العالم، وأنها تمر حالياً في تحديا يتمثل في تحقيق الاستدامة في قطاع البناء والمحافظة على البيئة الطبيعية. وقد ابدأ أن المشكلة الرئيسية أن تكون إدارة النفايات الناتجة من أنشطة البناء.

وكانت الأسباب الرئيسية لتوليد النفايات في دولة الإمارات العربية المتحدة ناتجة عن سياسات البناء الفقيرة جنباً إلى جنب مع نقص المعرفة والوعي بين جميع المحترفين في قطاع البناء والنتائج الناجمة عن نقص في التخطيط والتصميم، وبالتالي دراسة إستراتيجية أجريت لمجموعة من السائلين لهذا البحث مع الهدف من تحديد سلسلة من الحلول المبنية على رأي المجيب وخبرته خلال مواقع البناء.

تنظر هذه الورقة البحثية أيضاً إلى الوضع الحالي لتوليد النفايات في قطاع البناء لدولة الإمارات العربية المتحدة وتوفر فهماً شاملاً على التشريعات والسياسات الحالية التي يجري تنفيذها. يقترح هذا البحث مجموعة من الحلول المستدامة التي من شأنها أن تساعد على التخفيف من كمية النفايات المتولدة من خلال الخطوات المختلفة و الإجراءات الواجب اتخاذها كجزء من البناء الداخلي. ثم أدرجت عدة مقابلات مع مجموعة من المحترفين لضمان الحلول المقترحة وفعاليتها من وجهة نظرهم. وقد تم أيضاً اختيار حالة بناء لمناقشة مسألة هذا البحث عن طريق السيطرة على النفايات من خلال تحقيق نظم الاستدامة.

ومن الواضح أن وجود مخلفات البناء هو الخطر الذي يجب القضاء عليه. النتيجة الرئيسية لهذا البحث هو عدم وجود الوعي الكافي التي ترتبط بضمنها مع عدة جوانب منها تنفيذ خطة إدارة النفايات والدور الحكومي. يجب تدريب شركات المقاولات والوكالات الحكومية على فوائد منع النفايات وتقليلها وتقديم الحوافز لاحقاً لشركات البناء التي تطبق إجراءات الحصول عليها بكفاءة في تصميمها وتنفيذها. يقدم المسح الاستبياني ردود فعل إيجابية على وجود إجراء إلزامي من السيطرة على النفايات من قبل السلطات الحكومية ورفع المستوى التعليمي لقطاع العمل.

وينبغي إدماج الحد من النفايات وتنفيذها بشكل فعال بدءاً من مرحلة التخطيط والتصميم، من خلال إعداد وأثناء وبعد تنفيذ المشروع. إذا تم تنفيذ كل أو أجزاء من هذه الحلول فإن دولة الإمارات العربية المتحدة يمكن أن تواجه انخفاض حاد في مخلفات البناء وبالتالي، ستنشأ الفوائد الاقتصادية والاجتماعية والبيئية.

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Chapter 1: Introduction

1.1 Introduction:

Several statements and definitions have been raised up to define sustainability, as it becomes the new trend of both private and governmental sectors. The term sustainability has been differing by each and concluded as a series of strategies, essentials and in a wide frame it's a line of action that needs to be implemented to create a sustainable society with the help of government and humanity. In particular, sustainability construction will provide a major step towards sustainable vision by meeting the needs of the present with respect to the traditions of the enrich culture within the region.

Construction waste is any substance generated from construction work due to so many factors especially in early stages within construction sites (Hiete et al, 2011). This waste, processed or stockpiled, arises from excavation activities, refurbishment, fresh construction and demolition of buildings. There are numerous sources of material waste during construction. The most common source of construction waste is material cut-offs comprised of bits from timber, metals, tiles and glass. The main reason for excessive cut-offs is attributed to inappropriate designs that do not fit the construction material standards. For the materials to be of use they have to be cut to fit and the remaining pieces may not be utilized in the construction works and end up being waste materials. Other reasons behind excessive cut-offs are utilizing inexperienced building designers or foreign designers that are not conversant with UAE standards. The other sources of construction waste include unused cement, earth rubble and packaging materials.

Docksai (2014) mentions that construction waste in most countries form a substantial part of waste materials disposed in landfills and contributes towards filling them faster than anticipated. It is, therefore, important to identify and implement effective sustainable solutions to reduce the rate of use of landfills. This is the primary reason I chose to investigate on this topic. This study is important since it provides useful insights to building designers, building material suppliers, waste management organizations and building contractors as it enlightens them on the need to identify and utilize environmentally-viable, sustainable solutions (Docksai, 2014). This research paper also serves another important purpose which is to identify the latest development in UAE's construction industry and show readers where construction waste management is headed. Adherence to these measures should be reflected in lengthening the lifespan of the landfills as less construction waste is generated and disposed. Cleaner construction sites and an increase in environmental conservation efforts should also be a clear

reflection of adherence to these measures. In this spirit, this paper discusses, in brief, the global historical progress of construction waste management and then provides short background information on construction waste in UAE. Finally, the paper explicates some of the sustainable solutions for construction waste reduction by listing the specific activities that a contractor can perform to reduce construction waste on-site.

Construction waste management, as a concept, emerged in the 1970s. Before that year, only the traditional waste management practices existed which included safe disposal of human waste. The main reason why construction waste management was not practiced before then is that their population density was not so high as today's times. The levels of exploitation of natural activities to facilitate building constructions were also not as heightened as they are today (Adogbo & Chindo, 2008). Waste collection arguably started in 1751 when the British government passed the law setting up a municipal council with waste collection and disposal powers. This is the first instance where the people became concerned about where to dispose and whose responsibility it was to safely dispose this waste. However, all these waste management practices and exercised authority considered other wastes but not including construction wastes (Edmonton.ca, 2014). Prior to these, individuals would just release these construction wastes into the ground because at that time no one thought they had significant adverse environmental effects. It was not until 1938 that the first construction waste directions were provided in the US. This is after the members of the Congress voiced their concerns about the huge amount of wastes that are left around after construction and which was detrimental to efforts to conserve the environment (Edmonton.ca, 2014). This policy required individuals to, at least, clear all the waste at the construction site and dispose it at designated landfills. Since then, significant developments have taken place. For instance, in 1992 a plant to collect landfill gases was established in the New York. By 2005, construction waste reuse centers had begun sprouting in many parts of the world especially in North America and Europe (Tam and Tam, 2008). By 2008, construction and demolition recycling factories had already been established in the US. The latest development in construction waste management as of 2012 is the use of mixed construction and demolition waste to produce bio-fuels (Edmonton.ca, 2014).

Just like most of the other countries in the world, UAE is facing numerous challenges in waste management in its bid to achieve sustainability in construction. Currently, UAE is ranked as the second highest producer of construction waste per capita to USA among the world countries with more than 35, 000 tonnes of construction waste discarded daily (Al-Hajj & Hamani, 2011). This amount of debris being disposed has increased drastically over the past ten years when

only 15,000 tonnes were produced daily. For instance, there was a net leap of over 10.6 million tonnes produced between 2006 and 2007, jumping from 17.1 million to 27.7 million in 2007. The US led the generation of construction waste with over 170 million tonnes generated per year (Al-Hajj & Hamani, 2011); it is quite large amount comparing to other countries such as Hong Kong, which is producing 3158 tonnes of material waste per day disposed to landfills. However, the rate of increase in construction activities is not proportional to that of increase in landfills. The designated landfills are being used at a rate that was not envisaged and most of them are expected to fill by mid 2020s (Uaeinteract, 2014).

The unique characteristic that places UAE at the crossroad is its high premium land. The influx of investors in the UAE has intensified competition for building land. The increase in demand has made land prices go upwards. When these investors purchase a piece of land at premium prices it is only natural that they use every piece of it for their building construction purposes (bbc.co.ke, 2010). There is, thus, significant cut offs of building materials which then go to waste. The other UAE's unique characteristic is that the economic boom it is experiencing has necessitated the rush in building construction (bbc.co.ke, 2010). This rush by the owners and constructors leads to many building materials being damaged in transit and on site thus increasing the waste.

The government of UAE through its Waste Department has established that the main causes of increase in construction waste in UAE is individuals' lack of awareness and poor designing that leads to unanticipated materials cut offs. The other causes of construction waste as identified by Al-Hajj and Hamani (2011) were categorized under four factors namely: procurement, handling, operation and culture as shown in figure 1.1.

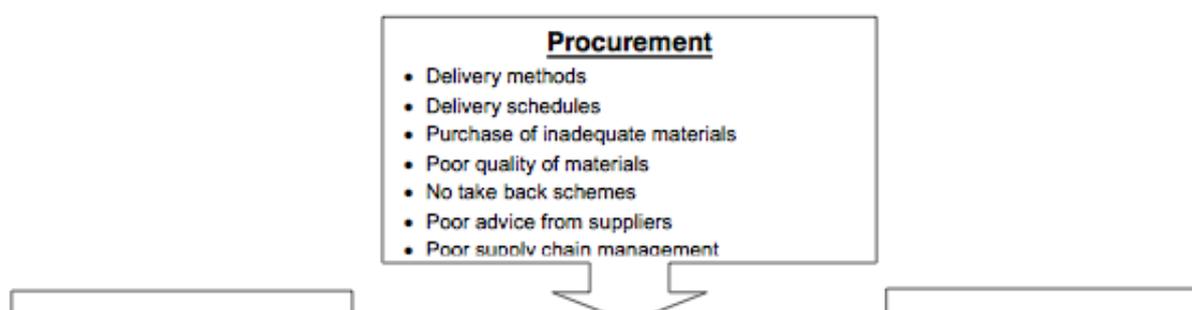


Figure 1.1: Main causes of construction waste (Source: Al-Hajj & Hamani-2011, p3)

The government, therefore, focuses its efforts towards reducing construction waste generation through promotion of specific measures such as training staff and other construction workers, availing appropriate storage facilities that minimize damage to construction materials and promotion of the use of just-in-time procurement schemes (Uaeinteract.com, 2011). Most notably, the UAE government is relying on community education to promote the reuse and recycling of construction waste in order to achieve sustainable construction.

The specific Emirates are tasked with developing their own construction waste policies and facilities. Dubai, for instance, has launched a program called “My City, My Environment” that is supposed to enlighten the citizens as to the importance of collecting and segregating recyclable waste. This program has been run across different areas such as Jumeirah, Al Barsha and Al Manara (Uaeinteract.com, 2014). In Abu Dhabi, a waste recycling plant has been established at Al Dhafra where waste materials will be aggregated and can be used later as a recycled material within the construction industry. The authorities envisage this initiative will reduce illegal dumping of building waste. As a result of the building of recycling factories, the problem of construction waste dumping has greatly eased in Dubai, Abu Dhabi, and Sharjah (Uaeinteract.com, 2014).

1.2 Aims:

To propose and evaluate a series of sustainable solutions that will help in reducing the waste generated during construction sites within UAE practices.

1.3 Objectives:

With the different methods being used and studied to conduct this paper, the following achievements are expected:

- To highlight the current status of UAE construction sites and to discover the importance of being sustainable within UAE construction industries.
- To determine all the barriers and the flaws that prevent from having an immaculate sustainable development within the context of construction industry.
- To assess the current regulations being used in dealing with waste reduction during construction sites with the help of analyzing a case study.
- To contribute in investigating the serious issues behind the gaps associated with construction waste production among all countries and participate in implementing a package of sustainable solutions that will help to improve the environmental status and sustainability development of the construction industry with respect to UAE conditions and roles.

Chapter 2: Literature Review

This section will summarize a comprehensive research done by going through previous studies investigated the same problem of controlling the waste in the construction industries based on different aspects and different implementations.

2.1 Economics and Climate Sustainability Status of UAE:

The United Arab Emirates is a constitutional federation of seven emirates that was formally established in 1971 after the states gained independence from Britain (Zaman, 2011). Over the years, the UAE has gained global prominence due to its exportation of oil and subsequent economic advancement. According to Zaman (2011), the hydrocarbon industry accounts for over 80 % of the government revenues. Beyond the oil industry, Gorgenlander (2010) noted that the UAE was unprecedentedly becoming one of the leading global financial centers and a core trading market in the Middle East. Wittingly, the UAE has diversified its economy sector beyond the oil industry, thereby expanding its non-energy sectors such as tourism, infrastructure and technology-oriented industries. These measures further cushion the country's economy against sudden oil prices decline and global economic recessions. However, Gorgenlander (2010) was quick to note that the economic development of the UAE had also led to increased environmental footprint in the country.

The economic prosperity of the UAE has come at a cost. The International Monetary Fund (2011) noted that the improvement of the country's economic welfare and explosion of the population had also been accompanied with environmental pollution and degradation. The report added that in 2010, the country had the highest ecological footprint per capita globally. In particular, Lawn (2013) noted that the country had tremendously failed to manage sustainably greenhouse gas emissions and water management. The observed increase in environmental footprint could be attributed to the continual growth and expansion of the high-energy intensity industry and proliferation of household appliances that highly consume hydrocarbon energy. Lawn (2013) further asserted that water management issues, primarily arose from climatological dynamics and heightened domestic water demand for the growing urban population. According to Fulekar et al. (2013), traditionally, the concept of sustainability and environmental protection has received little attention from the government in terms of policy formulation and establishment of regulatory frameworks. Fulekar et al. (2013) noted that the concept of sustainability in the gulf region had gained significant attention from domestic and international scholars from 2000 onwards. However, Lawn (2013) added that the reporting of the UAE in 2007 as the leading country with the largest ecological footprint per capita in the world marked the turning point of the nation with regards to ecological protection.

Figure 2.1 showing the ecological footprint over 25 countries showing UAE took the first place over Saudi Arabia and Kuwait from the GCC countries, which they took the 3rd and 17th places in this statistical survey.

Ecological Footprint of Top 25 countries

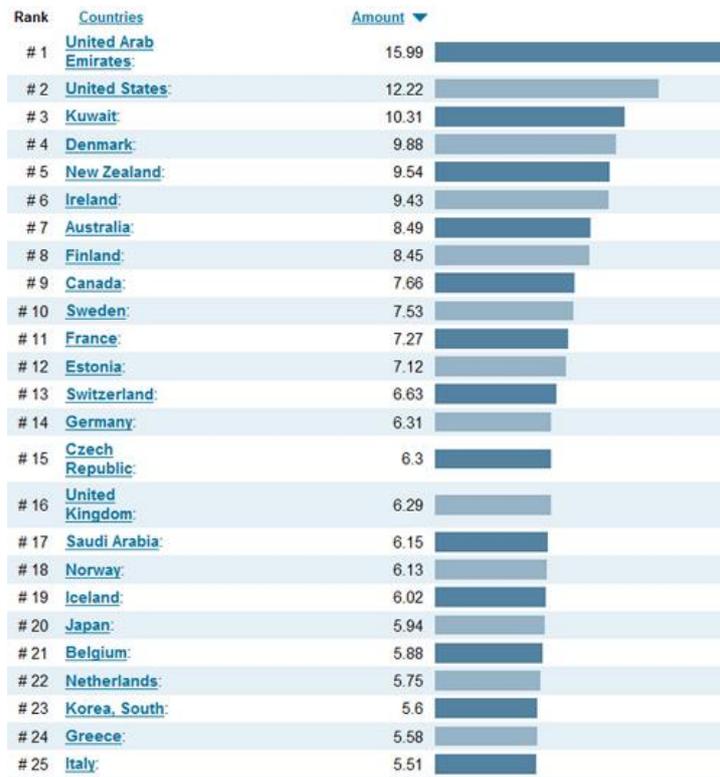


Figure 2.1: UAE top ranked on the top 25 counties of ecological footprint (Source: Global Environmental Stats, 2007- <http://www.go-green.ae/footprint/countries.php>)

Over the years, the UAE has witnessed heightened awareness for sustainable development in terms of energy production and consumption, waste management and water management. The growth of sustainability campaigns has further been accompanied by local partners primarily led by Emirates environmental groups, Abu Dhabi global environmental data initiative (AGEDI) and Emirates Wildlife Society (Fulekar et al., 2013). In addition, local scientists strategically collaborate with global footprint network to gain insight and professional expertise on how to formulate policies that will eliminate environmental footprints from the electricity segment of the country's economy.

In contrast to earlier stages of the country's propulsion to the world stage, the setup of UAE has greatly underlined sustainability and reduction of ecological footprint through application of effective building designs, construction of green buildings and appropriate disposal of construction waste. Abu Dhabi Urban Planning Council (UPC) has regulated sustainable urban

planning and effective construction of infrastructural networks in the country. In essence, Abu Dhabi UPC has fostered the concept of Estidama, meaning sustainability in Arabic through the review and guidance of new developments in Abu Dhabi to safeguard the sustainability of future projects.

2.2 Examination of Waste Material:

According to Vaughn (2009), waste material refers to an unwanted or undesired substance either from the manufacturing process such as industrial, construction, mining and agricultural or from a household. The effective management of waste material, hence directly relates to the maintenance of ecological sustainability. According to Practice and Everington (2013), all parties involved in the lifecycle of products such as suppliers, manufacturers, retailers and consumers should undertake responsive measures to lessen the environmental impact of the material waste. Greenwood (2004) in his argument proposed the implementation of the lifecycle assessment technique as a tool to mitigate the environmental impact of the waste.

According to Vaughn (2009), the classification of waste material varies from one country to another. However, Vaughn (2009) added that the classification is primarily based on the physical, chemical and biological properties of the waste material. In UAE waste is classified in the following groups, general waste, green or horticultural waste, construction and demolition waste, liquid waste and hazardous waste. According to Bossink and Brouwers (2000), general waste refers to any waste that does not qualify as liquid waste or hazardous wastes. General wastes mainly constitute packaging, dirt, rubble, waste wood and polyethylene from households and business setup. Based on the writings by Doukas et al. (2006) general wastes are also referred to as residual waste that have traditionally been disposed of using landfills.

According to the EPA guidelines and definitions, green or horticultural waste refers to the vegetative portion of the waste that primarily stem from domestic and commercial buildings and municipal processes. Green waste, mainly composed of organic waste derived from gardens, hence include off cuts of trees and branches, weeds, compost, leaves and snipping of shrubs and bushes. On the other hand, Bossink and Brouwers (2000) defined construction and demolition waste as the solid inert component of the waste stream derived from the construction, demolition or the refurbishment of premises or infrastructure. However, it does not constitute municipal solid waste, commercial, industrial waste or hazardous wastes. The mixed construction and demolition waste is comprised of concrete, wood, metals, glass, trees,

plastics and salvaged building components. Construction and demolition waste if improperly managed results in the degradation environment through soil and water contamination.

According to Vaughn (2009), liquid waste may be defined as such liquids that include human waste, sewerage water, run-off and industrial waste. Referring to OECD (2012), human waste and sewerage are generated from domestic residents and public institutions such as schools and offices. On the other hand, industrial waste arises from the industry and could be classified either as hazardous or non-hazardous depending on the content of the industrial raw material, industrial processes and the resultant output. However, runoff mainly constitutes of floodwater triggered by rainfall and is less toxic unless contaminated. Unlike other waste, runoff waste may be an agglomeration of all types of liquid waste hence may potentially be hazardous. According to Reeder (2010), both domestic and industrial classification of liquid and non - liquid waste should consider the following aspect when categorizing waste for proper management. To implicitly identify non-liquid wastes, the waste should indicate an angle of repose greater than 5 degrees and be free of liquid under EPA paint filter liquid test.

Reeder (2010) asserted that any waste that should fail to meet the aforementioned properties should be classified as liquid waste.

Esin and Cosgun (2007) defined hazardous waste as waste that could potentially result to environmental and public health risks. Nugroho et al (2011), further stated that hazardous waste have empirically tested and showed to exhibits the following detrimental properties, ignitability, corrosivity, toxicity, and reactivity. Hazardous waste are generated from a myriad sources ranging from industrial processes, business activities, agricultural undertakings and construction. Unlike other waste, hazardous waste transcends states matter hence could be solid, liquid or gaseous. Based on the public health and environmental threat of the hazardous waste, they cannot be similarly disposed of as other classes of waste. Bossink and Brouwers (2000) argued that treatment and solidification process could be employed in their disposition. Referring to Greenwood (2004) classification of wastes, hazardous waste could further be categorized as listed wastes, characteristics wastes, universal wastes and mixed wastes. Listed hazardous wastes refer to wastes that have categorized by EPA as potentially hazardous and included F-list, K-list, P- and U-list wastes. F-list wastes include manufacturing and industrial wastes while K-list constitutes waste generated by specific industries and P and U-list refers to waste from commercial chemical products. Characteristics waste encompassed waste not included in the listed waste but exhibited the empirical characteristics of hazardous substances while universal wastes defined waste from pesticides, batteries and mercury containing gadgets. Mixed wastes in addition to being hazardous contain radioactive properties.

Alarcon (2003) defined waste management as the administration of activities that encompass sustainable collection, source classification, temporary storage, transportation, transfer, processing, treatment and disposal of the wastes. Waste management technique and approach may vary from one state to another; however, the objectives of the exercises have been observed to parallel each other. Waste management is chiefly aimed at protecting the public health and ensure sustainability of the environment through minimization of generated wastes, waste treatment and advocating recycling and reuse of major commercial products. However, effective management of waste material has been hugely underpinned by the types of waste disposals method applied. CIOB (2004) identified waste disposal techniques to include landfill, incineration, recycling and sustainability, resource recovery and avoidance and recovery methods.

CIOB (2004) asserted that landfill method of waste disposal is primarily suited for the disposal solid wastes. Ekanayake and Ofori (2000) added that landfills are predominant adopted for solid disposal due to their structural simplicity and cost effective nature. CIOB (2004) further noted that the medium to low income developing countries directed almost 100% of their generated waste to landfills. According European Union, half of the member states still dispose of 75 % of their waste to landfills. Vaughn (2009) defined landfill as method of waste disposal by burying and covering of wastes with soil. Based on the studies by Reeder (2010), landfills may be categorized into the following types, sanitary landfill, municipal solid waste (MSW) landfill, construction and demolition waste landfill and industrial waste landfill. Sanitary landfills are characterised with the usage of the clay liner to separate the trash from the environment. The sanitary landfill system may either employ the trench method or area method in disposing of the wastes. Municipal solid waste (MSW) landfills are landfills that are managed and regulated by the local government and state government.

The architectural structure and design of the landfills are based on the provisions of the EPA guidelines on MSW landfills. MSW landfills are majorly constructed for the disposal of household garbage although, under EPA provisions, such wastes as paints, batteries, pesticides and chemicals have been banned from being disposed of on MSW landfills. Under the provisions of EPA, construction and demolition waste landfills are designed for the disposal of debris and wastes generated from constructions, modification and demolition of buildings and bridges. Construction and demolition wastes include concrete, woods, glasses, plastics, metals, and earth rocks. Non-hazardous wastes from manufacturing and industrial process are subsequently disposed of through the industrial waste landfills.

However, an extensive literature has cautioned against the environmental and public health drawback of landfill method of waste disposal. In their studies, Bossink and Brouwers (2000) indicated that landfills had the potential of contaminating groundwater through the proliferation of hazardous elements and microorganism thus resulting in outbreak of diseases. In addition, Spongberg and Becks (2000) documented the health risks of chemicals from cemeteries including arsenic, mercury and formaldehyde exposures. Vis a vis, Dhir (2003) recommended that landfills should be located at restricted area away from residence and fault lines, wetlands and flood plains. Composite liner on the floor and sides of the landfill should protect the soil from the leachate.

According to Dhir (2003) incineration refers to the disposal method of combusting wastes materials. As opposed to landfills, the final products of incinerators are gas, steam and ash. Consequently, Dhir (2003) cautioned that the incineration only reduces the volume of the waste but does not completely dispose of the waste. Incineration is both undertaken at both small and large scale to dispose of solid, liquid and gases wastes. Reeder (2010) noted that the incineration presented the most effective means of disposing of hazardous wastes that mainly constituted medical and biological wastes from hospitals. Nevertheless, the method of incineration has been fiercely opposed by McDonald and Smither (2010) and Masterman (2002) who argued that it directly resulted in environmental threats, air pollution. In light of incinerators limitations, Fulekar et al., (2013) noted that modern incinerators are fitted with emission control devices that include electrostatic precipitators, fabric bag house filters and acid gas scrubbers. In addition, the bottom ash and fly ash from the incinerators are properly disposed of in landfills. Furthermore, incineration method of waste disposal is closely linked with the concept of energy from waste (EfW) energy in the form where heat, electricity and steam are generated from burning wastes in furnaces.

In the recent years, recycling has attracted unprecedented interest from scholars as an alternative approach for waste management practices. OECD (2012) defined recycling as the process of attracting resources or value from waste principally undertaken to reuse or recapture the utility of the item. Kozlovska and Spisakova (2013) argued that recycling technology and technique was rapidly developing due to increased global awareness of the need to manage waste material. Kozlovska and Spisakova (2013) thus identified physical reprocessing, biological reprocessing, composting and energy recovery as the forms of recycling. Physical reprocessing involves the collection of waste material and subsequent reprocessing of the raw material from the wastes to new products such as beverage bottles. Physical reprocessing majorly concentrates on recycling of aluminium beverage cans, glass bottles, newspapers,

magazines and PVC plastics. Through biological reprocessing, wastes materials in the form of plant material, food wastes and paper wastes are biologically composited and digested to obtain compost manure that is recycled as mulch for agricultural undertakings. Kozlovska and Spisakova (2013) defined composting as a method recycling operation where solid waste is degraded, and the organic matter turned into refuse by microorganisms. The subsequent refuse is left to further degrade biologically to humus on the ground or through mechanical system of pipes according to OECD (2012). Energy recovery employs the concept of energy from waste where the energy contents of the waste material are harnessed in the form of heat and steam. Energy recovery recycling method utilizes the process of pyrolysis and gasification to treat thermally waste material with the resulting product being liquid and gas energy that serves as fuel.

2.3 Construction Wastes Discussion:

The future of the construction industry of UAE and sustainability of infrastructural sector is highly pegged on the strategic management of the increasing construction waste in the country. Apart from thwarting infrastructural developments, construction wastes are potent with public health and environmental risks to the country.

To reiterate earlier definition of construction, Bossink and Brouwers (2000) defined construction wastes as the resulting mixer of surplus materials that are generated from site clearance, excavation, construction, renovation, demolition and road works. The HK polytechnic of Hong Kong further defined construction waste as the by-products generated and removed from the construction, renovation and demolition workplaces, or sites of building and civil engineering structures.

According to Zawya (2014), the recorded amount of construction wastes in Dubai alone increased by 11% in year 2013 compared to 2012. In 2013, Dubai generated over 7.35 million tonnes of construction wastes triggered by the booming real estate sector. Extensive generation of construction wastes in the UAE thus calls for a delicate balance between continual development of the country's built environment and protection of the environment.

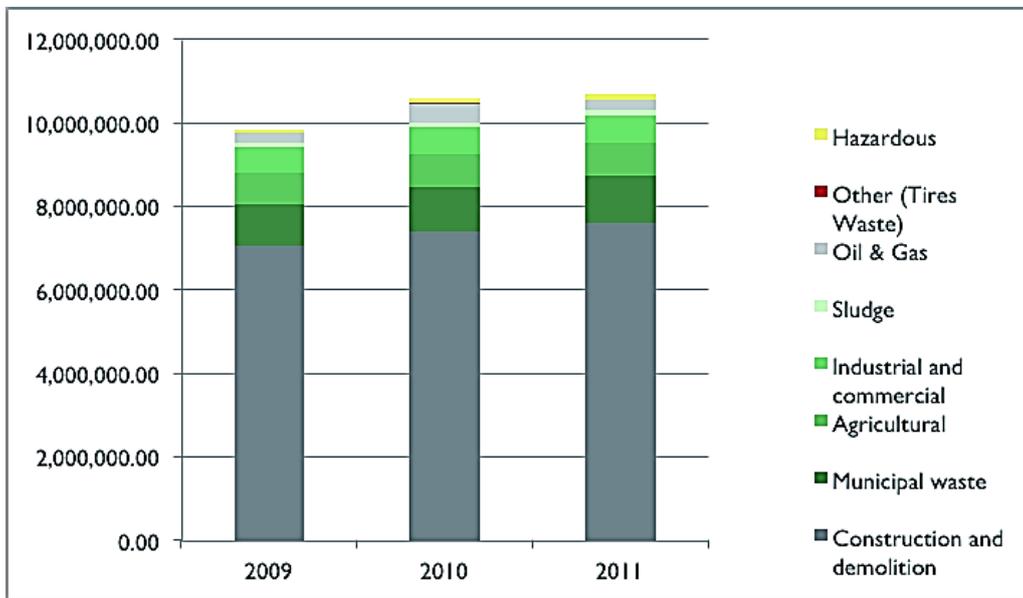


Figure 2.2: Waste Statistics in the Emirate of Abu Dhabi 2011, Statistics Centre – Abu Dhabi.

Based on the studies by Ekanayake and Ofori (2000), construction waste could arise from the following categories, wastes from partial or total demolition of buildings, wastes arising from construction buildings or civil structures, wastes from land levelling and constructions from road planning and related maintenance of the roads. These wastes were shown to be predominantly occurring in demolition and clear sites, renovation sites, greenfield building site, road build sites and road refurbishment sites. In contrast to Ekanayake and Ofori (2000) classification of construction waste origin, Keys et al., (2000) identified four processes as key generators of construction wastes. These processes included the design, procurement, handling of construction materials and construction operations. Consequently, Ekanayake and Ofori (2000) and Innes (2004) noted that the design process of construction contributed to the majority of the wastes. This finding paralleled similar conclusions by keys et al. (2000) and Rounce (2006). In an exhaustive survey by Saunders and Wynn (2004), findings demonstrated that excessive cuts off due to the inappropriate design of buildings were the leading cause of material waste in constructions.

According to Innes (2004) and Rounce (2006), the origin and causes of the construction wastes could be inherently examined through the consideration of the projects lifecycle. Masterman (2002) documented the lifecycle of building constructions to pertain the design, procurement, delivery and handling of materials, construction and refurbishment and demolition. Vis a vis, the extent of waste generation differed on the basis of the lifecycle stage as earlier noted by Innes (2000). At the design level, various pertinent factors were identified as the origin and cause of construction waste triggered by either professional incompetency or misinformation. Some of the highlighted factors by Ekanayake and Ofori (2000) encompassed inadequate

briefing, design dynamics, specification limitations, and drawing delays and lack of knowledge of alternative approach and techniques. Innes (2004) noted that the design stage accounted for one-third of the construction waste majorly attributed to sudden design changes and complexity of design interpretation.

The prevailing procurement system could have a further impact on the cultural, managerial, political and environmental aspects of the project based on Masterman's (2002) arguments. Ineffective procurement system could result to contract documentation errors, miscommunication, coordination, and adoption of a biased tendering method thus comprising the integrity of construction materials. Ekanayake and Ofori (2000) also added that proper selection of a procurement system enhanced the decision-making process during the design and construction stages hence limiting unnecessary additional work and thus preventing wastage of material. Referring to writings by Innes (2004), the project design phases of construction, renovation and demolition produced the significant amount of construction wastes compared to the previous phases. According to Graham and Smithers (2000) the predominant causes of construction waste at these phases are directly linked to labour, equipments and materials being employed in the building process. To reiterate Graham and Smithers conclusion, Bossink and Brouwers (2000) added that ineffective site waste management, inappropriate material procurement and handling errors also contributed to construction waste generation.

Unregulated generation of construction waste not only results to public health and environmental risks, but also contributes to increased cost of projects. According to studies by Nugroho et al. (2011), strategic management of construction waste could reduce the cost of the project by 6 %. The findings corroborated with Pinto and Agopyan (1994) assertion that the amount of construction waste was equivalent to additional cost amounting 6 % of the initial cost of the project. Consequently, the findings implicated that effective management of construction waste could save project managers 6 % of the project cost.

Therefore, for timely implementation of waste management programs, Poon et al (2007) noted that construction waste reduction practices should be undertaken at the early stages of the project and furthermore every participant of the project should be engaged in the process. Incidences of design changes positively correlated to the growth of project cost since the redesign and material alteration meant recurrent budgeting wastage of resources. According to Esin and Cosgun (2007), 92% of the wastes are as result of demolition and modification of buildings, of which modification of the interior accounts for 70 % of the waste and 10 % of waste are from minor construction material cuttings.

Effective management of construction wastes should be underlined with informed knowledge of the extent and volume of waste being generated by construction projects. Therefore, it is paramount that there exist comprehensive quantification mechanisms for construction waste. Esin and Cosgun (2007) noted that quantification system could aid as a tool for the assessment of the exact volume waste and further aid the formulation of sound decision making concerning the management of wastes. By facilitating prior quantification of construction wastes, project managers will be in a position to adequately plan for the construction sites, logistics and procurement procedures thus eliminating costs associated with wastes. McDonald and Smither (2010) noted that a successful quantification of waste calls for appropriate classification of the waste generated by source and type of the waste generated. For the purpose of classification by origin, Bossink and Brouwers (2000) identified building wastes occurring during the construction, packaging wastes subsequently generated from the packaging of the construction materials and wastes resulting from workers of the project.

Waste classes based on the type included wood, metal, mineral debris, plastic, papers, glass and hazardous wastes. Kozlovska and Spisakova (2013) further proposed two approaches for the empirical estimation of construction waste. These methods included global index approach and component index approach. According to Kozlovska and Spisakova (2013), the global index approach was pegged on the global data obtained from similar construction projects to estimate the amount of waste per square meter of the construction. The first stage should entail the definition of the list of construction components (CC) significant for the measurement of the subject construction project (Doukas et al., 2006). Preparation of the list should be guided by the characterization of materials, outlining of technical parameters and the determination of the constitution of the construction waste per single unit of the CC measurements. The global index data may be specific for given construction such as residential buildings, hotels or offices buildings. Subsequently, data files generated from the waste indicators from global data is utilized to estimate global waste from the prospective construction project.

Referring to Doukas et al., (2006) global index provides construction managers with pertinent information relating to the type of the construction, listing of the significant tasks to be undertaken and the associated quantity of materials in meters cubic and kg, list of expected waste on the site. Global index data conveniently provides for the computation of relevant management parameters based on the data from the waste generated, area and volume of the construction building. Vis a vis, Wrap (2007), recommended the global index approach provides the requisite information pertaining to volume, mass and the nature of the construction waste to be generated per square meter of the building.

On the other hand, the component index approach of quantifying waste highlights each component of the construction project and its associated waste generation. Component index approach conveniently indicates the volume of waste generated from each construction component. However, Wrap (2007) noted that the component index had a specific function to every building and should be determined by a professional located on site. The component index is considered as an independent and specific segment of the construction project. In a similar manner to the global index, the first stage entails the definition of the list of the construction components characterizing the waste generation in the project. In detailing the construction component, Lawn (2013) noted that the exercise should expound on the materials being used and the nature of the construction waste to be generated. Masterman (2002) added that additional information documenting the final destination of the waste; reuse and recycling mechanism could also be incorporated in the registration of parameters.

Consistent with Doukas et al., (2006) arguments, Gorgenlander (2010) highlighted that the component index data file should have three structures. These include the description of the construction components, composition of the generated waste and the waste management potential. For success implementation of the component index of quantification, Masterman (2002) recommended that contractors should design and develop their independent database for component index and with time refine generated data, expand the volume and continue adding related parameters for the achievement of a well-grounded quantification system. Unlike the global index, a component index is limited by its applicability to regional or international extent. Component index is highly suited for the quantification of specific components of the construction project whereas the global index parameters facilitates the overall estimation of wastes of similar projects for both national and regional domains.

2.4 Local and Global Construction Waste Management Solutions:

The potential risks to public health and environment degradation as a result of the growing construction waste has triggered global campaigns for the adoption of responsible construction practices. The unprecedented advent of responsible construction campaigns is predominantly pegged on practice of sustainable construction techniques and practices aimed at preventing, minimizing and mitigating adverse effects of construction wastes to the environment. Although the concept of responsible management of waste has attained gained public and scholarly interest over the last two decades, there already exists an extensive literature on measures that should be adopted by stakeholders in the construction industry. Consequently, at both international and local levels environment safeguarding authorities and the state

governments have formulated policies that advocate for the minimization, elimination and reuse of construction wastes.

Gorgenlander (2010) identified responsible management of construction wastes as the core solution to the financial burden and environmental risks associated with the wastes. Vis a vis, the European Union identified three components of the waste management. These include waste prevention, waste recovery and proper storage of wastes. Waste prevention is aimed at curtailing the generation wastes prior to the commencement of construction. Jacobsen and Kristoffersen (2002) highlighted that efficient frame design and construction material use plan is the key to preventing waste generation. The recovery stage emphasizes on the reduction of the environmental and health risks of the already generated wastes through reuse and recycling. Unrecoverable waste should further be safely stored at the construction site or at convenient location.

A closer examination of waste management practices by Ofori (2000) identified efficient prevention of waste generation as the initial stage of the process. Ofori (2000) further documented that waste prevention solutions could be achieved at the construction sites through logistics management, supply chain management, modern construction methods, training and incentivizing. According to UK based report by the Waste and Resources Action Programme WRAP (2007), the implementation of the material logistics plan (MLP) on the construction site resulted to significant reduction of waste through the elimination of double handling and ensuring safe handling of materials hence preventing damages. Based on the writings by Ofori (2000), the institution of a long-term agreement with suppliers through supply chain management systems ensures the just in time delivery thus minimization of waste due to storage and purchase of unnecessary goods. This argument was in line with the studies conducted by WRAP (2007), CIOB (2004) and Mc Donald (1997).

Dainty and Broke (2004) noted that there was an increased utilization of off-site prefabrication to minimize waste generation and degradation of the site in major construction in the UK. Similarly, a published study by WRAP stated, "The substitution of some modern methods of construction for traditional building methods resulted in a net reduction in waste levels" (Watson, 2009). According to Dainty and Broke (2004), various rating systems have been developed globally to monitor specifically and subsequently certify construction projects that are environmentally sustainable. The leading rating system in the North America is known as the US green building council leadership in energy and environmental designs (LEED) program. In addition to LEED, other systems include BOMA best, green star program of Australia, BREEAM in UK and the international code council's ICC-ES SAVE program.

According to Watson (2009), the number of global construction projects certified by LEED has doubled each year from 2000 to 2009. In Canada where the construction industry has witnessed rapid shift to sustainable buildings, the state government and universities emerged as the leading proponents of green buildings. In 2009, the government of Nova Scotia in Canada formulated a policy requiring all government-sponsored building projects to be designed and constructed according to LEED silver standards (Transportation and Infrastructure Renewal, 2010).

Consequently, the construction industry of UAE has also been characterized with adoption of modern construction methods. Watson (2009) wrote that since 2008, the government of Dubai passed a policy that mandated that construction projects meet international standards in particular, the LEED certification. The latest ranking by LEED indicated that UAE was among the top ten nations with most sustainable buildings globally (Gulf News, 2014).). Notable project in UAE that was cited by the report included the Dubai electricity and water authority headquarters that was awarded the highest LEED rating of LEED platinum. Canada was ranked first with 17.74 million GSM of LEED space followed with China and India (Gulf News, 2014). The variability of the countries topping the list signaled uniform global adaptability of the construction industry to implement sustainable construction practices through their design construction, operations and maintenance of the buildings.

Additional component of waste prevention involves the training and incentivizing of participants of the construction project on the merits of sustainable practices in relation to the environment and public health protection. Keys et al (2000) findings lend support to the claim that incentivizing of good performers contributed to organizational goals of waste reduction. Effective implementation of waste management program has also gained momentum from the increased workers awareness using toolbox talks and posters. These channels aid in communicating the benefits of adherence to waste policies and rules on construction sites.

In 2013, the Construction Industry Training Board (CITB) of UK allocated £ 30 million for the construction industry for incentivizing training that would incorporate sustainable development practices (CITB, 2013). Graham and Smithers (2000), further studied predominant drivers for waste material minimization in the construction sector. The data gathered by Graham and Smithers (2000) suggested that the key drivers of waste minimization practices in most industries included government policies, environmental standards and assessment tools and financial incentives from the national government. Under the federal law, the government of UAE has instituted agencies to responsibly manage and regulate wastes in the country. Crucial environmental agencies in UAE include Environmental Agency- Abu

Dhabi (EAD), Centre of Waste Management Abu Dhabi (CWM) and the Department of Municipal Affairs (DMA). Environmental management systems were pioneered by Rio de Janeiro summit of 1992. BS 7750 was the first environmental standard developed in 1992 by BSI and further followed by European Union's eco –management and audit scheme (EMAS) published in 1993. The highly adopted environment management system ISO standard, ISO 14001 was first published in 1996 and is UAE's foundational pillar for waste management policies. Greenwood (2004) stated that waste minimization and successive development of waste management system are an inherent requirement for the ISO 14001 certification.

Exponential growth of global economies has resulted to boom in the real estate sector and construction industry. Traditional means of disposing of construction wastes are no longer sustainable as landfills are expensive to maintain with the diminishing availability of disposal land. Consequently, emerging economies have adopted the reuse and recycling concepts of waste management. Masterman (2002) defined recycling as the reprocessing of a reclaimed material and converting it a new material or use. On the other hand, reuse was termed as the usage of the product again after salvaging the waste and treating or processing it. The reuse of construction waste contributes to strategic reduction of waste being disposed of to landfills. Graham and Smithers (2000) argued that certain components of construction wastes such as doors and windows in proper conditions could be serviced and further be donated for reuse. Reuse practices associated with the UK construction industry include the reuse of the excavation materials through fill and cut where importation of construction materials is costly. Unlike recycling, reuse utilizes less energy and does not alter the physical and chemical state of the product.

However, in Germany they involve the technique of recycling to mitigate the problem of construction wastes. Fischer (2013) noted that Germany reuses and recycles over 90% of the annual mineral waste from the construction industry. From the total 105.7 million tons excavated earth in Germany in 2010, 83.4 million tons were reused in the form of dredge spoil and track ballast, 74.2 million served as surface mining while 9.2 million tons were used for the landfill and road construction purposes (Fischer, 2013). In addition, 9.8 million tons got recycled into construction materials. A deduction of the above figures indicates that only 11 % of the waste was transferred to the landfill for disposal.

Koskela and Bertelsen (2004) further identified lean production system as a solution to the impact of construction wastes in the built environment. According to the Lean Production Institute, lean construction refers to production management system that is primarily focused on reliability and speedy delivery of value. The implementation of lean construction shifted

from the traditional linear production process and employs the cyclic form of process flow through the concepts of reuse and recycling of the construction wastes. Lean construction emphasizes the holistic synergy of the various construction processes in order to maximize on the project's value. According to Lean Production Institute, lean construction was specifically designed in the form of a continuing process that eliminates waste and facilitates customer's requirement by concentrating on the projects value stream. The conceptual model of lean construction considers the construction project inform of three core processes, transformation, flow and value generation processes.

Koskela and Bertelsen (2004) noted that the concept of lean production achieves waste minimization through the efficient coordination of stakeholders, seamless integration of project design with process design and the production process and the decentralization of the decision-making process. Turner, a multinational North America construction company, has emerged as the leading campaigner of lean construction techniques by embracing the lean management system. According to Turner's website, through the implementation of lean construction, the company boast of waste elimination, improvement of workflow and delivery of utmost value using fewer resources. Notable lean construction projects by Turner construction in the United States include Kent State Science Centre in Ohio, Hilton Cleveland downtown Ohio, genesis medical center Ohio and Ann frank inspire academy in Texas (Turner Construction, 2014).

After reusing and recycling construction wastes, there still exist specific category of construction wastes that should be disposed of through landfills. Although landfill method of waste disposal has been identified to pose an environmental threat, it still considered as the final option for reducing waste construction from the built environment. According to CIOB (2004,) construction waste disposed of in a landfill should include waste that could not be recovered, reused or be recycled hence should be disposed safely. Unrecoverable construction wastes in the US end up either in the municipal landfills or the C& D landfills. Under the charging scheme for the disposal of construction waste in Hong Kong, contractors are mandated to open billing accounts with the state's environment protection authority in order to access waste disposal facilities (GovHK, 2014). Construction wastes scheme constitutes construction contractors, renovation contractors and homeowners. Therefore, disposal charges are applied based on one's scheme. These mechanism assist in the reduction of waste generation by enforcing coordination of home owners and contractors to minimize waste generation, emphasizing the recording of generated waste for appropriate charges thus promoting awareness and the facilitation of the separation of inert and non-inert wastes for efficient waste management. Similarly, the state of New York had 113 registered land-clearing debris landfills

and additional 12 regulated construction and demolition debris landfills in 2013 (Dec , 2014). These landfills however posed limited environmental threat by meeting standard requirement in addition to being less than three acres, having compacted soil cover, single composite liner and designed with a leachate collection system

2.5 Case Studies of Successful Implementation of Sustainable Construction Waste Management Programs:

There have been exemplary cases of construction projects that have successfully integrated responsible waste management programs in their undertakings.

2.5.1 Waste reduction, reuse and recycle Program:

Construction waste management program of Chicago's O'Hare international airport has effectively implemented alternative methods for minimizing construction waste in airport construction works. The completion of the O'Hare's modernization program was characterized by core principles of waste reduction, reuse and recycle.

According to Federal Aviation Administration (2013), the multi-phased project provided a unique opportunity for the reuse of wastes generated from one phase of the project to another. Federal Aviation Administration (2013) noted that the entire project recycled over 600, 000 of materials, mainly generated from concrete and asphalt, scrap metals and landscaping wastes. As result of the recycling program, 98 % of the construction wastes was diverted from being disposed in the landfills. According to project manager, OMP successfully managed over 20 million cubic yards of onsite soil by utilizing it on other new projects and sustainably storing it for future use. The practice was estimated to have saved the project over \$ 140 million in form of disposal related costs. The sustainability of the OMP project was underpinned by the integration of the Sustainable Design Manual (SDM) and the Sustainable Airport Manual (SAM) systems. These manuals facilitated responsible construction through the provisions of sustainable design and construction guidelines, rating and certification systems and green airport models. Additional implementation specifications included requirement for the submission of waste management plan, estimation of design waste generation and monthly construction waste forms.

Recycling program has been implemented in the US and shown that great value of recycling has been achieved since 1980 when less than 10% of the waste was recycled to 1990 with almost 34% recycled waste. This way the pressure on landfills has been eased from 89% to 54% of our garbage from 1980 to 2009 as shown in figure 2.3.

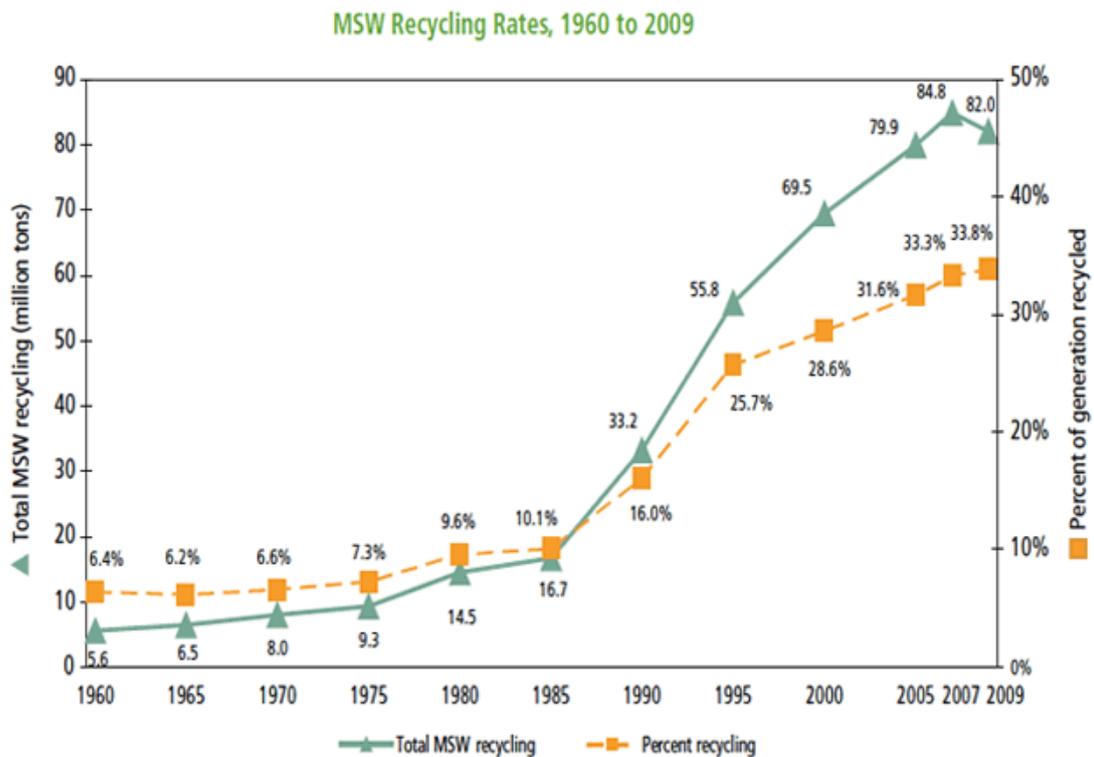


Figure 2.3: US MSW Recycling rate by EP from 1960 to 2009. (Source: <http://whyfiles.org/2011/trash-does-burning-beat-burying/>)

2.5.2 Tax over disposal waste construction materials:

Construction waste in Denmark has drastically reduced due to the introduction of landfill taxes. Stringent policies mandating contractors to remit taxes on the disposal of construction wastes has led to overwhelming upsurge of construction waste recycling programs. As result of increased recycling of wastes, the country has been able to manage waste from the booming construction industry. According to CIOB (2004), 90 % of the waste recycled comprises of crushed concrete, bricks and asphalt. In addition to the waste disposal taxes, the government of Denmark further introduced strategic measures to incentivize the reuse and recycle of construction waste as they have shown the highest percentage of incinerated solid waste among the European union statistics in 2008 by the CEWEP as presented in below graph. Further noted that UK and Ireland have facing a serious landfill directive through this statistical survey, which they have to stop over burying organic waste by the year of 2020 otherwise they will have to tax over every ton of waste with around 48 Euros. Germany and Austria are the top two countries through the European Unions who has taken the recycling habit seriously with 65 and 69% respectively as shown in graph 2.4.

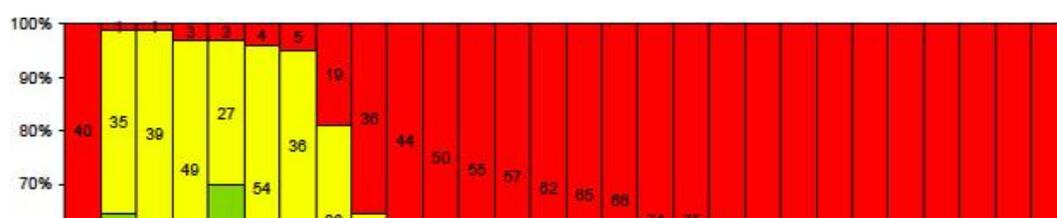


Figure 2.4: The Fate of Municipal Solid Waste by the European Union, 2008. (Source: <http://whyfiles.org/2011/trash-does-burning-beat-burying/>)

The government allocates grants to institutions engaged in the development of cleaner technology and recycling techniques in the construction industry. There further exist municipal assignment schemes mandated with tasks of directing wastes sorting and processing plants before recycling. In addition, the usage of virgin raw material for construction is further discouraged through taxes. Consequently, recycling of waste materials leads to cost saving as multinationals construction companies are able save up to £ 40-47 per ton by avoiding landfill taxes (CIOB, 2004). Jacobsen and Kristoffersen (2002) further noted that recycled construction materials such as windows, timber, doors and pipes are sold at half price of the similar virgin materials hence additional gateway for saving by the construction firms. Therefore, apart from the minimization of construction wastes, the Danish waste tax system has triggered the development of the market for recycling of construction and demolition waste in the construction industry of Denmark (Jacobsen and Kristoffersen, 2002).

2.5.3 Waste and Resources Action Programme (WRAP):

In Scotland, the management of New South Glasgow Hospital (NSGH) realized minimization of construction wastes through the implementation of sustainable project designs (Zero Waste Scotland, 2014). The NSGH identified 21 potential sources of construction waste through the implementation of the Waste and Resources Action Programme (WRAP). As result, the WRAP design tool assisted in the identification, quantifying and reduction of waste opportunities in the course of the project. One of the key strategies that were marked as instrumental to the realization of sustainability was the onsite sorting system that accounted for over 90 % of the

diverted wastes from landfills. According to Zero Waste Scotland (2014), the design tool of the NSGH project comprised of the following design principles, reuse and recovery design, design for off-site construction, design for the construction material optimization, the waste – efficient procurement design and the design for the deconstruction and flexibility. The off site design aspect concentrated on the prefabrication and manufacturing of key construction components away from the construction sites.

The project effectively managed to divert numerous onsite manufacturing activities away from the hospital site by fabricating link bridges, the glass curtain walling, columns, stairways, beams and floor slabs of the building. Similar the design for the material was also in line with the waste reduction principles, where the design process ensured maximization of the resource and material's value through strict adherence to standardization procedures for the key components. Some of the notable aspect of the construction process that underwent material optimization procedures included the internal walls, room dimensions and the subsequent setting out of the final layout materials. In the end, a comparison of the standard construction industry baseline of waste generation indicated that NSGH achieved waste reduction of over 6500 tones. Consequently, the project was further able to save on cost that has been incurred in the disposal of the avoided construction waste (Zero Waste Scotland, 2014).

By being a signatory to the Waste and Resources Action Programme (WRAP), Lend Lease, a multinational property and infrastructure firm implemented nine-step waste management plan to reduce construction waste on its projects (Zero waste Scotland, 2013). Lend lease implemented the nine step plan during the construction of the Strathclyde fire & Rescue training center in Scotland. As member of the WRAP, lend lease set a corporate target to achieve construction waste reduction by diverting over 94 % of the generated waste from the landfills (Zero waste Scotland, 2013). Astonishingly, the execution of the project resulted to disposal of only 4 % of the construction wastes to the landfills. The lend lease's nine-step waste recovery program constituted of the following stages, client engagement, design team waste minimization, subcontractor waste forecast, waste management options, waste contractor procurement, waste training and communication, waste reporting and targets, ongoing review and completion review.

Through client engagement, the team fine-tuned client's requirement with waste reduction designs while the waste minimization step established the mechanism to eliminate waste generation opportunities and design out expected wastes. Subsequently, estimation of the waste from the subcontractors availed the necessary data for the waste management options where the team determined efficient methods to address types of waste to be generated. Lend lease

hence contracted waste handling firms to manage safely waste streams through the reuse, recycling and salvaging techniques. The other steps of the process underpinned waste management practices awareness to all stakeholders, accurate waste reporting to relevant authorities and progressive review of the project's waste management undertakings and documentation of the successful lesson learned from the entire project. All inert waste generated from the SFR project were sorted and transferred for reuse at an equestrian facility. Over 22 % of the construction wastes were transported to recycling facility for reprocessing. These included wood, plasterboards and recyclable plastics wastes. Lend lease donated 1.5 % of the construction waste for reuse to Yooz Active4All, a charity construction company. The remaining waste that could be recycled or reused was taken to transfer station where only 4 % of the remaining 9.5 % of the waste was disposed to the landfills. Therefore, Lend lease was able to achieve five credits under the BREEAM Bespoke 2008-certification standards (Zero waste Scotland, 2013).

2.5.4 Setup of policies and infrastructure implementation within UAE construction industry:

UAE has also embarked on the development of policies and infrastructures that will aid in the mitigation of construction waste problems in the built environment. One of the country's project aimed at sustainable management of construction wastes is the Al Dharfa project that was tendered in 2008 and officially opened in 2010. The facility has the capacity to process 5,000 to 7,000 tonnes construction and demolition waste per day. In addition to reduction of the construction waste disposed in landfills, recycled materials from the plant complement virgin materials in the UAE construction industry.

The recycling plant reprocesses the waste into road base and sub base materials, trench bedding, asphalt products and structural fills. In line with the ISO 140001 standards, the plants produces merchandises that meet the international standards of the American association of state highways and transportation officials (AASHTO) and the American society for testing of materials (ASTM). According to Clean Middle East (2014) the project has led to reduction of waste disposal to landfills by 50%, significant reduction greenhouse gas by reduction of waste transportation to landfills, conservation of natural resources and the minimization of the carbon footprint of the construction industry in the country (Clean Middle East, 2014).

2.6 Highlight the Status of Landfills in the UAE Regarding Waste Reduction:

Landfills cannot be avoided during these discussions in relation to its application in the UAE.

Landfills in the UAE have been a waste destination since the fledgling start of the construction field in the country. Sustainability has altered the reliability of this solution to waste. Only inorganic waste is now dumped in landfills. Al Qaydi S. (2005) explains that the proper geographical distribution of landfills in the UAE have allowed for the avoidance of certain waste problems in landfills. However, landfills create a different kind of problem, noise and odor pollution. Affecting the ground water table causes dangerous pollutants to be released into the public realm, which endangers the lives of the UAE residents who rely on underground water as a resource.

Al Quadyi (2005) suggested that the best way to deal with the issue is to place the waste landfills away from the residential areas. Placing them instead in industrial cities, a practice adopted by the UAE with the assignment of the Jabal Ali area as a construction waste landfill. Located between Abu Dhabi and Dubai, there are no residential areas along its path. The main considerations for this decision stemmed from its soil, wind direction, and the possible future urban expansion of UAE. Figure 2.5 showing a typical landfill area at Jabil Ali.



Figure 2.5: Typical landfill Destination among UAE (Source: Shutterstock)

Abu Dhabi has set a target to achieve a diversion of 90% of waste by 2018 in an attempt to convert ten million tons of waste generated yearly. The amount of waste generated by the Capital of Abu Dhabi is 33,000 tones daily as stated in the Construction online magazine in 2011 and they were trying to set a plan for waste reduction and find alternative infrastructure to reduce the waste by providing more recycling centers in UAE.

The importance of pretreating waste, specially pumping hazardous waste into the ground needed to be addressed in order to reduce pollution consequences in relation to underground water as Dubai targeted to achieve the zero waste output by 2030.

2.7 Current sustainable legislations in the UAE:

Both LEED and Estidama (sustainability rating systems) adhere to existing guidelines that merge sustainable construction from within management in a successful manner within the UAE, as stated in the case study analysis that part of Estidama requirements is to provide waste skips color coded and waste signage with three different languages bearing in mind the different cultures of the workers.

Abu Dhabi, under the local arm of Estidama evaluates all their projects from beginning to end. It requires the approval of the urban planning council for any project, and its sustainability must be justified prior to the construction project. It has 3 main fields of mandatory waste reduction covering non-hazardous waste materials, reduction of construction waste, and dealing with operational waste on a large framework. A waste management plan is submitted containing those narratives and evidences with regard to waste management handling, but still the poor communication of segregating the waste and the bad habits done on-sites lead to critical issues of achieving the mandatory requirements of Estidama due to the lack of awareness and knowledge of the labors.

Waste Management in Building and Construction Projects brochures in Abu Dhabi shows that 70% waste reduction can be achieved by 2015 using the Estidama process. The system uses electronic databases, which allows for the monitor and control of all related waste information. LEED meanwhile, is best used in the emirate of Dubai, according to Al-Hajj A. & Iskaandarani T. (2012) it was implemented in a construction project with a noticeable improvement in waste production management and emphasizing waste segregation during construction.

There are some specific credits in LEED focused on alternative solutions to landfills using recycling and reusing strategies. Emphasizing preventing waste in construction sites and the reduction of waste during the construction process. It is still being implemented by Dubai authorities and has produced a sustainable level within the construction industry of the emirate.

2.8 Recycling Construction Waste Procedure:

In order to save the waste sent to landfill destinations due to poor management control, maximum attempts should be made to ensure that the recycling wastes are segregated appropriately for each waste type and each in its specified skip.

Recyclable wastes should be separated from trash, debris and other waste materials. All the recyclable waste should be separated by type at the site so they can be collected by the Recycling collectors.

There are some steps that need to be taken to make the recycling process easier while deposition and collection:

- All the wastes should be collected in Container to protect it from the weather.
- Provide appropriate colored and labeled containers for containing wastes till collected from the site.
- The containers should include a list that includes all acceptable or unacceptable materials.
- Before the deposition of wastes, all the containers have to be checked for contamination, and if contaminated, proper steps have to be taken to disinfect the container.
- Processed materials have to be stock piled separately without mixing with other materials. These should be covered to prevent windblown dusts.
- Processed materials have to be stock piled away from construction site and trees.
- Once the containers are brimming then wastes has to be collected and transported to respective Recycling collecting services.

2.9 Government Role:

The government role in the successful implementation of waste reduction and management cannot be belittled. It is the government's role to oversee and monitor the implementation of the SWMPs at all construction sites within a sustainable package. In the case of the UAE, government role cannot be emphasized enough as specific legislation and policies need to be

drafted, developed, and passed in order to widen the coverage of the waste management sustainability programs. Legislation will lead to a uniform and standardized SWMP throughout various projects under the lead of properly educated construction staffers and professionals resulting in sustainable and adaptable construction programs. In the UAE, a conceptual hierarchy system meant to motivate those concerned will appeal to their sense of obligation. The traditional approach to this problem will not work because the seeds of professionalism, responsibility, and achievement need to be planted in the future professionals in terms of their ability to work in a sustainable construction field.

The national target is the only way to set the value or percentage of achieving a target ratio for waste reduction. This will result in a competition between the construction corporations in both the private and public sectors that tend to reap economic benefits from such government mandates. These are then passed on to the real takers and clients as their own economic benefits. Such a target can be achieved once a systematic plan for distribution within the construction industry is created and implemented. The easier the government makes it for the construction companies to comply with the environmental requirements, the more compliant the companies will be. Also, the government can further promote reduction of construction waste through incentives to contractors (Uaeinteract.com, 2014). Since there are construction waste recycling facilities in UAE, the government may offer a reward to contractors who segregate their construction waste and take it to construction for recycling and reuse.

In conclusion, it is important to remember that proper coordination and communication between those involved are the main keys to creating a sustainable, achievable, and implementable waste management strategy in the construction industry with the help of the mandatory programme planned by the government.

2.10 Benefits ascribed to Construction Waste Minimization:

Waste minimization has many benefits to the client, contractor, the environment and our ecosystem. Some of the benefits are explained below:

Financial Benefits

Recycling and reusing of waste material goes a long way in reducing the overall financial expenditure of the project. It is also a fact that preventing and minimizing waste that comes out of the construction process is way more economical than hiring a waste contractor to dispose of it. Some of the waste such as packaging material can be sold back to the supplier or to other

contractors for income. And with waste disposal costs escalating within the UAE, waste management is the most effective way to go (Council, 2013).

Ensure Regulatory Compliance

Firms that do not follow guidelines as set down by the government and environmental agencies face punitive measure and high taxes on the waste (Agency, 2012). Every construction firm that produces waste has to meet several guidelines by established by the Environmental Standard Systems Management. Complying with legislation ensures suave running of the firm and avoids financial penalties (Naum, 2007).

Conserving the Environment

Recycling and reusing waste materials ensures that lesser raw materials are extracted and this preserves our natural resources and ensures an extended provision of supplies. Lesser landfills will avoid the issue of derelict land (KEMBANGAN, 2014). Decrease in pollution of the air, land and water slows down the extent of global warming and ensures balance in our ecosystem.

Competitive Advantage

Contractors will a sterling record in waste management are more likely to get hired than firms with poor and ineffective waste management systems. Implementing waste minimization will keep the client, investors and authorities happy.

Chapter 3: Methodology

In this section, the different types of methodologies used by other studies and researchers focusing on the same topic are analyzed in-depth. The weaknesses as well as the strengths of the methods used by the researchers are also analyzed. At the end of it, the methods suitable for this study are also evaluated. The methods suggested for the current study include literature review, survey and case study. However, there are also other methods used by researchers who delved in the same topic. This includes, interviews, focus groups and observation methods that are also evaluated based on their strengths and weaknesses.

3.1 Methods used by Other Researchers Researching on the Same Topic:

Methods that other researchers have used to investigate similar topics include surveys, literature reviews, case studies, observations, focus groups and interviews.

3.1.1 Surveys:

Surveys have the capability of providing a large representation of the population. Azhauruddin (2011) used online questionnaires to conduct a descriptive survey that targets the professionals in the construction industry in UAE in various organizations. Through this descriptive survey, the views of the professionals concerning sustainable construction piling practices and their suitability, is captured. There is usually a large number of population or people who answer the survey questions. When surveys are used the data collected from the sampled individuals has a higher frequency of having a better description of the relative features of the total population combined. In that way, surveys as a data collection method, has the assurance of extracting data that has high level of precision and is near accuracy.

Assem and Karima (2011) in their study to identify the causes of material waste and their impact on construction sites conducted a survey aimed at evaluating the measurement of material waste in construction sites. The respondents were cooperative and are willing to fill the questionnaires; however, some the respondents got it hard to answer some questions they think are invasive in one way or another with reference to the oath taken.

The surveys are cost effective; when conducting surveys, the researcher only needs to pay for the production of the questionnaires that will be filled by the respondents. In cases where the sample is large the researcher always has the choice of allotting incentives so as to lure the respondents. This compared to other methods of data collection is less costly, compared to the data that is gathered through observation and experimentation. With surveys there is convenience in gathering data (Marsden & Wright, 2010). The researcher has a variety of ways

at their disposal to administer a given survey. This is of course dependent on their convenience. The researcher might decide to do it in the form of questionnaires that are sent via fax or email to the respondents, or even administer them online in websites. With the advancement in technology, online surveys are the order of the day when conducting a research. Above all, the researcher is also able to have a wide geographical coverage compared to other methods.

Statistical significance of the result of any given research is usually important. Surveys have high representativeness allowing multiple variables to be tested and effectively analyzed. Through surveys the participants are provided with standardized stimulus. Therefore, the researcher must not be present since reliability is assured. The researchers' biasness is also reduced because the respondents are free to answer the questions based on their own understanding. Since the questions used in a survey usually undergoes scrutiny, the chances of getting precise results are usually high. This gives the researcher easy time to measure the level of reliability of the results obtained.

The surveys also have their own limitations (Marsden & Wright, 2010). First, the questions bearing controversies may not be well answered by the respondents. This makes it difficult to understand why the respondents are shying from giving an answer compared to methods such as face-to-face interviews and focus groups. Secondly, the design of a survey is inflexible. Once a specific design of a survey has been chosen it remains the same all throughout data collection process (Marsden & Wright, 2010). However, this is also to some extent strength because, fairness and precision are highly likely to be practiced in this case.

The questions administered in survey questionnaires are not usually simple and understandable to every respondent being that not all the respondents have the same level understanding. Most of the authors of different journals experience more or less the same strengths and weaknesses in using surveys as data collection method. For that reason the former is to the advantage of the researcher while the latter forms a challenge that is usually overcome by combining one method of data collection with another to supplement it.

Most of the challenges are different. Azhauruddin (2011) asserts that some of the workers were not willing to fill the online survey. Additionally some of the professionals in the construction industry are illiterate or semi-illiterate making it difficult to respond to the survey.

3.1.2 Literature Reviews:

Rodríguez-Robles et al. (2014) studied the effects of construction debris on environmental degradation. The authors used literature review method to investigate the findings from other authors concerning this issue. The primary concern of the authors was to identify how remains from construction sites affect the surrounding natural environment. The study was not based in any particular locality, but the findings were to be generalized to the Spain. Findings from the research revealed that debris from construction activities had several negative effects on the environment. First, the construction debris ends up in municipal solid wastes landfills, where it causes land pollution. Most of the debris contains metallic materials that are perilous to life in the surrounding. Second, construction debris ends up in water bodies and causes widespread water pollution, affecting aquatic animals. The authors noted that some constructors dispose solid wastes to water bodies especially in developing countries due to lack of strict regulations concerning pollution. Third, the authors found out that construction debris is beneficial since it can be recycled and reused to minimize its generation through green building.

Saravanan (2011) decided to use literature because of believe that it is advantageous than other methods of data collection. According to the author, using literature review as a method of data collection is versatile. Here, versatile implies that the researcher would study several topics of interest at the same time. Using literature reviews, the researcher can conduct studies for all topics they could ever think of, providing information either superficially or in-depth. Al-Hajj and Hamani (2011) explained in their methodology section that they decided to use the literature review because it did not require excessive inputs in terms of time and finance. Given the fact that most studies and research are published online in journals, accessing the studies or research was relatively easy. In cases where a researcher has to subscribe to a given site so as to have access, they are cost effective compared to the large amount of data that will be at the disposal of the researcher.

Lehman (2011) used literature review method in his study and enjoyed widespread cost minimization and time-saving. The general objective of Lehman's (2011) research study was to identify effective ways of minimizing environmental effects caused at construction sites. The research concluded that the best strategy for minimizing the effects of construction wastes on the environment is by reducing its generation; this could be achieved by the use of 3R (reduce reuse, recycle) Strategy. The fundamental reason for choosing literature review as a method of study by Lehman (2011) was because it is cheap and affordable. According to Azhauruddin (2011), literature review constitutes what others have collected from the field across time and place; using literature review is similar to conducting actual research study.

The only resources required for access are a good library, a competent reviewer or an online database for example sage publications and PUB Med. To conduct a literature review, the researcher needs not to schedule or coordinate as with other methods of data collection that is the only person involved is the researcher. Literature reviews are usually a good step in a study or a project since they usually provide a skeleton framework that then forms the base for planning and conducting the study.

Through literature reviews, a researcher is able to look into the gaps that existed in the previous studies and address them effectively in the current study or research. Additionally, the researcher may also choose to lengthen the scope of the study based on the data available from other studies. Assem and Iskandarani (2012) have used the information gathered from other studies focusing on waste management in UAE to group the wastes, come up with eradivative methods in a step by step format to help mitigate the wastes based on the classification. Additionally, Assem and Iskandarani (2012), for example, outline the hierarchy of construction and demolition wastes based on the previous studies by other researchers. This provides the researchers with a background from where to start the research.

Literature reviews, however, are associated with several disadvantages. Johnson and Beatrice (2013) missed the element of primary data that characterize effective research studies. Relying on the literature review exposed their study into biasness that could have been experienced in the original study. Fink (2005) argues that for an effective literature review, a high level of skill in identifying resources, analyzing the sources to spot the relevant information and writing a reasonable and significant summary of the study is required of the researcher. As such the researcher if not keen enough may be biased in picking the resources to use thus the study will be inclined towards the perception of the researcher and not whet really is on the ground (Fink, 2005). There are other disadvantages associated with literature review. Additionally, tastes and preferences changes with time to keep pace with advancement in technology; people's preferences at the time of the study could have changed with time. This cannot be reflected under the literature review method.

3.1.3 Case Study:

Case studies approach is another method that previous researchers had used in data collection. Case study method is particularly used in qualitative research. The case study approach is of

great assistance in the event where there is need to appreciate an issue in-depth, or even a natural life phenomenon (Welman, Kruger, Mitchell, & Huysamen, 2005). In other words it allows multifaceted exploration of complex issues in their real life environments. There are various types of case studies. The choice of one among these is guided by the purpose of the research.

Azhauruddin (2011) chose to use a descriptive or demonstrative case study in explaining carbon (IV) oxide emission in completed piling construction sites. Additionally, the author also demonstrates how the cost of carbon (IV) oxide emission reduction can be achieved. The author achieved the objective of the study by studying and identifying methods used in carbon (IV) oxide minimization in selected industries. Analysis of environmental benefits of using sustainable reduction methods is also demonstrated in the case study. Lehman (2011) also used a multiple case study approach in describing wastes that are encountered in construction industries. Although the case studies are focused on major cities the main recommendation lies in the solution of waste management in construction sites.

The case studies include: exploratory, descriptive and explanatory case studies. Additionally, there are also single case studies as well as multiple case studies. Explanatory case study is used when the researcher is seeking to answer a question that is aimed at explaining the presumed casual links in real life situations that are complex for survey and observational study methods. The outcome of such case studies is usually the implementation of a given program or idea. Exploratory case study on the other hand seeks to explore or look deeply across a complex issue or situation, which the intervention being evaluated, is ambiguous; having no set of clear outcomes. Azhauruddin (2011) used descriptive case study because he wanted to give a description of the phenomenon of interest, which was, minimizing the amount of carbon (IV) oxide released to the environment. Multiple case studies allow the comparison between cases and coming up with one clear outcome that can be grounded to solve a given issue (Jha, 2008). The major steps when using the case study approach are: definition of the case study, selection of the cases, collection and analysis of evidence or data, interpretation of data and finally reporting the findings.

Like any other method of data collection, the case study approach also has its own strengths and weaknesses (Jha, 2008; Lehman, 2011 & Azhauruddin 2011). There are a number of advantages when using the case study in research. As noted by Azhauruddin (2011) in his study, it simplifies complex concepts, making it easy for the researcher to explore any given

situation. Through the case study, the author was able to evaluate all the possible causes of carbon (IV) oxide emission in construction sites. Case studies exposed the researcher into real life situations that were naturally difficult. The case study approach also served as a value addition mechanism to a research and the researcher since concrete subjects are usually discussed in the case study.

The researcher is also bound to gain from the case study approach. Through analysis, communication and concept linkage the researcher will be able to have a different view as well as perspective in approaching given situations. Lehman (2011) agrees to the idea that the case study approach also enables the researcher to tackle the same problems as the one in the study should they make an appearance in future research; he is able to recall the past research he has done thus making it easy to use the method. Crowe *et al* (2011) observe that case studies the researcher is also able to challenge theoretical assumptions. Lastly, it also complements other methods of data collection for a research.

The case study method also has its own pitfalls. During the initial stages of the project, Azhauruddin (2011) found it tiresome and difficult to find a good and applicable case study to the research topic at hand. According to Crowe *et al*, (2011), case studies may also contain study of observations and perceptions of one person. This then increases the chances of bias especially when the person intentionally leaves out information that might be crucial to the research. In terms of time, case studies usually consume a lot of time compared to other data collection methods. Therefore, for shorter durations case studies might not be the best method of consideration by the researcher. When using a single case it is usually hard to draw a meaningful conclusion.

Many authors have criticized the case study approach for lack of scientific rigor and provision of a small basis for generalization. During the collection of data the researcher might collect little information regarding the study this going astray from the core objective of the research. Despite the weaknesses being many the strengths of the case study approach still outnumber them. This makes it a plausible method to consider when discussing this topic (Welman, Kruger, Mitchell, & Huysamen, 2005). Most of the researchers, who have used the case study approach, have combined it with other methods such as literature review so as to cover for the weaknesses discussed above.

3.1.4 Observation:

Some of the researchers also opt to use observation method of data collection. It has a number of advantages. It allows the researcher to see directly what the people are doing without relying on hearsay. The researcher also has the first-hand experience, especially when they participate directly in the activities. When the observations are standardized, it provides a relatively objective measure of the behavior of the respondents. Jha (2008) notes that the researcher is also able to discard what do not happen. If the researcher is keen enough, they are able to understand the setting more than those being observed. Participants with weak verbal skills can be used in this method. It is the best method for descriptive research.

The weaknesses of the method however, include: The reason for observing the participants of phenomena may be unclear. The respondents are likely to change upon noticing they are being observed. Investigator effects are likely to intervene especially through observer biasness and selective perception of the observer as well (Welman, Kruger, Mitchell, & Huysamen, 2005). It is not applicable to a large dispersed population with different attributes. The analysis of collected data may be ambiguous.

3.1.5 Focus Groups:

Focus groups are useful for exploring ideas and concepts that are complex to understand. The researcher is also able to have an insight of the respondent's internal thinking (Barbour, 2008). Through this the researcher can obtain in-depth information about a given topic. Most of the respondents will be willing to give clear explanation to the questions at hand (Jha, 2008). The researcher is also able to probe for the answers in the event that questions are ambiguous. Most of the content of the process of data collection can be probed. The turnaround time is also quick.

Data collection using focus groups also has its own weaknesses. The process is sometimes expensive and time consuming. Kamberelis & Dimitriadis, (2013) points that finding a focus group moderator may be a difficult task especially if the respondents are incorporative. Bias may occur if the participants feel they are being watched. There is also risk of domination by one or two participants. The results may be difficult to generalize especially where the sample is small. Lack of a proper parameter to measure validity may botch the whole process of data collection (Barbour, 2008). The method must be supplemented by other methods for proper data collection. Finally, the analysis of the data collected might be time consuming and cumbersome.

3.1.6 Interviews:

Most researchers opt to use interviews as one method of data collection. There are a number of advantages in using interviews. It allows probing the interviewee for clarification. Additionally, the researcher is also able to pose follow-up questions to get more insight of the interviewee and thus clarity (Jha, 2008). The interviewer is likely to get deep information that would otherwise not be possible to get using other methods. The interviewer is also able to gauge the accuracy of the answers given through observation of the nonverbal cues of the respondent.

The researcher always has the choice of using observation method to evaluate the interviewee. This provides easy time during the assessment of the whole process and validity check of the answers. The researcher is also able to interact with the respondent thus creating a rapport for the interviewee to feel free to answer the questions posed. Interviews are also flexible since they can be conducted in various locations at different time. They can also as well be adapted to given circumstances. Closed-ended interviews limit the answer the respondent might give thus ensuring that only exact information is given. There is a good turnaround time for interviews conducted via phones and emails (Welman, Kruger, Mitchell, & Huysamen, 2005). The researcher is also able to use probability samples to obtain the best response possible. Interviews can supplement other methods of data collection.

There are also disadvantages of interviews. First off, interviews are usually expensive and time consuming. The time required to place a request for the interviews and to inform the respondents is very much. Additionally, the researcher has to undergo rigorous evaluation by the responsible organizations prior to administering an interview in the organization. The interviewer also has to be prepared handy for the whole process (Welman, Kruger, Mitchell, & Huysamen, 2005). At times the researcher may need some form of short training to be able to understand the whole process. This includes how to use videotapes and recorders.

The interviewer may be biased based on the tones, rephrasing of the question, airing an opinion and inadequate note taking. Additionally, factors such as gender and appearance may also make the researcher biased and include errors in the research. Flexibility previously seen as one advantage is also a weakness in itself. Too much flexibility may cause inconsistencies in the response given. This is because the respondents may lose control with their environment and thus their attention to the interview. Lastly, during analysis there is a huge amount of data that

is analyzed and short time to complete the analysis. Without a proper analysis plan, the researcher may fail to beat the deadline of the research. Furthermore, the results of an interview are usually, subjective in nature.

3.2 Selected Methods for this Study:

For the purpose of this study, the methods to be used are the case study approach, surveys and literature review based on their strengths and few weaknesses that can be ironed out. The three methods are complementing one another in the study to provide clear and concise findings at the end. Even though some researchers have considered other methods, the three chosen methods still stand to be the best so as to take care of the gaps in previous studies and also address the issue in the topic from different points of view.

Since the methods selected covers previous studies experienced the same issue of the conducted paper to the survey questioners, which were designed to cover all the aspects being highlighted from previous researchers in order to ensure its validity and presence in UAE construction industry, as well as by experiencing a real life problem with the selected case study which was chosen to ensure the current problems occur during construction sites. Thereafter, a comprehensive coverage of the problem will be able to sort out.

Each of the chosen methods has its advantages and disadvantages and by working all together a holistic perspective of the problem will be able to investigate.

Using more than one method in conducting such research will help for overcoming the weaknesses and the limitations of each method by consciously combining more than one method at a time with the same investigations which will help in comprising variety of information's and opinions that may be different from one method to another. Multi methodology will offer a clearer picture for the raised issue and make for more adequate explanations.

In conclusion, as the highlighted subject of this research paper is a real life scenario that faced during any construction stage, then the only possible way to deal with it is by communicating with the responsible parties which are the contractors and Health and Safety Executive (HSE) team.

In regards to the various cultures/ mentalities and languages of the construction members and labors, the author insisted to have a real talk interview and a real case study to explore the gaps and difficulties faced by the construction team.

3.2.1 Literature review:

Based on the numerous advantages that literature review has, this study will use it as one method of data collection. This is because through it analysis of what other researchers have done shall be done, after which a summary will be given. In the process of conducting a literature review it will be possible to look at the gaps that existed in previous studies and address them effectively in the study (Marsden & Wright, 2010). The choice of the resources to use shall be strict based on the year and the source. This will make the results plausible to the study and relevant. Additionally, being that most literature has been done identifying their limitations will make this research better because repetition of the same mistakes will be avoided.

Most of the backbone of the research shall hail from the literature review section. This section shall explain the types of waste materials; classify them into degradable and biodegradable and the ease with which they can be eradicated. The sources being reviewed will be selected based on the date of publication that is only the relevant publications of between 2000 and 2015 will be applicable. This will be done to reduce the chances of exemplifying the weaknesses of the method previously stated. Only academic journals shall be considered. Some of the advantages that will come with this include the ability to cover gaps that exists impervious studies.

3.2.2 Survey:

There are many individuals both online and offline willing to answers survey questionnaire upon request. Using the poser of technology, a designed survey questionnaire with relevant variables related to the topic will be administered. This does not mean that other methods of administering the same shall not be considered. They will also be considered as well. Clear validity checks will be done as well as standardization on the questions. Surveys being one of the methods to collect data that has a variety of advantages shall be used to supplement the other two chosen methods.

The survey questioners were designed based on existing problems being raised by previous researches; the case study associated problems and also based on general awareness and governmental role of overcoming this matter. The aim of these questions was to ensure all the

highlighted issues by the other two methods to limit and evaluate its validity during construction sites within UAE construction industry. The survey design, timeframe and survey selection will be discussed in details in chapter 4.

3.2.3 Case Study:

As previously stated there are reasons why case studies have to be applied to given studies and not others, based upon that foundation, supplementing literature review and surveys will be a case study approach. This will be viable since answering complex question lying in the topic of study will be possible through application of real life scenarios. A properly analyzed and researched case study shall be given in reflecting all the parameters in the research topic.

Emphasis shall be placed on the relevance of the case study and also its applicability in real life. To proper understand the issue in question the case study shall take the form of exploratory approach. This will make a good base to offer a concrete finding at the end of the study. Through the case study approach the research will be able to classify the waste materials encountered in the construction industry regardless of the location, since the sites are almost similar. The sustainable solution on how to reduce waste materials shall then be presented after analysis of the scenarios in the case studies presented.

To mitigate the weaknesses the case study shall be selected in a careful manner to suit the topic of discussion. This is to mean that, the possible methods of reducing material wastes in construction sites shall be of focus. The case study was selected due to the sustainability rating system achieved for this project, and the main idea is to evaluate the problem while having waste management program and the need of proper housekeeping in order to manage the amount of waste generated. Table 1 analyzes the chosen case study for the proposed research paper.

Chapter 4: Survey selection and analysis on how to reduce waste generated during construction practices in UAE

This chapter will summarize and analyze the survey conducted for this study based on many aspects that will help to overcome the problem of waste generated during the construction sites. Survey questioners were selected due to its several advantages in summarizing respondent's opinions in a very minimal time with high convenience and effectiveness and also to the easy access of Internet in Abu Dhabi, which all stakeholders can reach.

4.1 Survey Design and Selection:

The type of survey selected for this research was the E-survey method, which aimed to collect as much as possible of data's from different people working in different sectors from different countries but unfortunately, uncompleted responses from 5 respondents were only received when the survey posted on **SurveyMonkey.com** and after waiting for almost two weeks an expressive study was directed by sending the survey through Emails to individual experts working in distinctive associations in the UAE to acquire their perspectives and reactions with respect to the information. It is usually on essentialness of manageable quality; reasonable heaping development rehearses and its hindrances and profits.

The researcher decided to post the survey on Facebook media and got emailed answers from work colleagues and at the same time the survey was printed out and distributed to the contractors where the author work. Due to author work position as a sustainability consultant in a consultant company, most of the projects handled were designed to achieve Estidama rating system. Author was handling so many projects in the construction stage and decided to take a step further in order to get direct response for the survey questions from actual people who dealt with the issue of construction waste every day. A screenshot of the survey was taken to indicate the questioners conducted for this research as shown in figure 4.1.

The questions were designed to cover all the aspects being raised in the literature review chapter and by the results got form the selected case study covering all the required aspects that need to be improved and provide a serious action in order to be followed during the construction stage.

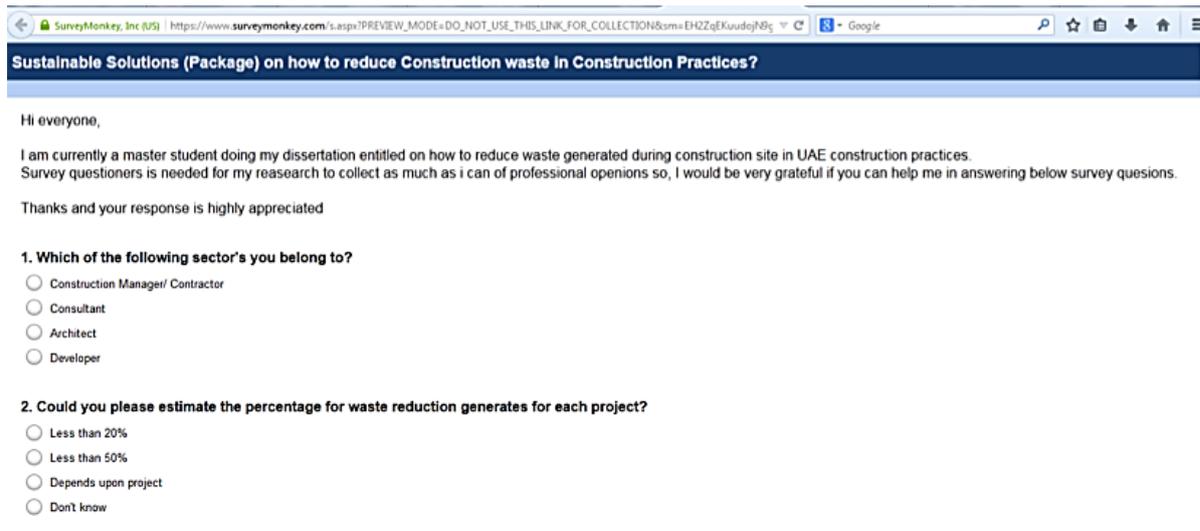


Figure 4.1: Screenshot of the survey questioners conducted for this research

The survey was conducted of total of 6 questions to make it more specific and clear for respondents. Two of the questions consist of more than 15 statements covering all aspects related to construction waste generation. The statements have been designed to cover all the issues found in other studies seen in the literature review and from the selected case study as most of the construction sites are facing mostly the same reasons behind waste generation. The survey got isolated into different segments as per the research targets and included with both open sort inquiries to urge the respondent to give free reactions. Shut sort addresses keeping in mind the end goal to get the direct investigation with speedy replies by short reactions.

The survey comprised of two main sections: the first section primarily addressing the different benefits needs to be considered or achieved during design and/or construction stage, respondents were required to answer to which they agree with the statements by checking with not important, mandatory important or strongly important. The second section (two questions/ 15 statements) : was about listing different barriers/obstacles identified from the literature review and the case study, thus respondents' were asked to evaluate the statements based on their experience and personal opinion in the construction field on a scale of strongly disagree, disagree, neither agree nor disagree, agree or strongly agree. Screenshot of the survey questions were indicated in figure 4.2.

The survey questioners were designed to cover different roles surrounded by the literature review and the case study and based on the common problems the researcher faced during the duty of handling Estidama construction projects for construction rating. The questioners covered everything that might affect and amount of waste generated in UAE construction

practices such as; the governmental role, educational and awareness of professionals, procurement delivery, waste management plan implementation and the waste avoidance of reducing the construction waste generated.

3. Please rate the following statements: (Please answer all)

How Important Do you think of the following benefits to be achieved/considered during design and/or construction phase?

| | Not Important | Moderately Important | Extremely Important |
|---|-----------------------|-----------------------|-----------------------|
| Implement measures aimed to reduce construction waste from the design stage | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Appropriate site layout planning | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Management support and commitment | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| On-site recycle waste operation | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Audits waste management programme, controls and monitors | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sustainability and social corporate responsibility | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Reduce waste disposal costs | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Increase competitive advantage to meet sustainability objectives | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Environmental benefits and credit points awarded | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| High priority achievement while reducing waste during construction stage | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

4. Evaluate the following statements: (Please answer all)

In your opinion, Do the following Barriers/Obstructions influence the amount of waste generated in construction sites?

| | Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree |
|--|-----------------------|-----------------------|----------------------------|-----------------------|-----------------------|
| Lack of training awareness | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Inappropriate timetable for delivering the materials | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lack of effective waste management tools | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Laborers culture and behavior differences | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lack of promotion of waste minimization extent | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

5. Have you attended any training programmes related to waste reduction or waste management plan commitment?

Yes
 No

6. Do you think there is enough encouragement from the government to reduce construction waste ?

Yes
 No
 Somewhat

7. Please provide any additional informations or any other issues which you think can help in the future for site waste management plans?

Figure 4.2: Type of questions designed for this research

The survey were designed to cover all the aspects that affect the amount of construction waste in accordance to UAE conditions, unlike other studies that failed in implementing some measuring solutions without examine its effectiveness with the concerned country and its conditions.

4.2 Sample Timeframe:

The survey was first designed by the surveymonkey website and due to the incomplete responses received; the author decided to post the survey on Facebook media and printed out the questioners to get on-site answers and in order to get the chance to discuss the selected answers and if the respondents have any other suggestions for waste reduction improvements.

The rates of the respondents can be classified by 80% (28 respondents) as most the respondents who received the survey as a hardcopy answered the questions completely, while the rest 20% (5 respondents) was based on the uncompleted responses sent out through the website.

The time spent for collecting the data was almost one month and the time required for summarizing and finalizing the results was done within 3 weeks. So the total timeframe for sending out the survey and analyze its results was almost 2 months.

4.3 Who Received the Survey?

The survey questioners were received from 28 respondents working in diverse associations keeping in mind the end goal to get their individual perspectives and profitable sentiments with respect to the research subject.

The survey was designed for specific group of people who dealt only with the construction industry not to public pollution for the purpose of accurate screening of answers as it will be difficult to subsets of the overall group as the quality predominate the quantity in such survey because the statistics lack the necessary power.

7 of the respondents were contractors, 10 project managers and 11 were engineers from different specialties. All respondents have a minimum of 5-12 years of experience in public and private organizations dealing with different scale of projects within the construction industry.

The respondents were divided based on their professions not based on their positions in the projects as most of the project managers and/or engineers take the responsibility of handling the contractor duties in most of Estidama projects due to the lack of knowledge and awareness of the contractors to run and follow the requirements of the projects that designed to achieve the sustainability systems.

Due to the lack of the contractor's knowledge in most of the projects seen, the project managers were handling the work of the contractor due to the limited time of the project completion and the cost entails on every day of delay.

Most of the respondents were given their responses based on their current position in the project and based on their experience and actual profession in other projects ex. Project manager working as the main contractor in the project due to the reasons mentioned above. This was one of the benefits received from face-to-face surveys alongside with the chance of getting to

capture also the non-verbal questions by explaining the questions that not being understood, likewise lead the interviewer to keep focus on the goal of the conducted survey.

70% of the respondents' were not working with projects achieved sustainability system before, 30% of them were experienced projects targeted Estidama rating system and they were highlighting the same aspects being raised in the survey questioners during their experience with Estidama targeted projects during the construction stages.

Table 4.1: Summarizing the number of respondents under their professions

| Sector | Number of respondents | Years of Experience |
|------------------------------|------------------------------|----------------------------|
| Construction/Project manager | 10 | 10-12 yrs |
| Contractor | 7 | 8-9 yrs |
| Consultant | None | None |
| Architect Engineer | 3 | 6 yrs |
| Civil Engineer | 1 | 5 yrs |
| Safety Engineer | 2 | 4-5 yrs |
| HSE Engineer | 3 | 5-8 yrs |
| Resident Engineer | 2 | 10-12 yrs |

The American Association for Public Opinion Research (AAPOR) has been stated that face-to-face surveys are getting the highest rate comparing to e-surveys due to its possibility of getting more detailed responses from the respondents.

In actual fact, the response rate cannot be measured by how many people are having the survey; it is about the amount of information's you got and how far off we're willing to be. One of the most important aspects in measuring the response rate is the respondents are enough educated/experienced to answer the survey questioners and are from the same population field to fit our criteria for eligibility.

4.4 Survey Results and Analysis

The key findings of the survey conducted for this research are illustrated in this section. As mentioned above the total number of respondents was 28 received the survey as a hardcopy during the construction site visits attended by the author for different projects. One of the

questions being raised in this survey was the estimated percentage of waste reduction during the construction process. The results shown that 45.9% of respondents stating that the waste reduction in each construction project was about less than 20% while 45.1% indicating that the amount of waste reduction cannot be estimated as it will depend upon the scale of the project. Followed by 6.5% did not know about the waste percentage as they were not aware about the importance of waste reduction in every construction project. 2.5% was the results of waste reduction less than 50% which is minimal in most of the construction sites due to the inadequate actions and habits done during the construction process, these rates are illustrated in figure 4.3.

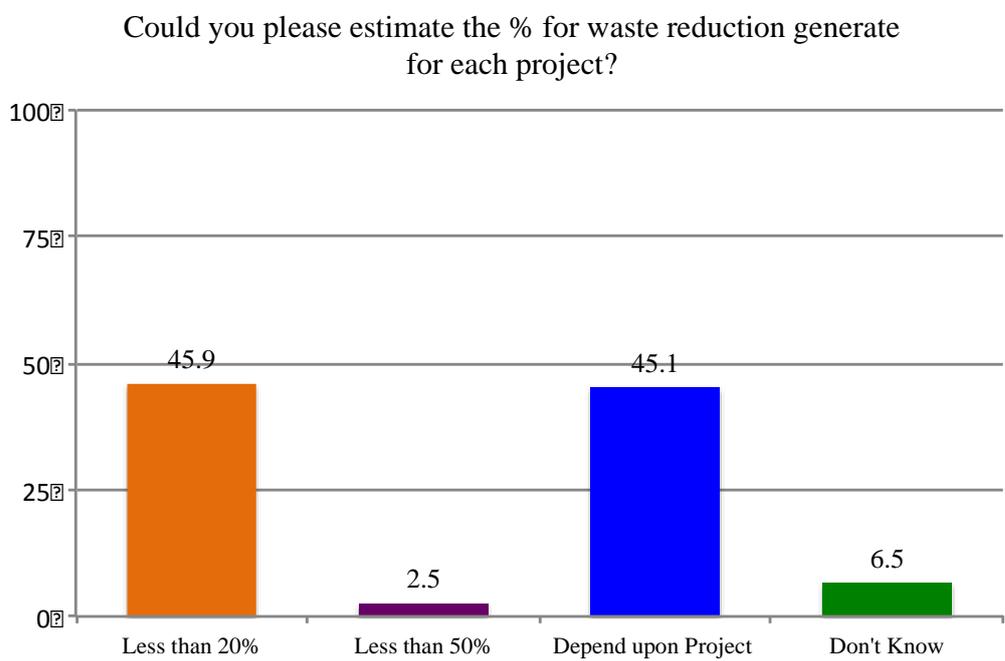


Figure 4.3: The estimated percentage of the respondents on the amount of waste reduction for any construction project

One of the survey intentions is to evaluate the respondent opinions on many aspects that they think it would be of help in reducing the waste, the results have been shown that 48.9% of the respondents thought that it is not important to implement any measures from the design stage for waste reduction while 30.6% stated that it is moderately important of having some measures since the design stage that will be helpful of controlling at least the design of building materials followed by 20.5% of respondents who believed that building materials can be controlled from the design stage which then can be resulted in minimal construction waste. Figure 4.4 showing

the respondents opinion on the importance of implementing measures and/or taking actions from the design stage.

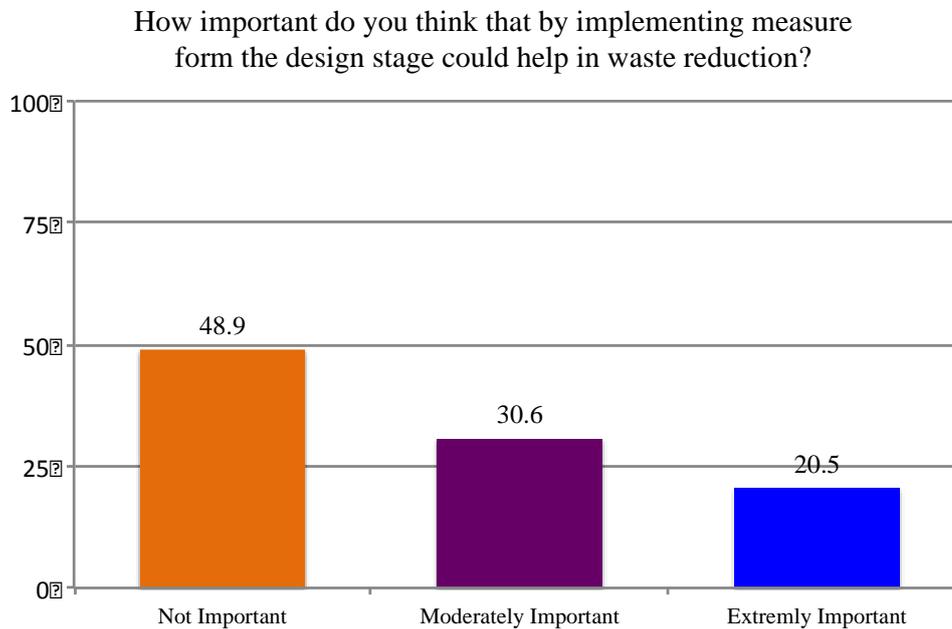


Figure 4.4: Respondents opinion on the importance of implementing measures from the design stage

The amount of waste reduction through appropriate site layout planning shown in figure 4.5, which resulted with 60.3% stated it is moderately important to have proper site planning which is related somehow to the measures need to be taken during the design stage. 22.5% cited that site planning layout scale would help the labors in controlling the waste during construction by having enough space to segregate the waste on-site. While 48.9% of the respondents mentioned that the issue of waste reduction is not strongly linked to the site planning as much as with the aware of labors and other stakeholders on how to deal with the construction waste even if the site is fully designed.

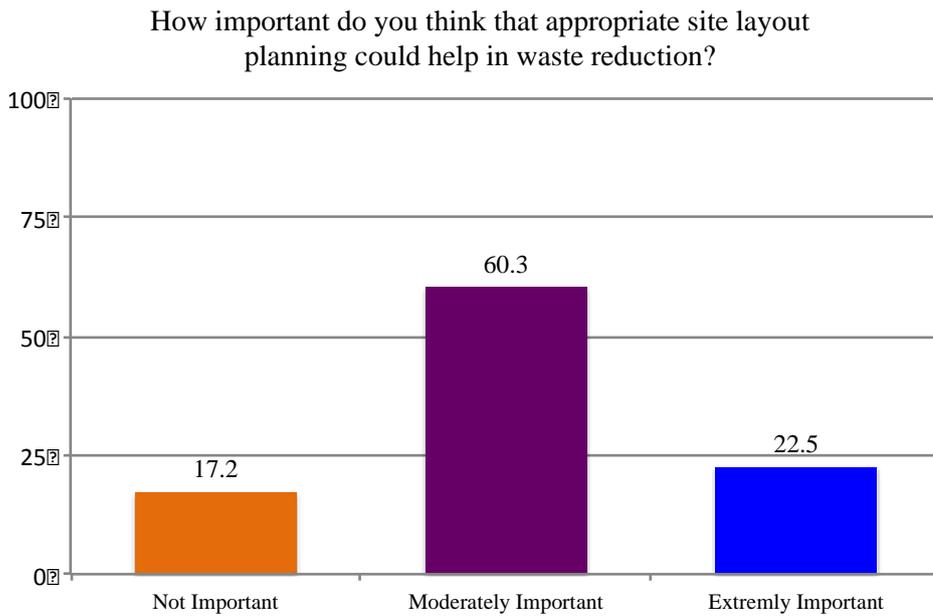


Figure 4.5: Respondents opinion on the importance of having appropriate site planning layout

One of the issues raised in the survey questioners was the importance of having management and support in order to reduce the waste, respondents were highly recommended if there were management and waste control since early stages of the construction process with 70.6% followed by 28.4% agreements as there is no management plan and proper housekeeping is yet implemented to reduce the construction waste thus no waste reduction can be achieved without this major phase that need to be taken into consideration. Taking such serious action could also minimize problems related to construction waste, which is consistent with my observations for the bad appearance of waste management on-sites. The issue of figure 4.5 will be discussed in the discussion chapter as one of the sustainable solutions that need to be implemented for the purpose of reducing construction waste.

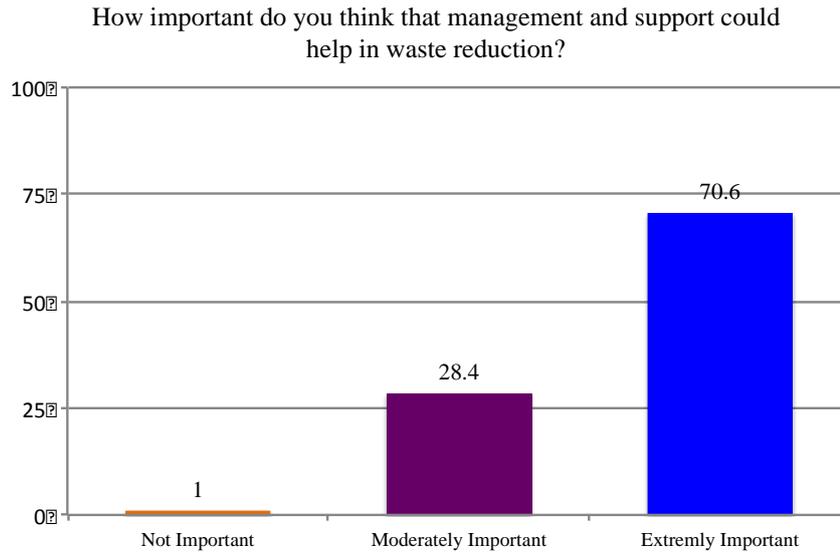


Figure 4.6: Respondents opinion on the importance of having waste management and support for the help of waste reduction

The issue in figure 4.7 of having on-site recycling is complying with proper site planning as respondents stated that on-site recycling would be of help if there is enough space for collecting the waste and provide on-site waste segregation with 55% of highly agreement and 24.8% of moderately agreement. Others have stated that awareness and proper management would be more effective than having on-site recycling with 20.2%.

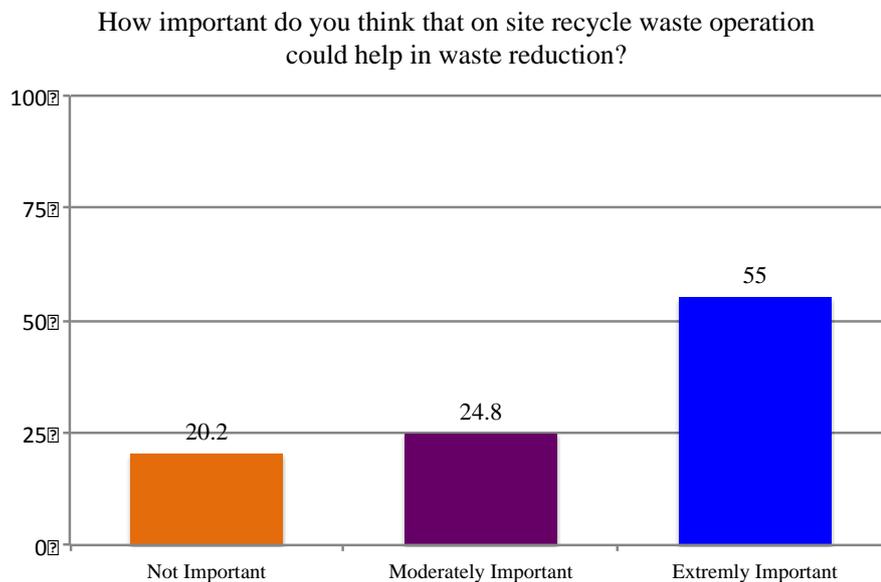


Figure 4.7: Respondents opinion on the importance of having on-site recycling waste operation

Respondents have agreed with 72.5% that this problem is considered for all socials due to the associated aspects related to this problem, such as waste pollution and environmental affects.

Individuals should be more aware about the related problems corporate with the waste generated as cited by 26.2% about the health problems associated with the amount of waste stored on the construction sites. I believe that increasing the awareness of all professionals and also through the government action will be the fastest way of minimizing the construction waste generated.

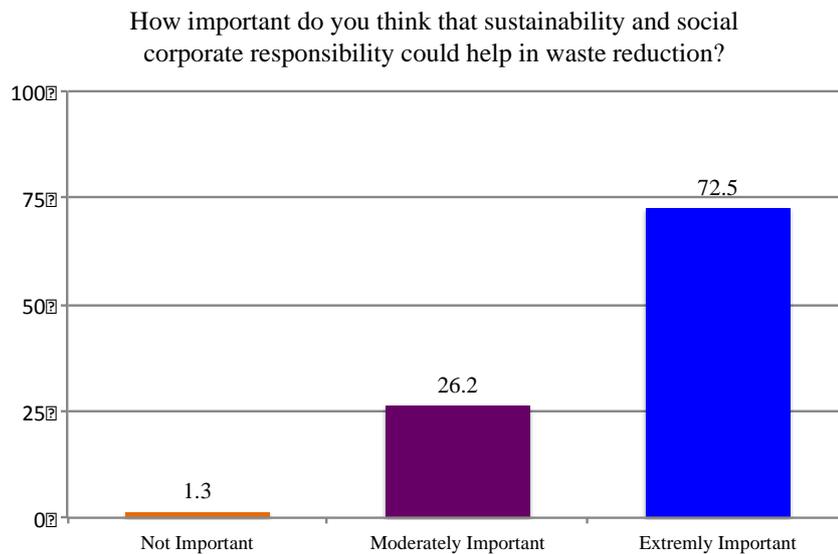


Figure 4.8: Respondents opinion on the importance of social corporate responsibility on waste reduction

If there is no proper plan taken during construction sites on how to segregate the waste and what are the materials that can be segregated then the cost of the waste disposal is not as important as the action need to be studies before as stated by 60.4% of the respondents. There is one major aspect that needs to be known in order to provide a greatest waste disposal for the money being spent for the waste schedule by knowing the proportion of each waste type generated during the construction process as mentioned by 11.4% in figure 4.9.

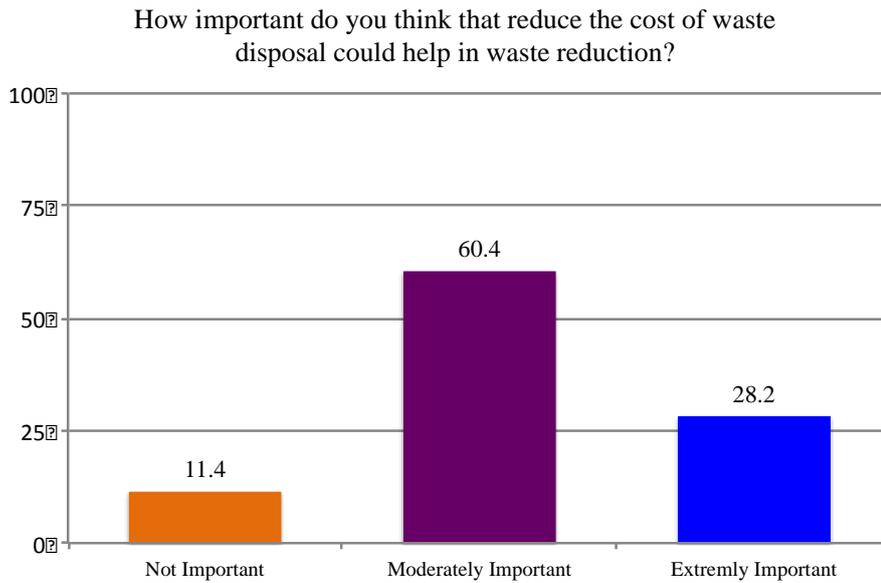


Figure 4.9: Respondents opinion on the importance of reducing the cost of waste disposal

The issue of controlling the waste is covered or taking some attention for the projects achieved sustainability systems such as LEED and/or Estidama due to the mandatory credits requirements that force the contractor and the labors to give some care about the waste control, while in other projects there is no such plan for waste reduction. Most of the respondents 62.5% stated that for the projects that did not meet any credits requirements they do not even provide a waste skips presented on-site, they just collect the waste and allocate it on the side till the site engineer take the action to take the waste to landfills. This issue can be considered of highly importance based on my observation to the construction sites targeted to achieve Estidama which at least provide color coded waste skips and appoint a waste management company as per Estidama requirements, this was mentioned by all parties who experienced Estidama projects before and resulted with 35.1% of extremely important to raise this aspect.

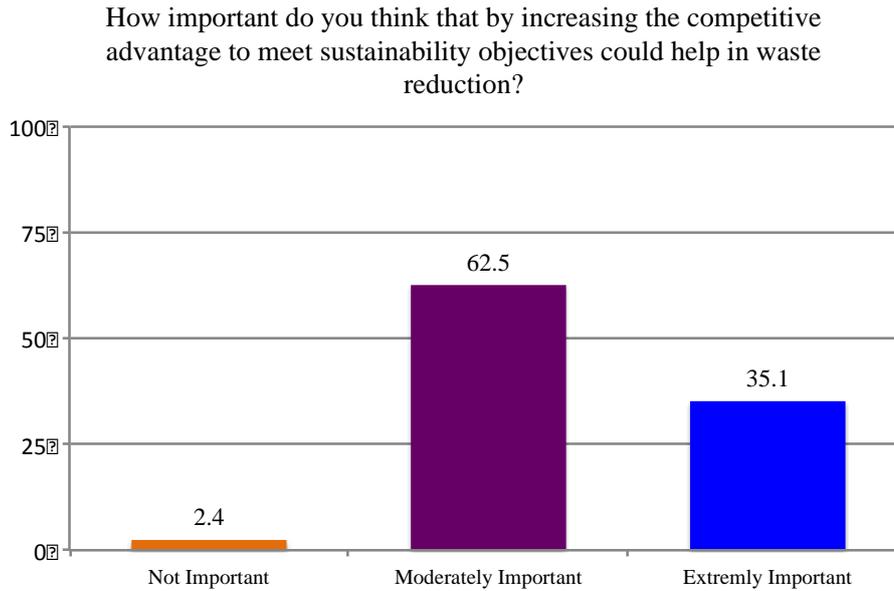


Figure 4.10: Respondents opinion on the importance of increasing the competitive advantage to meet sustainability objectives

The percentages of the highly importance and not importance of providing environmental benefits and credit points awarded in reducing construction waste were almost on the same range due to the importance of other aspects such as increasing the awareness and the government serious action for reducing the waste.

From another aspect 50.2% of the respondents as shown in figure 4.11 have stated that this issue is depending on the project status on achieving sustainable rating system (LEED and/or Estidama). There are no credits or certificates to be issued for the projects that have the least waste generated during construction stage and by providing environmental certificates will help in exciting the stakeholders to control the waste but as long as this issue is optional then nobody will take a serious step in order to achieve it.

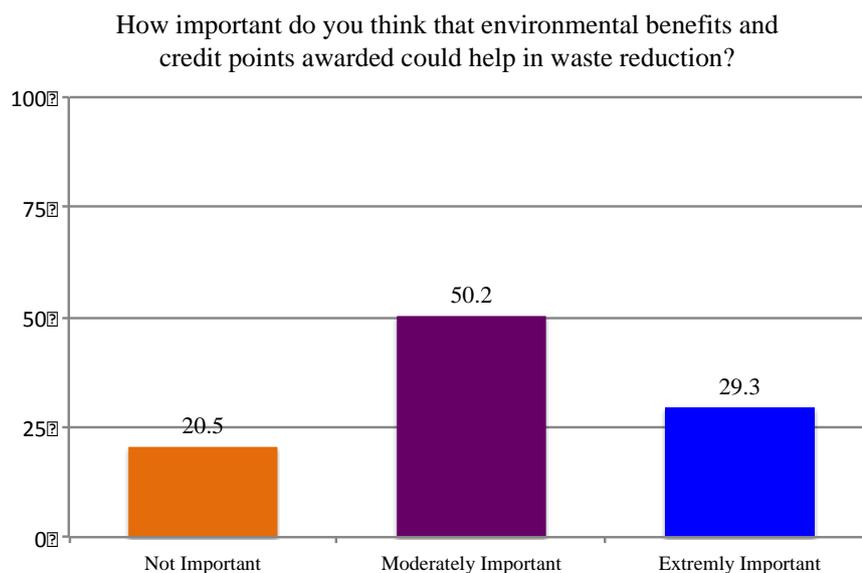


Figure 4.11: Respondents opinion on the importance of providing environmental benefits and credit points awarded for the least construction waste generated

The most important point highlighted by the entire respondents that training will be the first step that will enhance the probability in reducing construction waste along with other aspects. But at least starting with the training awareness in UAE would be of help to overcome the raised issue due to the flexibility and acceptance of the majority of contractors, engineers and labors to attend training workshops to increase workers awareness. This initiative step will be the right step to be taken in the short term of controlling the amount of waste generated during construction sites. 96.5% stating the importance of training awareness even if this step will require some sort of payment as they were believe that this will help the environment thus increase the performance of individuals. The question now is provide workshops to enhance the awareness is enough in order to bring out the desired improvement of waste generation alone without any addition actions from the individuals and the government to be under taken. Since the majority raises the importance of having training awareness then planning for such trainings should be done. This issue will be discussed more in the discussion section.

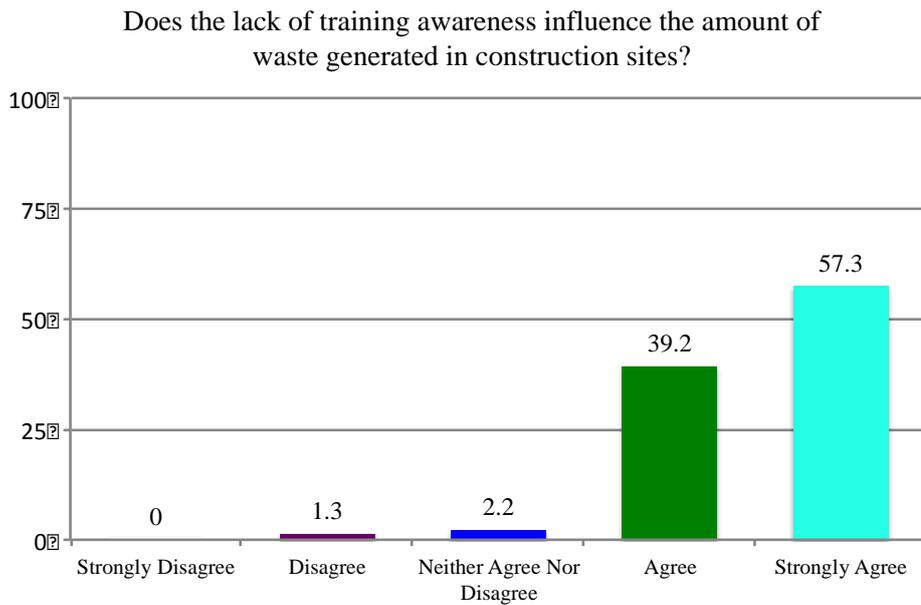


Figure 4.12: Respondents opinion on the lack of training awareness and its influence on the amount of waste generated

Lack of management plan in delivering the material to the construction site since early time of the project creating miscommunication and incoordination as stated by 14.3% of respondents as indicated in figure 4.13. Followed by 38.1% of contractors who believed that the amount of materials being delivered should be documented and studied properly from the design, as the extra materials that are left unattended often created a problem for the project management team as these cause extra waste pollution and need to be stored onsite until such a time that it can be taken away. 25.4% of respondents are agree from the side that the materials should be more planned and scheduled for the time to be delivered to the site and from another side they believe that even so if there will be a proper waste management plan and regular housekeeping control the problem can be avoided.

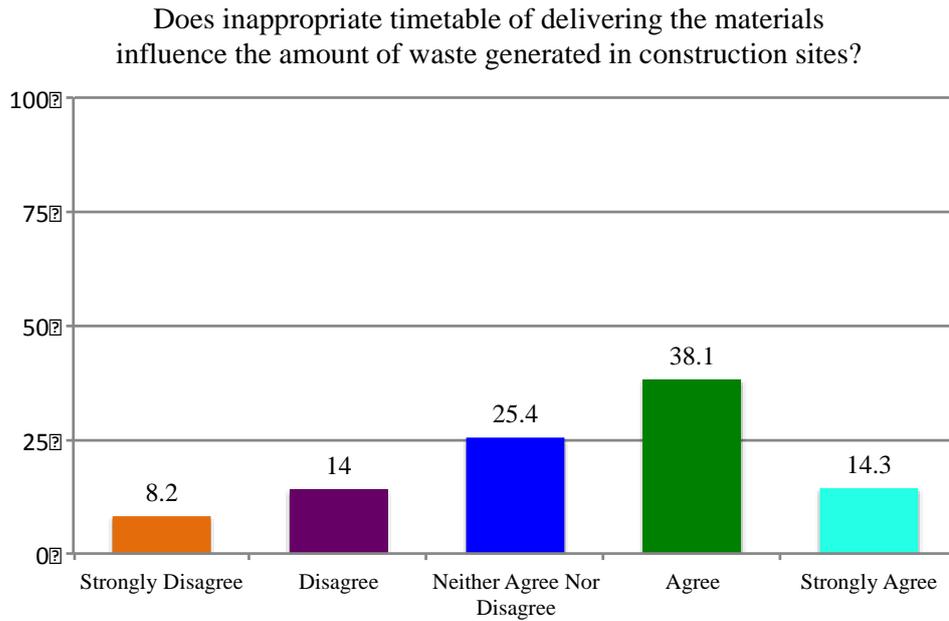


Figure 4.13: Respondents opinion on the inappropriate timetable of delivering the materials to the construction sites

The waste management tools would be of value if the construction waste management plan (CWMP) has been studied properly before the final implementation to make sure of its effectiveness and initiatives as shown in figure 4.14 with 77.8% of agreements on the interest towards this method.

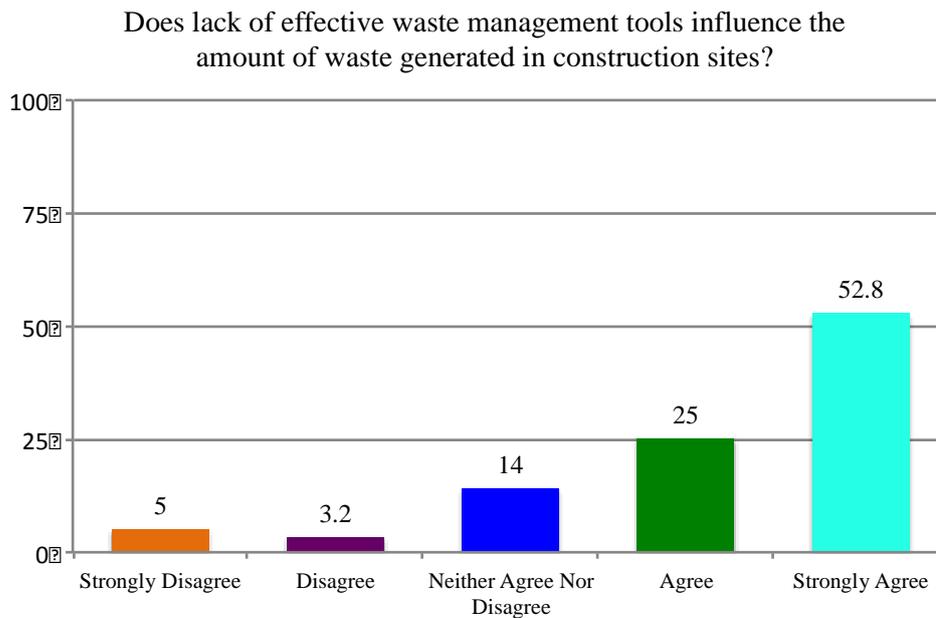


Figure 4.14: Respondents opinion on the effectiveness of waste management tools

Different cultures, different mentalities are one of the important points that need to be addressed, labors come from different countries under different behaviors and they require a proper instructions and processing to be followed in order to overcome and minimize such problem. The rates are shown in figure 4.15 showed the respondent’s opinion on the different labors culture and behavior and does that influence the amount of waste generated. One of the requirements stated by Estidama was to provide waste signage for all waste skips in three different languages: English, Arabic and uredo taking in consideration that labors are coming form different cultures.

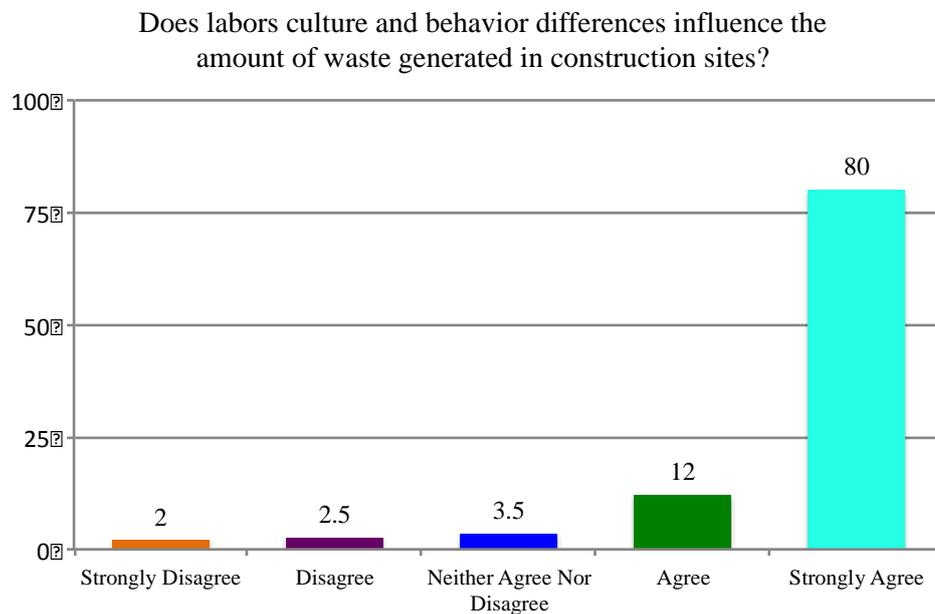


Figure 4.15: Respondents opinion on the labors culture and different behaviors

The lack of promotion on the waste minimization tools was one of the aspects being asked in the survey and the rates indicated in figure 4.16 shown that this point has linked to the training awareness, full training program for all responsible parties are a must for those who are going to supervise, coordinate and work in the project by providing list of solutions on waste reduction through brochures to be followed during construction stage, as there is no action has been taken yet for waste minimization.

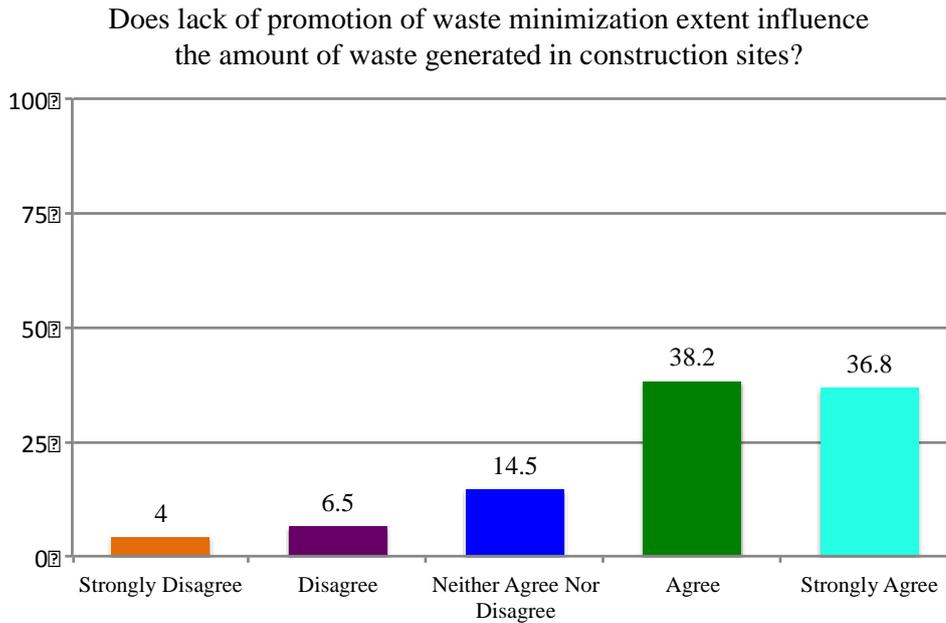


Figure 4.16: Respondents opinion on lack of promotion of waste minimization extent

It is mandatory for the contractors being assigned for any project targeted to achieve the sustainable rating system (LEED and/or Estidama) to attend awareness program for waste reduction as shown in figure 4.17 that 32% of the contractors experienced Estidama projects before have been attended such workshops and 68% of the respondents have not attend, as long as this training is not part of the construction procedure, it will not get any attention from the professionals.

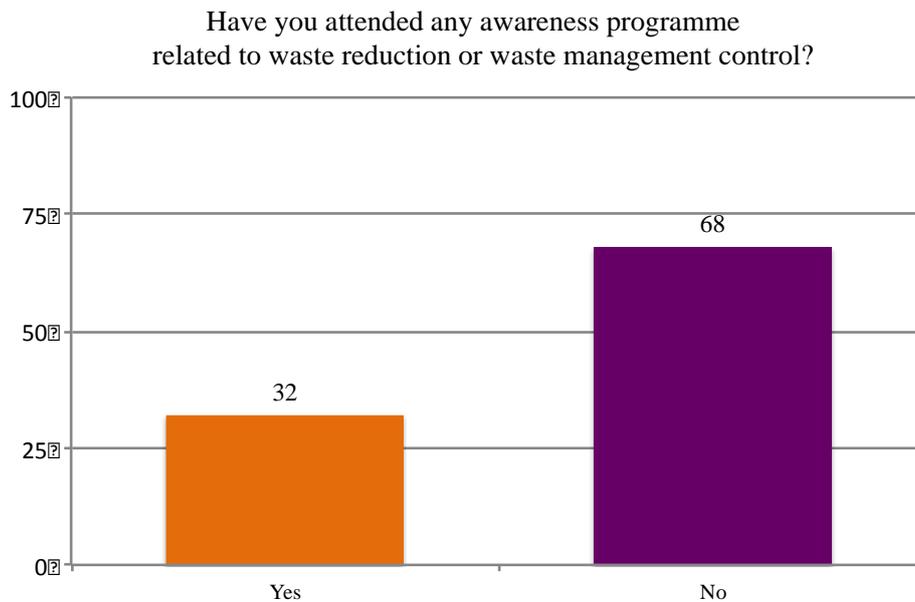


Figure 4.17: indicates the percentage of those who attended any awareness programme related to waste reduction

The government has taken no serious action regarding this issue as 60% clarified that governments need to improve its roles and mandatory procedures that need to be followed in every construction project as clearly shown in figure 4.18.

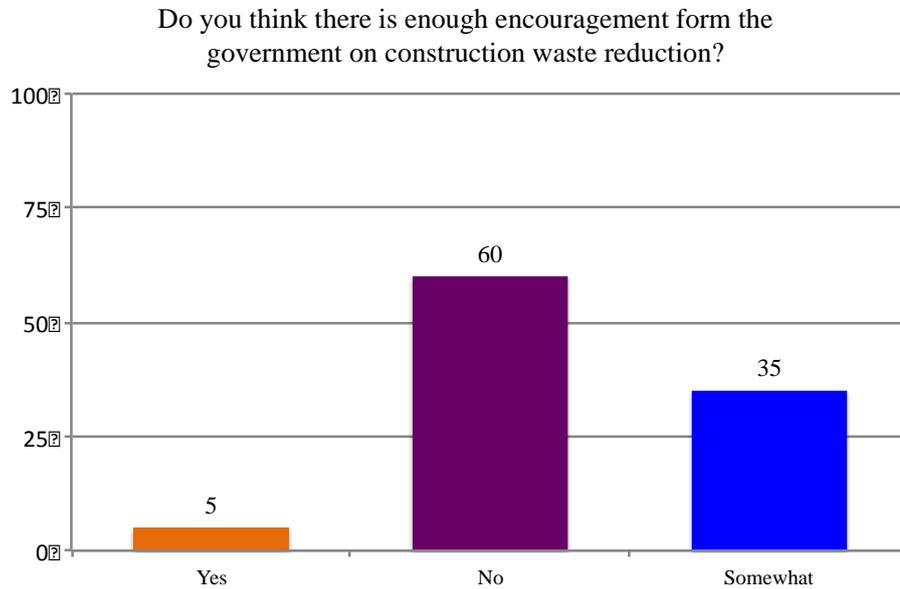


Figure 4.18: Indicates the percentage of the government action on construction waste reduction

A general understanding of all raised factors illustrated from the survey questioners that all construction stakeholders are willing to improve the status of construction waste generated with strong intentions to save the environment and provide clean firm of sustainability for all construction projects.

The findings of the survey have been taken in consideration while revising the current status of waste reduction in the construction industries, as seen in chapter 6. The most significant outcome understood from this survey is to enhance the level of knowledge and awareness among all professionals and to provide effective waste management plan and ensure its quality assurance before implementation. Alongside these concerns the government needs to provide a stable plan to be followed as part of the construction process.

In conclusion, simple and specific data analyses were used to identify the results of this research paper. Present a clear and original opinion about the topic will help in Derivative the main points and make the results easy to understand and to be followed by the corporate construction team members.

Chapter 5: Case Study Selection, Analysis & Results

This section will discuss the selected case study and highlight the design and construction requirements as per Estidama system for the selected project and summarize the results being achieved through the comprehensive study and observation by the author.

5.1 Case Study Selection:

Although using a case study, as one of the methodologies to conduct a research but the selection should be made upon a strong reason, the reason behind this selection was because the author was working as an Estidama consultant for this project since early stages of the construction process. Experiencing real life scenarios will make you go more in details in dealing with such projects and force you always to find solutions in order to get over the small difficulties that might face you during the construction stage.

Due to my job position as a sustainability consultant in one of the consultant companies in Abu Dhabi, handling both Estidama design and construction stages, I decided to choose one of the projects that I was working on in order to get information's as much as I can and to discuss my experience with the project. At that time when I started working on my thesis I was responsible for 12 projects on the construction stage running at the same time, some at Abu Dhabi area and some at Al-Ain city.

The case study selected is a kindergarten located in Abu Dhabi, UAE. The main objective of the project is to develop a kindergarten that achieves 2 pearls from the pearl rating system as per "Estidama" requirements; by utilizing all sustainability practices that help in protecting the environment during its operations and fulfill a sustainable development to the best possible extent. Table 5.1 includes a brief description on the selected case study.

All construction projects were facing mostly the same problems during the construction stage especially if it was targeting Estidama rating system. And based on that fact I choose one of these projects to explain all the difficulties which may affect in controlling the waste. Furthermore, identify the gaps behind the housekeeping in the construction sites are one of the aims of this research that need to be answered.

The site construction was started on December 2014 and the total duration was planned for 12 months based on the client requirements. The project was targeted 2 pearls rating system during the design stage by DEWAN Company, which means that the project should get the 2 pearl rating during the construction process as well.

In order to handle any Estidama Projects you should have to be a certified PQP, which means that you're a certified professional who attended and passed Estidama exam.

Table 5.1: Case study analysis (Source: Author)

| | Case Study | |
|--------------------------------|---|----------------------------|
| Site Location: |  | Located in Abu-Dhabi, UAE. |
| Description of the project: | <p>Al-Bahya Kindergarten.</p> <p>It is a one-story building with total area of 4775m².</p> <p>The project was set to achieve the sustainability goals based on Estidama principles. The target is to meet the sustainability requirements set by Abu Dhabi Urban Planning Council (UPC) as captured within the framework of the Pearl Building Rating System. The project was awarded for 2 pearl rating building.</p> | |
| Client: | Abu Dhabi Education Council (ADEC) | |
| Contractor: | Medium size organization | |
| Workforce | Mostly Indians and Pakistanis | |
| Methodology used: | Survey Questioners, interviews and site observation. | |
| Respondents' | Contractor, construction manager and site engineer. | |
| Procurement strategy: | Waste management company (WMC) was hired since early stages due to Estidama requirements. | |
| Construction waste quantities | It is part of Estidama requirements to keep records on the amount of waste being transferred to landfills or recycled destinations. Waste records are not well documented for this project due to the lack of awareness on how to segregate the waste and make a proper control. | |
| Waste management program (WMP) | Although WMC was hired since early stages of the projects, thus no proper follow up and lack of management was occur. | |

Al Bahya kindergarten faced many difficulties in achieving Estidama pearl rating system and the reasons behind these obstacles will be presented in section 5.4 of this chapter and how did they mitigate the problem with the help of all stakeholders.

5.2 Design basic requirements:

In every project, which will achieve any of the sustainability system such as Estidama rating system, estimated calculations and handling procedures should be done for both construction and operational waste control.

Based on Estidama requirement for the mandatory credits related to construction waste management, there is a waste calculator which should be filled based on the gross floor area of the project, number of students, and other technical factors that will automatically calculate the percentage of the estimated construction and operation waste. The calculator can be downloaded from Estidama website www.estidama.upc.gov.ae for every Estidama project, Table 5.2 extracted from Estidama waste calculator for Al-Bahya Kindergarten during the design stage.

Table 5.2: Estidama waste calculator during the design stage of the project showing the estimated % of the recycled waste in the construction stage

| Estimated Construction and Demolition waste | Generated | Landfilled | Salvaged/ Recycled | Salvaged/ Recycled |
|---|-----------|------------|-----------------------|-----------------------|
| | Tonnes | Tonnes | Tonnes | % |
| Demolition waste | 0 | 0 | 0 | 0.0% |
| Construction waste | 504 | 96 | 408 | 81.0% |
| Total waste | 504 | 96 | 408 | |
| Percentage of Construction and Demolition waste recycled/salvaged | | | | 81.0% |

The figure showed that 81% is the expected amount of waste that can be salvaged and/or recycled during the construction stage, which mean that 19% of the waste was expected to be only the landfilled amount going to be burial as shown in figure 5.1.

Construction and Demolition Waste: 504 tonnes

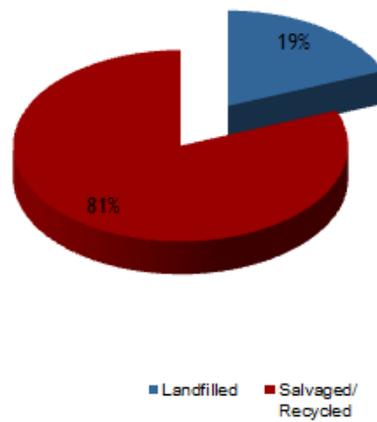


Figure 5.1: The estimated % of waste going to be recycled and/or landfilled during the construction stage (Source: Estidama Calculator)

Not all what is expected during the design stage can then be achieved and awarded in the construction stage due to so many pitfalls faced during the construction.

Also, Estidama calculator calculates the percentage of waste that can be treated and achieved during the operational stage. The amount of paper and cardboard is 14 tonnes per annum (tpa) expected to be generated during the operational stage as per Estidama estimated calculation from the design stage, 8 tpa of paper and cardboard is going to be treated and recycled as identified in figure 5.2 while the rest 6 tpa will be sent to landfill destinations. For metal, glass and non-hazardous waste the expected amount generated were 1 tpa. For the plastic waste the total expected amount was 4 tpa half of it was expected to go for recycling and the second half will be treated to be recycled. Then the organic waste is going to the landfilled area as shown in figure 5.2.

Operational Waste: 25 Tonnes per annum

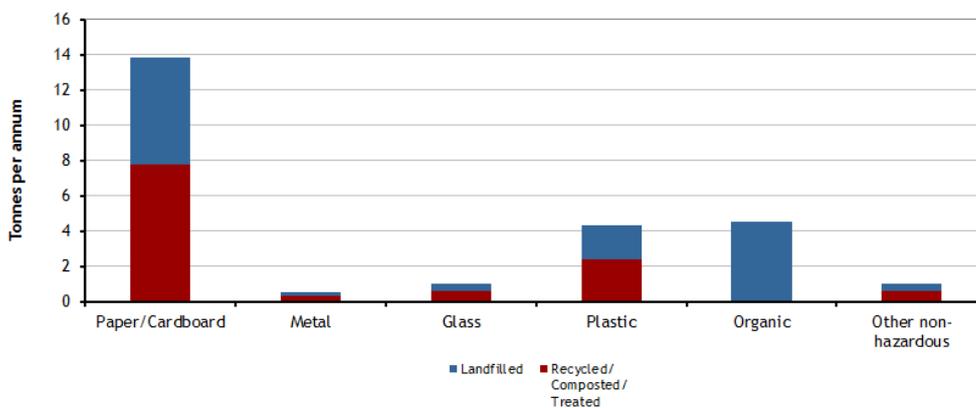


Figure 5.2: The estimated % of waste going to be recycled and/or landfilled during the operational stage (Source: Estidama Calculator)

5.2.1 Expected Project Waste, Disposal, and Handling:

Table 5.3 identifies waste materials expected on this project, their disposal method, and handling procedures before the construction started which should be followed during the construction stage in order to prevent any critical issues related to waste control or recycling management:

Table 5.3: Expected waste to be generated during construction stage for Al-Bahya Kindergarten (Source: Author)

| Material | Quantity | Disposal Method | Handling Procedure |
|--|---|---|---|
| General Waste (This Include all the non-Recyclable waste produce In the site) | A skip of 20.5 tones | This waste should be directed to Al Dhafra Landfill. | Keep separated in designated areas on site. Place in General Waste container. |
| Food Waste (This includes the food Waste or any other non- Recyclable compactable Waste) | A skip of 12.5 tones Covered with flat lid | This waste should be directed to Al Dhafra Landfill | Keep separated in designated areas on site and it should be collected by using a compactor truck. |
| Plastic | A skip of 42 tones | This will be sent to Musaffah Re-cycling area once the skip Is full & segregated. | Keep separated in designated areas on site. |
| Concrete (This include concrete & concrete blocks Which cannot be reused) | A skip of 8 tones | This should be sent to Al Dhafra crusher once the skip Is full & segregated | Keep separated in designated areas on site. |

| | | | |
|--|--|---|---|
| Cardboard& Paper | A skip of 50 tones | This should be sent to Musaffah Re-cycling area once the skip Is full & segregated. | Keep separated in designated areas on site. |
| Wood Waste (De-nailed wood) | A skip of 50 tones | This should be sent to Union Paper Mill, Al Quoz for Re-cycling once the skip Is full & segregated. | Keep separated in designated areas on site. |
| Hazardous Waste This includes Contaminated soil, Empty paint/chemical Cans, oily rags etc... | This waste will be packed individually In specialized bags (Jumbo bags) suited for any hazardous application | The contractor will dispose or treat these material as per AD CWM centre regulation. | Keep separated in designated areas on site. Place in “Hazardous waste skip” |
| Metal Waste (This include steel rods, Plates,nets etc..) | A skip of 20 tones | This will be send to Pan Middle East yard in Musaffah once the skip is full & segregated | Keep separated in designated areas on site. |

Table 5.3 summarized the expected waste to be generated during the construction and what was the correct action to be taken once the skip of each type of waste is full and correctly segregated.

5.3 Construction Basic requirements:

In every construction project targeted to achieve Estidama system, PQP has to conduct a workshop to the contractor and to the safety site engineers explaining all Estidama requirements in relation to waste control, material submittals and procurement. One of the most important issues that raised during the workshop is the waste management; as all PQP’s were aware that in every construction project they ended up facing a very critical issue and putting

the project on high risk to achieve the pearl rating system due to the uncontrolled housekeeping and the unmanaged waste.

There are several requirements that need to be studied and followed before starting the construction work such as:

5.3.1 Construction Waste Management plan (CWMP)

Waste Management Plan (WMP) has to be developed and implemented during Construction Stage to channel the construction & Demolition waste through orderly manner for recycling or salvage. The Plan includes both Construction and demolitions waste but wastes such as hazardous waste are not included due to its requirement of specialized treatment. The target of the Plan is to manage minimum of 30 % of the total waste produced in the site in order to achieve the mandatory credits of Estidama. In the design stage there they were supposed to achieve 70% in order to get the maximum credits for Estidama but due to the unmanaged control of waste it was difficult to achieve this percentage and focused on the mandatory requirements only.

Before any construction begins, the contractor has to update the CWMP as required, and sign a contract with a waste management company to transfer the recyclable waste to recycling haulers whenever the skips are full.

5.3.2 Waste Disposal Company:

As part of Estidama requirements, the contractor is required to provide the official PQP of the project with the prequalification of the waste management company to get the official approval about the company. And in order to get the approval, the company should be listed under TADWEER which is the center of Abu Dhabi waste management to make sure that the company has the required garbage skips to be presented on-site during construction process. M/s TRASHCO L.L.C has been appointed for the waste management services of the kindergarten as they are established in the UAE since 1977 and it is a waste management subsidiary of SUEZ ENVIRONMENT.

Trashco Company was required to submit a monthly report along with the copy of trip sheets with a stamp on it as an acknowledgement from the final destination.

5.3.3 Signage requirements:

The signage requirements will be identified in the CDWMP and implemented in conjunction with the waste management contractor. Information prepared as part of the Primary Contractors CDWMP will identify the types and quantities of waste arising from the development and should be used to determine the number and type of containers required to store the different waste streams. The signage should be written in three different languages due to the different cultures of the labors as shown in figure 5.3 and the waste skips should be color coded system to identify containers for different waste materials as part of Estidama requirements.

Signage is one of the most helpful aspects that should be presented on-site in order to make it easier for the waste responsible party to make segregation and control the waste.



Figure 5.3: Waste signage requirements presented in three different languages as per Estidama requirements (Source: CWM.ae)

5.3.4 Waste Manifests

The contractor has to provide the PQP with a clear evidence of waste manifests for the purpose of waste calculation as per Estidama requirements.

Every waste being shifted from the site has to be recorded with the waste type, the quantity of waste either by volume or weight, recycled or landfilled and the hauler company information. All these data should be filled inside the manifest as part of Estidama requirements and for the PQP to update the waste calculator. Figure 5.4 shows a sample of the waste manifest created by the center of waste management in Abu Dhabi.

Figure 5.4: waste manifest sample created by CWM for the waste producer (Source: CWM.ae)

5.4 Case study results & analysis:

As part of Estidama requirements, the official PQP has to visit the site on weekly basis in order to check on the work progress, waste tracking, waste management and provide minutes of meeting in each visit for the purpose of records and follow up.

During the walkthrough visit, the PQP highlighted the poor control of waste on the site and thus required a meeting with the contractor in order to discuss this issue.

The contractor has stated that the waste cannot be controlled during the construction specially when there are construction activities adding that the site is busy with lots of materials which has been delivered to the site without any planning or schedule.

Alongside these concerns, segregation and waste tracking are required and need to be emphasized in every construction project. The selected case study (Al-Bahya Kindergarten) resulted in a very poor segregation plan although the kindergarten was designed to achieve Estidama pearl rating system; and due to the bad segregation and the additional materials being stored in the construction site, delay in the completion of the project and also in Estidama construction stage awarded. There were no proper housekeeping during construction, which was resulted in delay in the project; no tracking table was designed to transfer the waste to the proper location for treatment or disposal.

Garbage bins are only highlighted within the sustainable rating systems weather Estidama or LEED, color coded bins and clear signage for waste segregation are one of the solutions that lead workers to understand and follow the strategy of splitting the waste each with its specified containers and that waste reduction and a zero infection on the environment will be achieved.

During the walkthrough visit, photographic evidence has been taken in order to record the waste management issue in the site. Figure 5.5 shows the color-coded skips presented on site. However not all the skips were presented with signage and this issue has been raised and discussed with the contractor in order to provide them to the site as soon as possible as part of the requirements in addition to its importance on how to segregate the waste each in its specified container. Different cultures, different mentalities are one of the important points that need to be addressed, labors come from different countries under different behaviors and they require proper instructions regarding the waste signage and the use of different skips.



Figure 5.5: Waste skips presented on the construction site with the signage (Source: Author)

The skips were presented on site without any instructions to the labors on how to segregate the waste on each skip; the red skip was designed for the plastic waste collection while the container was mixed of concrete, sand and plastic. This skip cannot be sent to the recycled area as it should be properly segregated and all the waste collected inside the red skip should be only plastic waste. However, this skip will be sent to landfill due to its bad segregation. Figure 5.6 showed the poor segregation inside the plastic collector bin.



Figure 5.6: Poor segregation inside the plastic skip (Source: Author)

Waste management companies are also required to be trained and be aware about the consequences behind the waste production and provide suitable timing and schedule to convey the generated waste to landfills or treatment locations, this is one of the points being raised and discussed with the contractor that once the skips being full of waste, the labors start collecting the waste on different locations on the site which leads to disruption to the workers and create lack of management plan in delivering the material to the construction site since early time of the project creating miscommunication and incoordination. The amount of materials being delivered should be documented and studied properly from the design. As the extra materials that are left unattended often created a problem for the project management team, as these cause extra waste pollution and need to be stored onsite until such a time that it can be taken away. Figure 5.7 clearly showed the amount of material stored on the site without any previous planning of timetable for delivering the material on site.



Figure 5.7: Storing material on the construction site (Source: Author)

There is minimal knowledge on how to segregate the waste and what are the materials that considered as hazardous material and need special treatment. Hazardous materials were

observed on-site distributed around the site without any coverage and wrapping containers. Figure 5.8 showing the hazardous materials presented on-site during the construction work, this was resulted due to the lack of knowledge of the workers on the harm and damage that could be presented from the unmanaged control and action required to deal with the hazardous materials.



Figure 5.8: Hazardous material on the construction site (Source: Author)

After the completion of the project the amount of waste generated 1653 ton was much higher than the amount of waste estimated 504 ton which is 3 times higher than the expected.

The quantity of waste being sent to landfill destination 680.427 tons is almost near to the amount of waste being recycled 680.427 tons, which means that poor knowledge and lack of awareness prevented from segregate the waste properly and send it to recycling destinations instead of being landfilled. In order the waste to be sent to recycling area needs to be segregated accordingly and to be checked before collected and transferred from the site in, any mixed waste collected in other skips than the general skip will be sent to landfilled directly.

What were observed in the selected case study are the poor segregation habits and poor housekeeping behaviors. Figure 5.9 showed the sub-total quantity of waste extracted from Estidama waste inventory.

| Construction Waste Inventory Form | | | | | | | | | | |
|--|----------------------|------------------|------|-----------------------------|-------------------|-----------------------------|----------------|-----------------|-------------------|------------------------------------|
| Project Plan : Al Bahya Kindergarten | | | | | | | | | | |
| Project No. : AD259 | | | | | | | | | | |
| Subject: ESTIDAMA Construction Rating (PBR5) | | | | | | | | | | |
| Month and Year Jul-14 | | | | | | | | | | |
| Date completed: 7/28/14 | | | | | | | | | | |
| Data Recorded by: Mina Yahya | | | | | | | | | | |
| WASTE TYPE | | UNIT | | Date | RESPONSIBLE PARTY | | | COMMENTS | | |
| S/N | Material Description | m3 | tons | Exact date | Invoice number | Hauler/Recycling Receptient | Re-used (tons) | Recycled (tons) | Landfilled (tons) | Market for Recycled /Salvaged item |
| 5 | | | | | | | | | | |
| TOTAL Waste | | 1653.5405 | | Sub Total | | | 973.114 | 680.427 | | |
| | | | | Recycling Percentage | | | 58.85 | % | | |

Figure 5.9: Sub-total of the recycled and the landfilled waste generated during the construction stage of Al-Bahya Kindergarten (Source: Estidama construction waste inventory form)

The largest amount of waste generated was concrete, which was resulted in 787.954 tons and the second largest amount was wood for 175.31 tons sent to recycling destination. While the lowest quantity of waste generated was for paper and cardboards resulted in 2.18 tons. Table 5.4 identifies the amount of each type of waste sent to recycling destinations.

Table 5.4: Sub-total of the waste quantities sent to recycling destinations (Source: Author)

| Waste Type | Waste Quantity (Generated) Unit: Tons | Waste Quantity (Expected) Unit: Tons |
|----------------------|--|---|
| Wood | 175.31 | 50 |
| Concrete | 787.945 | 8 |
| Metals | 4.15 | 20 |
| Paper and cardboards | 2.18 | 50 |
| Plastic | 4.52 | 42 |

The amount of waste shifted to landfill destinations is shown in table 5.5, which shows a very high amount of mixed waste with about 680.427 tons sent to landfill area. This amount was supposed to be controlled and segregated in order to reduce the amount of landfilled waste and increase the percentage of recycled waste.

Table 5.5: Sub-total of the waste quantities sent to landfill destinations (Source: Author)

| Waste type | Waste Quantity |
|-------------------|-----------------------|
| | Unit: Tons |
| Mixed waste | 680.427 |
| Food waste | 36 |

Contractors should do more effort on the awareness of his labors about the importance of housekeeping and it should be applied at least once a day due to the minimal background of the worker regarding the waste issue. In conclusion the amount of recycled waste was 59% which means that 41% is the amount of waste being landfilled. Figure 5.10 shows the final % of waste calculated at the completion of the project based on the waste manifests supplied and submitted to the PQP on a monthly basis for the records and the purpose of updating the construction waste inventory form as per Estidama requirements.

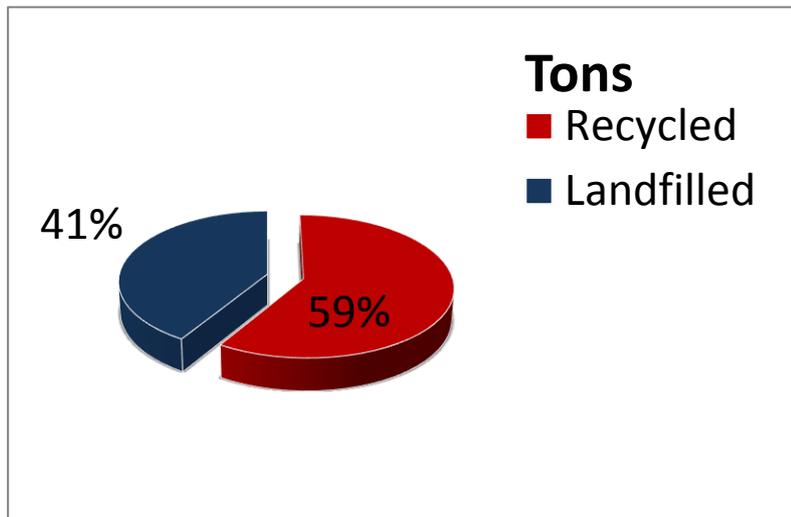


Figure 5.10: The total % of waste calculated after the completion of the project (Source: Author)

Due to the huge amount of waste generated during construction process which is almost three times higher comparing to the expected amount to be generated and based on the site inspection which was conducted on weekly basis and the improper waste control observed, the main causes of the construction waste generated in the selected case study Al-Bahya Kindergarten can be concluded as follow:

- Poor workmanship.

- Poor segregation and housekeeping.
- Lack of labor awareness.
- Lack of workshops and instructions.
- Lack of waste management plan.
- No appropriate waste signage for all waste skips.
- No allocated space for waste segregation was observed.
- Inaccurate quantities and not planned timing for delivering the materials.

Chapter 6: Discussion on the Current Situation of Waste Reduction in UAE and the Revised Recommended Sustainable Solutions based on Stakeholders Feedbacks

Sustainable solutions in terms of waste management and related pollutions will be presented in great detail in the following section, providing an insight into the possible methods that could promote waste reduction and sustainable environments in a construction site based on the results achieved from the survey questioners, literature review and the selected case study.

This section of the study will analyze the results indicated from the selected methodologies and focus on a package of solutions that are meant to address the waste pollution in UAE construction sites through evaluated solutions stemming from previous studies, which compare the existing UAE constructions sites with other countries. While the sites utilize an almost standardized construction procedure during various phases, the study will focus on the relationship of the activities with the existing waste management reduction.

This section will highlight the current status of UAE regarding the pitfalls faced during any construction process within UAE construction sites followed by the current legislations and the governmental action in addition to the suggested solutions that concluded from the results analysis in order to provide a set of sustainable solutions to reduce construction waste.

6.1 Current status in waste reduction on construction sites in UAE regarding the following aspects:

6.1.1 Weak waste collection:

Waste collection has been mentioned as one of the most important interventions that can be used in the effective reduction and management of waste from construction sites (Lee & Harrison, 2010). This is because with an effective waste collection system, wastes do not get piled up on construction sites to create attendant discomforts and problems. For example having wastes piled up at construction sites for days could lead to pollution issues including air and land pollution (Acharva & Lee, 2005). What is more, piling wastes on construction sites could trigger diseases when wastes are not collected for a long time and they begin to decompose on the site (Hudson & Willekes, 2000). Sadly, Filiz (2012) observed a situation in the UAE where the collection practices are wholly inadequate, compared to the current needs of the construction industry of the country. What this means is that the current status of waste collection is weak as the collection systems do not meet the requirements of the industry.

It was for example noted that with 9,657,420 tonnes of wastes produced on construction sites in UAE, only 15% are collected on the same day. Meanwhile, 40% of the remains on are collected within a week, and as many as 35% of the wastes remain uncollected for months.

Unfortunately, the 10% of the wastes remain on the sites even after a month. This statistics is further displayed in the figure 6.1.

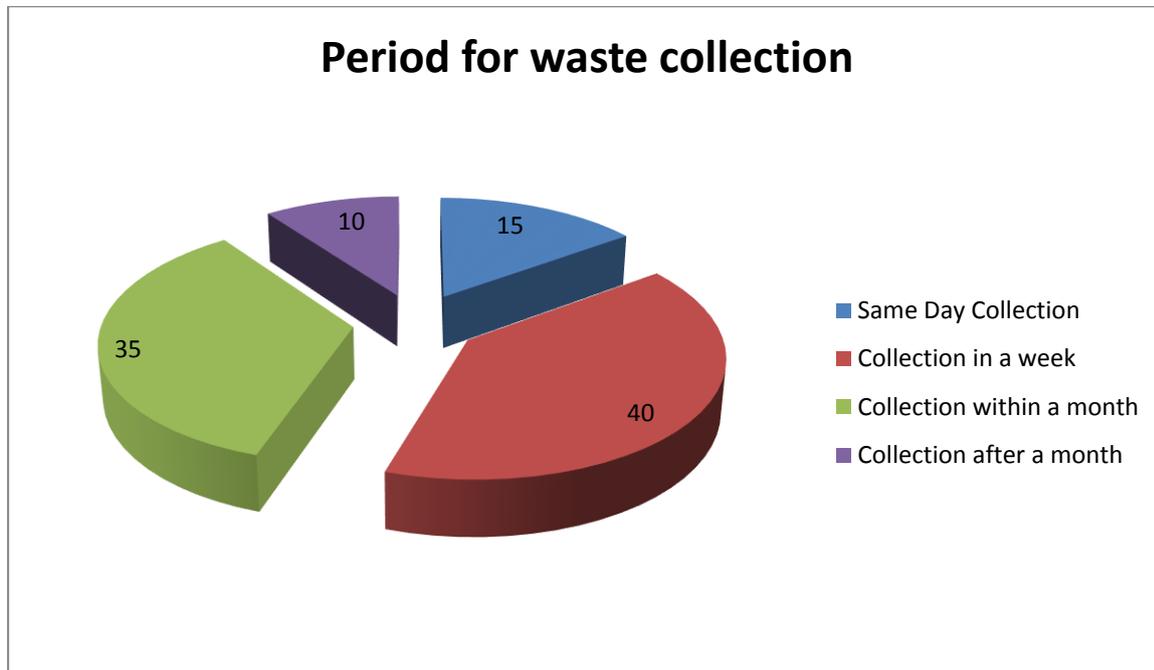


Figure 6.1: Period for waste collection on UAE construction sites (Source: Banerjee, 2014)

As far as waste collection best practices are concerned, it is expected that wastes will be collected within 24 hours that they are produced (O'Toole, 2012). This is because doing so minimizes the risk of harm they could cause. Discussing the current status of waste collection in UAE therefore, it can be said that the collection system has a potential of leading to serious impacts from waste produced at the construction sites. The current situation is certainly alarming and calls for pragmatic interventions or solutions to be put in place in reducing the possible havoc from waste on construction sites.

6.1.2 Weak waste transportation:

Zohar & Luria (2013) observed a very close link between waste collection and waste transportation. This is because when wastes are collected, it is expected that they will be transported to the appropriate waste management sites. What is more, wastes collected are expected to be handled very well during their transportation so that they will not end up creating more mess on the way. The current status of waste transportation in the UAE has however been described as weak and inappropriate (Kumaraswamy & Chan, 2009). This is largely because of the issue of lack of proper waste transportation system that can be considered as effective.

For example in a study by Zhu et al. (2010), it was noted that there is an over dependence on Dubai when it comes to waste transportation system. What this means is that it is only in this city that an effective waste transportation system can be found, leading to pressure from the transportation system there from other parts of the country.

In a related study, construction site managers expressed their frustration with difficulty in getting wastes successfully transported from their sites to the waste management sites. The table below shows the responses of construction site managers regarding their current status about waste transportation.

Table 6.1: Current status of waste transportation in UAE (Source: Chan & Kumaraswamy, 2013)

| Variable | Percentage |
|---|------------|
| Have private transport means sufficient for the waste produced from site | 7% |
| Have private transport means but insufficient for the waste produced from site | 14% |
| Relies on both private and public transport of waste | 23% |
| Rely on solely on public/commercial transport, which is effective for the waste produced from site | 23% |
| Rely on solely on public/commercial transport but is not effective for the waste produced from site | 33% |
| Total | 100% |

Table 6.1 certainly shows a very worrying situation that currently faces UAE in its waste transportation system. This is because only 21% of the population of construction site workers has private transport means. Meanwhile, the use of private transport is generally considered effective since they can be available for use at any point in time. Unfortunately however, of the 21%, only 7% found their private transports sufficient for the wastes they produce. It is not

surprising that 23% of the people use both private and public transport. With the high dependence on public transport for waste, it is important that that sector will be revamped and improved for effectiveness.

6.1.3 Improper waste recycling behaviors:

Recycling has been mentioned as one of the most effective approaches to waste reduction (Arslan & Kivrak, 2009). In a study by Flanagan and Norman (2013), it was noted that the practice of recycling helps to reduce the presence of waste by more than 80%. This is largely because of the potential of most materials, particularly those within construction sites to be recycled. Studies about recycling in the UAE have therefore been widespread, all of which aim at finding ways in which UAE have benefited from recycling so far and how it can benefit further from the practice. Unfortunately, Jaselskis and Ashley (2011) lamented that the attitude of construction stakeholders, particularly engineers, project managers and contractors in general towards recycling has not been positive. This is because most of these stakeholders seem not to believe in the power and value of recycled products when compared to fresh raw materials. The result of this situation is that people involved in construction have always looked for newer raw materials to use when they could indeed recycle excess and waste products and put them to more meaningful use.

Because of the lack of preference for recycling, this has led to different forms of improper waste recycling behaviors on construction sites. For example less time has been committed to recycling in terms of research and development (R&D) (Kumaraswamy & Chan, 2009). The funding of projects involving the use of recycled materials have also not been forthcoming with compared to funding received for most forms of fresh and traditional raw materials (Chan & Kumaraswamy, 2013). There has also been a situation where recycling is not opted for by contractors at all. These improper waste recycling behaviors sadly happen to be the current situation that can be found on construction sites in UAE. Due to the neglect for waste that could have been recycled into other meaningful and useful products, it is common to find all these wastes piled up at construction sites. The apathy towards recycling has also currently increased pressure on dumping sites because if the materials were recycled, they would not have gone to the dumping sites at all.

6.1.4 Lack of awareness and education regarding the importance of waste reduction:

Flanagan and Norman (2013) opined that with the right form of education and awareness on waste reduction, all stakeholders whose activities and actions border on the production of waste will be more careful when handling waste. Unfortunately, the UAE currently experiences a situation where there is lack of awareness and education regarding the importance of waste reduction. What this implies is that at the current situation, people who ought to be aware and educated on why it is important for them to be conscious of reducing waste do not have this form of awareness and education in UAE (Gerstel, 2001). This lack of awareness and education has also resulted in its own attendant problem where people engage in waste production without really knowing the effect of their actions. Hutchings and Christofferson (2001) admonished that for people who are aware of the outcome of their actions, such people are likely to be more careful in their dealings regarding waste.

To discuss the situation described above, it can be said that people with awareness and education understand that the impact of their actions could go down to affect both the current generation and generations unborn. On the other hand, those who lack awareness and education are likely to engage in bad practices towards waste production with impunity. As the latter is the current situation facing UAE, it can be implied that the country is currently heading towards an era when people will continue to engage in waste production rather than waste reduction. It is not surprising that Jaselskis and Ashley (2011) found that in the last decade, the number of waste produced from construction sites in UAE has been increasing by the years. Surprisingly, figure 6.2 shows that there are other industries that have successfully reduced the quantum of waste they produce in UAE but construction industry continues to be a major contributor of waste (Zhu et al., 2010).

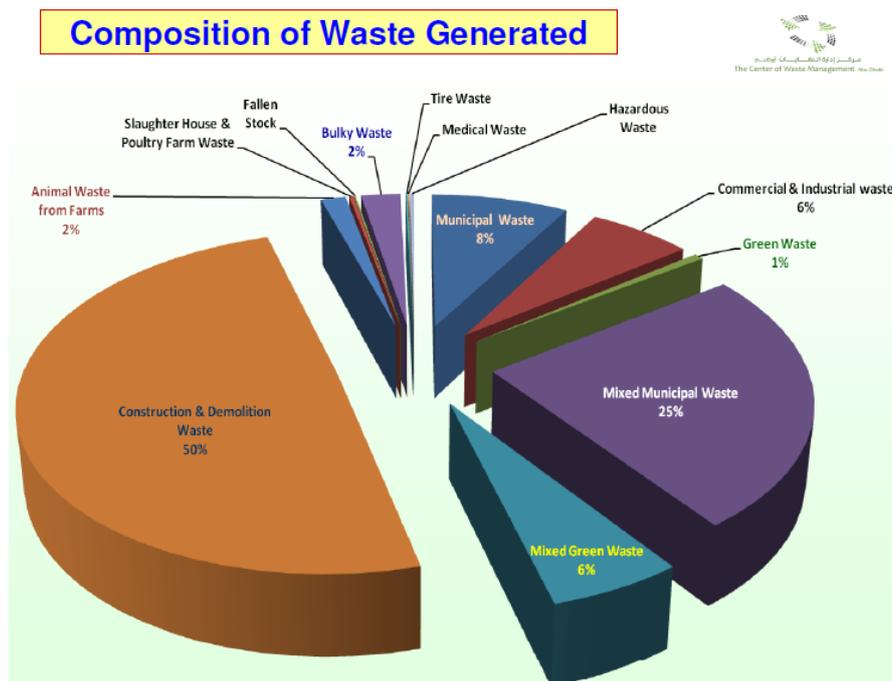


Figure 6.2: Composition of waste generated in UAE (Source: Banerjee, 2014)

The implication with this finding is that the lack of awareness and education regarding the importance of waste reduction has been largely concentrated on the construction industry.

6.1.5 Governmental role towards construction waste reduction:

As it is now, government is seen to be the most powerful stakeholder when it comes to waste reduction in UAE. This is because of the powers vested in the government to both punish offenders and reward those who do the right thing. Unfortunately, Enshassi, Al-Hallaq & Mohamed (2006) lamented that this role of government has not been executed very effectively. By implication, government has failed woefully in the enforcement of laws regarding the production and management of waste in construction sites. Meanwhile a correlation can clearly be drawn between government enforcing laws and the attainment of waste reduction in UAE. For example, when government shows sufficient activeness towards law enforcement, people who abuse the laws and regulation on waste production would not have done so due to the fear of punishment (Lee & Harrison, 2010). At the same time, when people do not abuse the law to produce avoidable waste or to manage their waste effectively, it would be a very direct means to be assured that the levels of wastes coming from construction sites will be minimal or reduced.

Still on government, it can be discussed that the failure of government to use its powers as the holder of the government purse to reward people engaged in best practices has also defeated the goal of attaining waste reduction. Currently in the UAE, there are efforts aimed at motivating people involved with construction to produce as fewer wastes as possible (Chan & Kumaraswamy, 2013). There have however been indications that most of these people require financial incentives to choose sustainable products that minimises waste as against inferior products that would only pile up the level of waste. Unfortunately, the financial incentives that these people are expected to receive have not been forthcoming, making most of them have no motivation and urge to go for more sustainable approaches to construction. This situation has certainly contributed to the current situation where waste coming from construction sites has been declared as being more than desirable and internationally accepted (Jaselskis & Ashley, 2011).

6.1.6 Material procurement handling:

Currently, material procurement is used in the UAE as a means of promoting fairness with the sourcing of raw materials used in construction. At the same time, the procurement processes also affect the sourcing of logistics used to handle waste on the construction sites for the purpose of waste management. It is also important to describe the nature of the procurement process in UAE at the moment, which can be said to be more centralized and bureaucratic (Zohar & Erev, 2011). The procurement process is said to be centralized because there is lack of even distribution of centers across the country where people working on construction sites from every part of UAE can easily access.

With a cumbersome procurement process, the result can directly be said to influence waste reduction negatively. This is because when contractors secure sourcing for certain materials, getting additional or complementary materials in addition to start or continue construction becomes challenging. This leads to the dumping of old materials on the construction sites for long, creating waste. What is more, after the whole construction process has been completed, getting logistics ready to manage waste also delays. Such delays serve as a disincentive for contractors to attend to the wastes by getting rid of them from the construction sites (O'Toole, 2012). Once such undesirable situations persist, the result is for there to be more wastes on the construction sites than expected. Also related to procurement is the issue of outsourcing of raw materials for construction, which has also been noted to be a major source of delay in getting both raw materials and logistics for the handling of waste from construction sites in UAE (Enshassi, Al-Hallaq & Mohamed, 2006).

6.1.7 Lack of implementing site waste management plan (SWMP):

The use of SWMP has been noted to be an effective means of achieving sustainable waste management practice. The reason for this assertion is that the plan helps in laying out the current needs of the area it is serving, identifies possible interventions to be used in curbing the situation, allocates resources for proposed solutions, gives out implementation schedule, and assigns personnel to execute specific tasks (Hutchings & Christofferson, 2001). It is rather unfortunate Filiz (2012) reported of lack of SWMP in most construction sites in UAE. This outcome can further be discussed and blamed on lack of understanding for the importance of the SWMP. This is because if the importance of the SWMP is really known to the construction site managers, they will take strong steps aimed at getting them in place. It is also possible to deduce that the current lack of implementation of SWMP accounts for the high rate of waste recorded on the sites.

The claims made above could further be supported with facts and figures on the number of construction sites that have SWMP as against those who do not have them.

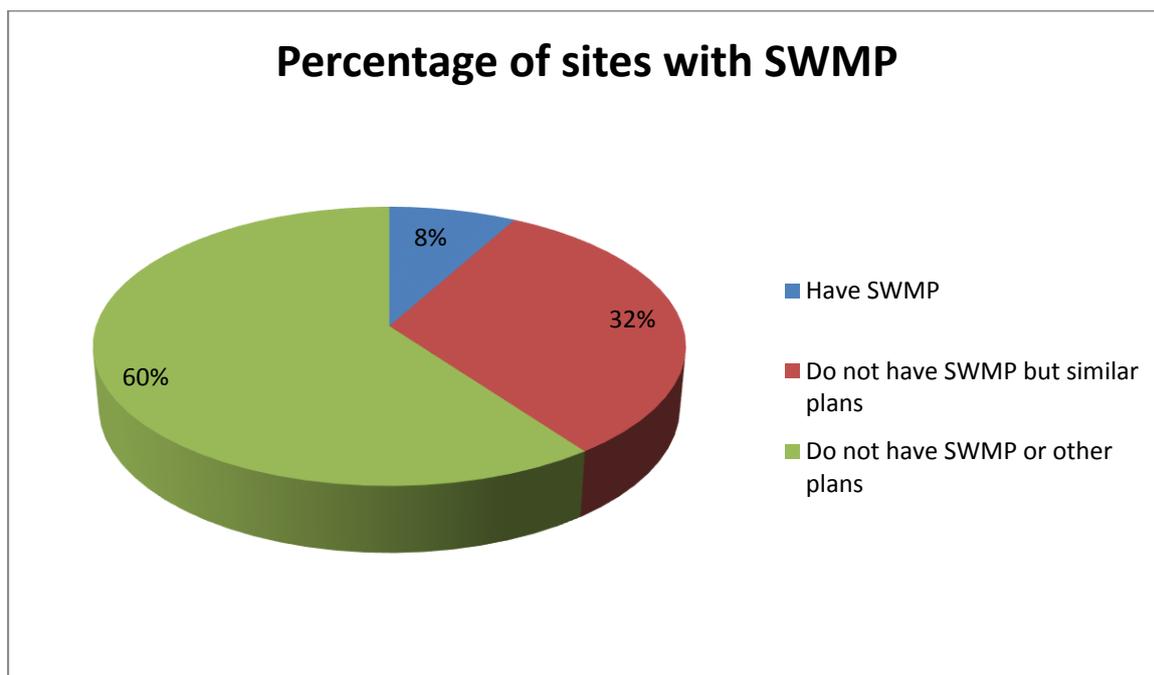


Figure 6.3: Attitude of construction sites to SWMP (Source: Banerjee, 2014)

The claim of the absence of SWMP being a possible cause of the poor waste management attitude can be confirmed from figure 6.3. This is because poor waste management practice takes place in UAE amidst 60% of construction sites who do not have SWMP or any other form of plan that is used for the purposes of waste management. Meanwhile, 32% of

construction sites do not have SWMP but have other models of plans that serve relatively same purposes. In a worrying situation, there were only 8% of construction sites that could be found with SWMP. This is indeed a negative attitude that cannot be encouraged or left to continue. Instead, it is very important that pragmatic steps will be taken to educate construction site managers on the need to having and using SWMP.

6.2 Proposed sustainability solutions on how to reduce waste generated during construction sites:

It is possible to implement a sustainable package in the UAE in relation to construction waste on a local and global level. The enhancements produce considered as an economical benefit for the country as the reduced construction waste creates more community jobs with fewer sick days. The government role in the goal of achieving reduced waste management creates a new dynamic for the local community and entices all to participate and appreciate the results of this undertaking. By creating a positive image for the professionals and residents, their sense of pride will increase and create a sustainable dimension of prestige in today's society.

6.2.1 Increase training and awareness for waste reduction habits:

Effective waste reduction habit can be said to be process rather than an event. What this implies is that it does not take a single step or task to get people to be conscious about waste reduction or develop waste reduction habits. Rather than this, there are several different events, tasks and actions that need to be put in place to ensure that these waste reduction habits are instill in people. As a result of this, it is strongly recommended that waste reduction on construction be achieved through the use of increased training and awareness to all major stakeholders concerned with waste reduction on construction sites. By stakeholders, reference is being made to people who are directly involved with construction activities on the site such as project managers, contractors, engineers, laborers, and project owners. In terms of the training and awareness for waste reduction habits, it is strongly recommended that the stakeholders concerned with construction in UAE will be equipped with standards of practice that are considered to be globally acclaimed and accepted.

To provide training and awareness that are of global standards, best practices recommended by the International Organization for Standards (ISO) could be adopted for UAE construction sites. The advantage with such training and awareness programmes that are globally standardized is that the contractors, project managers, engineers and other people working on construction sites in UAE can be assured that their standards of practice in terms of waste can

be replicated in any other part of the world they may happen to find themselves. What is more, it will be possible for other investors to come from other places of the world and find waste management practices in UAE good enough to adapt to them. The use of training and awareness is recommended as it has the potential of making waste reduction habits a more permanent part of the stakeholders. The reason for this assertion is that training and awareness will be carried out as a continuous process rather than a one-off event. Because the training and awareness will be taking place on frequent basis, the stakeholders will constantly be reminded of the need for them to make waste reduction practices a part of them.

6.2.2 Law enforcement:

The second recommendation that will be given with reference to construction waste reduction is the need to take law enforcement much seriously than is currently done in the UAE. This recommendation is being made with the understanding that having laws in place is not enough to solve problems. Rather, the implementation or enforcement of the laws is the real process needed to ensure that the laws are put to action. Currently, it cannot be denied that there are laws governing waste management practices in the UAE. However, because of weak enforcement practice, people have hardly adhered to the laws on waste reduction at the construction sites. It is therefore expected that enforcement of construction waste management laws will be taken more seriously than currently prevails. In a situation where law enforcement is weak, it is very common that a culture of impunity will exist. Such culture of impunity will come about with people knowing that even when they break the laws no legal sanctions will be put up against them.

The solution of enhancing law enforcement regarding construction waste reduction is expected to be beneficial because it will serve as a catalyst to reinforce the adherence to rules, regulations and laws on construction waste reduction. As it is now, stakeholders working on various construction sites in the UAE do not have any motivation to stick to the rules made to guide their actions. At the same time, they do not have any form of reinforcement to force them to respect the laws. Law enforcement is therefore expected to be a major way forward for achieving construction site waste reduction that can be sustainable for the future. But as the recommendation is being made for law enforcement to be in place, it will also be recommended that law enforcement agencies be rightly equipped to undertake their roles in a more pragmatic and effective manner. This recommendation is made knowing that the construction industry is becoming sophisticated by the day and without an equally sophisticated law enforcement agency, people will always break the rules and possibly get away with them unpunished.

6.2.3 Financial incentives for the low amount of waste generated during construction sites:

As much as punishment may be used to deter people from engaging in unacceptable construction site behavior that increase waste, rewards could also be used to serve as a motivation to get people doing the right thing. Under law enforcement, the overall ideal was to punish people for going contrary to the law. The opposite of this could also be the issuance of different forms of rewards, particularly financial incentives to construction sites where high levels of waste practices are engaged. As noted earlier, there are different forms of global and international standards that stakeholders in the construction industry must be trained with. As the training and awareness programmes go on, issuance of finance incentives could be factored in them to ensure that construction sites adopting the waste reduction habits that are thought them are rewarded. In the present situation, the reward is recommended to be the use of financial incentives because it has the potential of serving as an extrinsic motivation that can easily be seen and quantified by beneficiaries.

The use of financial incentives could also be introduced in such a manner where construction sites producing lesser wastes are rewarded. As the idea of the study is to rid UAE construction sites of wastes that are avoidable, it is expected that one way that policy makers will approach this will be to ensure that avoidable wastes are not produced at all. The reason for this assertion is that in most cases where wastes are made before interventions are put in place to reduce or manage them, issues and factors such as low financial commitment and lack of logistics makes it difficult to effectively reduce or manage the waste. When financial incentives are given to construction sites for not producing avoidable waste therefore, it will be expected that a very giant step will be taken whereby the wastes will not be seen all together. As it is said in ordinary parlance, prevention is better than cure. In the same way, it will be more beneficial to prevent the occurrence of waste than to expect that the waste will be produced and later reduced.

6.2.4 Easing out material procurement handling and timeline:

In the point given above, it was briefly mentioned that lack of logistics have often fought against the need to effectively reduce or manage wastes that are produced at construction sites. As far as the UAE is concerned, one major problem that can be referred to as leading to this situation is poor procurement handling and timeline given for the procurement of logistics. In order to deal with this situation, a solution is proposed to ease out the material procurement handling and overall timeline used in procuring logistics. To ease out the procurement process will mainly involve the practice of taking away most forms of structures that create

bureaucracies with the sourcing of logistics. Indeed as much as it will be accepted that procurement process is necessary to avoid corruption and ensure fairness in bidding processes, overly burdening the procurement process will come with its problems, one of which is delays with getting logistics to handle wastes on construction sites. Meanwhile, the delays associated with the procurement can directly be blamed on the issue of bureaucracy.

To facilitate the proposal of easing out material procurement handling and timeline, it will be expected that a decentralized system of procurement will be used in the UAE. With a decentralized system, it is expected that all emirates within the UAE and local councils and authorities will have their own offices that fully handles issues having to do with material procurement handling. When this is done, the current situation where centralized procurement offices experience long delays as a result of procurement results being lined up for authorities to attend to will be avoided. What is more, material procurement handling and timeline can be eased when the number of officials and personnel working on them are increased. As construction activities increase, it is very important that the number of personnel and officials serving various construction sites will also be increased. When the number of officials and personnel is increased, the problem of delays with handling will be avoided because one person will not have to attend to several construction sites at the same time.

6.2.5 Governmental role:

Last but not least, it is proposed for government to wake up to its role regarding the waste reduction agenda being championed in the UAE. From every indication, government can be seen as a major stakeholder whose actions and inactions can directly affect the outcome of waste reduction practices in the country. Typical example of this is the mandate that government has to both sanction and reward. Two of the points given focused on the need to sanction offenders through law enforcement, and the need to give financial incentives to construction sites that does well to reduce waste. One thing that cannot be denied from these two recommendations is that no other stakeholder can be said to have much power to ensure this than the government itself. In terms of law enforcement, the arms of government which are judiciary, executive, and legislature are all controlled by government, all of which could also influenced to make law enforcement effective. In terms of rewarding also, it would be acknowledged that government is the holder of the national purse and therefore has the single largest expenditure to give financial incentives.

Apart from the role of enforcing laws and rewarding, the government can be seen to have other roles regarding waste reduction that must be taken up very seriously. One of these roles is the creation of enabling environment for foreign investors to come into the country to invest in the area of waste management. Such an enabling environment could be created from several perspectives including political, economic, and legal. Politically, government through its policies must demonstrate to the outside world, a strong commitment to safeguard the security of foreign investors and local investors alike. Economically, UAE must be seen as a country with the right economic indicators such as inflation rate, interest rate, tax margins, and cost of doing business that boost investor confidence. From a legal perspective also, it is the responsibility of government to behavior in a manner that gives investors' confidence that once they come to invest in the area of waste management from construction sites, their rights will be fairly protected.

6.2.6 Framework implementation, Site Waste Management Plans (SWMP):

In order to put the project on the track of sustainable firm and achievements, several aspects need to be followed for better future and cleaner environment.

The methods of waste minimization also need some discussion at this point in research. The reason is that waste cannot be completely prevented regardless of whatever efforts are made by any department of the construction company. However, serious efforts and proper thinking regarding effective waste reduction methods can minimize waste. Some of the most feasible actions or solutions for reducing construction wastes include reviewing and implementing the SWMP in detail, recycling of the material and resources, monitoring and evaluation of construction activities, government policies and regulations regarding waste management, and acquiring of the services of waste disposal companies. Waste minimization practices is required for any construction project which can be started with enhancing the level of knowledge and awareness among construction professionals by conducting workshops and provide clear instructions and brochures in different languages and to be distributed to labors in order to understand the goal of aiming to reduce the waste generated during construction practices and its damages through the construction process.

An effective plan can be achieved in reducing the waste that need to be followed by all stakeholders presented during the construction stage by the following steps:

1. Site preparation

2. Plan implementation
3. Quality assurance

1-Site preparation

The site should be prepared before any construction activity begins by allocate a specified area for the waste skips and the waste skips should be located in an area where the vehicle can get an easy access to collect and loading the waste.

Another issue, which needs to be taken into consideration, is to provide a specified area for segregating the waste and by this, waste can be easily managed and sent to recycling destinations.

2-Plan Implementation

Before the Implementation of the Waste Management plan it has to be approved by the Engineers and the official PQP of the project. After the approvals, the plan is put into place by making proper arrangements for handling, containers, storage, signage, transportation etc... Also, appoint one person who will be responsible to handle the waste control on the site and to communicate with the waste management company for any shifted transportation and he should be presented for the entire duration of the project.

For this plan to work out, contractor has to do the following so all the wastes will go to appropriate location:

- Segregate all the wastes to hazardous and non-hazardous waste
- Segregate the nonhazardous wastes to landfill or recycling
- Segregate every recycling waste separately to go to different recycling units.

3-Quality Assurance

Quality should be maintained throughout the Plan by respecting the rules of waste disposal and collection authorities, and by having frequent meeting at the Project sites to ensure that all parties are following the rules and regulation of respective authorities during the hauling and disposal of the wastes. Site meetings should be conducted with the contractor in weekly and monthly basis for reviewing and discussing the waste management procedures such as:

- Responsibilities of waste management coordinator.
- Review quantity of each type of wastes and its proper disposition.

- Review and finalize procedures for material segregation.
- Arrange containers for recycling and bins for disposal to avoid delays.
- Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
- Review waste management requirements for each waste collection / disposal Authorities.

All of these steps can prove a very effective management plan for the cause of bringing reduction in the construction waste; thus, they can be termed as the most appropriate and sustainable solutions towards reduction of the construction waste at construction sites in the United Arab Emirates.

This is the more logical approach in terms of implementing a well-developed waste management plans within the UAE. It can actually be integrated into the mission objectives of the construction industry.

After analyzing the results out of the case study and the opinion of most of the entire respondents on the survey questioner conducted for this research, a policy and aspects, which cover all the missing aspects in UAE construction industries, were identified as sustainable solutions for this topic.

A set of checklist being designed to cover the pitfalls resulted form the :

- Site waste management plans SWMP
- Knowledge and awareness
- Government Role
- Waste Avoidance through law enforcement and law incentives
- Attitude and behavioral factors
- Material Procurement and Handling
- Waste reduction within the design stage

6.3 Feedbacks from the construction professionals on the selected solutions and polices

After proposing some aspects as a sustainable solutions which can be followed in the future to prevent and minimize the amount of waste going landfills and provide proper housekeeping and waste control, an interview has been done with the project manager and the site PQP of the selected case study and one safety engineer from different companies to evaluate the selected aspects and polices and examine its effectiveness.

6.3.1 Feedbacks form UNEC

Table 6.2 illustrates my interview with Mr. Abdullatef Al-Solh, project Manager with UNEC Contracting Company, who was hired for Al-Bahya Kindergarten (Selected case study).

Date: 28-05-2015.

Location: UNEC Head Office.

Table 6.2: Feedbacks form UNEC regarding the proposed solutions on waste reduction.

| Major Issues | Recommendations and effectiveness |
|--|---|
| Site waste management plans SWMP | <ul style="list-style-type: none"> • The construction team need to read and understand the plan provided at the beginning of the project and the plan should cover the waste management process, as it includes everything related to housekeeping on site, waste segregation, waste recycling process, and the recycling destinations for different types of waste. • One responsible person should handle the WMP from the first day of the project and follow the same procedure implemented from the design stage. |
| knowledge and awareness among construction professionals | <ul style="list-style-type: none"> • This is one of the best aspects that need to be implemented on the top of the sustainable solutions, as the construction team didn't have enough knowledge about the waste management process which should be followed on the construction site. • Workshop should be done, for the project engineer, site engineers, forman's, and workers. • The construction team should know all the factors that might affect the waste management process on site, and the reason behind implementing the waste management process. |
| Government Role | <ul style="list-style-type: none"> • The government has stated that waste management process is not optional for the construction projects that achieved any of LEED and/or Estidama rating systems in order to cover the process requirements. However, it is not mandatory for all construction projects and |

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| | <p>makes all professionals familiar with the waste management controls in the construction industry. This point need to be taken seriously and make it mandatory to be followed.</p> |
| <p>Waste Avoidance</p> | <ul style="list-style-type: none"> • During construction there is no way to avoid waste, however it should be monitor and controlled throughout the whole construction process. • In the case of the UAE, the steps can be adapted to our culture and business dealings, government guidance is necessary in order to implement important strategies that deal with waste source production. |
| <p>Attitude and behavioral factors in controlling waste management</p> | <p>The contractors don't have enough knowledge about the waste management process during construction, and this considered as the main reason of failing to implement the process during construction. The below are some of the wrong practices audited on the construction site which cause a failure in implementing the waste management process on site:</p> <ul style="list-style-type: none"> - There is no enough waste containers on site, the waste containers should be available for 7 different types of waste not only 4 as required by Estidama : <ul style="list-style-type: none"> ➤ Wood, Concrete, steel, plastic, hazardous, general, cardboard and food waste. - There is no segregation area provided next to the waste collection area, which will result in having mixed types of waste inside the waste collection containers. - There are no restrictions from the upper management of the project regarding the waste management process on-site. - No food container available next to the workers restroom, which will result in dumping all the food waste in the general skips and mixed it with other types of waste. - All the waste manifests should be filled properly and collected from the waste management company as an evidence of shifting the waste to a recycling destination not to the landfills, as we |

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| | <p>are trying to get benefit from the waste going recycled and/or reused.</p> <p>This point is one of the major issues that need to be addressed and distributed to all construction professionals for their records and action.</p> |
| Material Procurement and Handling | <ul style="list-style-type: none"> • The material procurement process considered as one of the most important elements as well in the construction process. The contractor should have a procurement team in order to manage the procurement process on-site. This will have a role in the waste management process as the procurement team has to arrange the timing of the material delivery on-site, and arrange for unload and unpacking of the materials when it's delivered to the site. • The waste generated from unpacking the materials delivered to the site will have an impact on the waste management process. |
| Waste reduction within the design stage | <ul style="list-style-type: none"> • First of all, it is important to standardize the design of building materials, as it is the first stage whereby the control over construction materials can be exercised. • In order to properly manage waste, waste reduction and management must be implemented from the initial stage of project design. |

The interviewee Mr Abdullatef Al-Solh from UNEC stating the significant importance of awareness and training among construction team and the necessity of having mandatory workshops for all construction professionals. Mr Al-Solh raises the issue of having mandatory roles by the government in all construction projects not only for the projects targeted sustainability rating system. However, the waste skips and waste signage are also need to be implemented for all projects by having 7 waste skips for different type of waste as well as food containers to collect the organic food.

The interviewee support the idea of lack of waste reduction initiative drives construction prices up and reduces the economic output of UAE , from this viewpoint, it can be concluded that construction waste is not only harmful for the economy, but also for the environment. UAE can be considered the home of construction industry considering the number of construction projects going on all over the country by various local and international construction

companies. Waste avoidance, awareness and governmental role were the most fluent indicatives in minimizing the amount of waste generated.

6.3.2 Feedbacks from ACE

Table 6.3 clarifies my interview with Mr.Al-Hassan Wafi, Site PQP with ACE Consulting Company, who was hired for Al-Bahya Kindergarten (Selected case study).

Date: 08-06-2015.

Location: ACE Head Office – Hamdan Street – Al-Jamal Tower.

Table 6.3: Feedbacks form ACE regarding the proposed solutions on waste reduction.

| Major Issues | Recommendations and effectiveness |
|--|---|
| Site waste management plans SWMP | <ul style="list-style-type: none"> As per any project or idea, planning is one of the most important steps in order to reach a certain goal. Plans will be considered as a baseline or reference to the projects which will lead the projects to achieve the environmental requirements by applying the waste management plans. |
| knowledge and awareness among construction professionals | <ul style="list-style-type: none"> If the knowledge and awareness of all the parties of the construction members were existed, it will reduce the amount of waste generated from the sites. All the parties should be aware of the environmental harms which are generated by moving the waste to the landfill, so they can avoid the increasing of the amount of waste during the construction. |
| Government Role | <ul style="list-style-type: none"> Governments should apply strict rules regarding the waste issue, which will lead the construction teams to strictly segregate the waste and prepare for recycling. Therefore, all the construction teams will follow the government rules and it will lead to the decreasing the amount of waste. |
| Waste Avoidance | <ul style="list-style-type: none"> The practice of waste minimization is very significant in the construction process. It reduces costs, protections and preserves our environment, complies with rules and regulations and above all places the firm head and shoulders above fellow competitors. |

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| Attitude and behavioral factors in controlling waste management | <ul style="list-style-type: none"> Usually in the construction field, the most important thing is to handover the projects on time with less cost. Therefore, the idea of decreasing the amount of the waste is missing for most of the projects. In my opinion, the clients should request for the environmental impacts as well as the handing over of the projects to ensure the reduction of the waste. |
| Material Procurement and Handling | <ul style="list-style-type: none"> In construction fields, it is usual to procure extra material and to ask for the delivery ASAP especially in the fast track projects in order to handover the projects on its time. In my opinion, storing the materials in proper way won't affect the waste management system in bad way. |
| Waste reduction within the design stage | <ul style="list-style-type: none"> It is applicable to reduce the waste by using some techniques which will force the construction teams to reduce the waste. The design of fast track projects will lead to increase the amount of waste, so it's better to avoid this type. |
| Other Recommendations | <ul style="list-style-type: none"> Governmental regulations are the most significant aspect for all stakeholders to follow. Stable roles and mandatory instructions will force and followed by all construction team. |

Mr Al-Hassan Wafi stated that the SWMP is the baseline of reducing the waste as here the predictions of waste volumes are refined and the laid down procedures are implemented. The quantities of the various wastes are quantified and the waste management action for each specific type waste is completed if the SWMP has been followed properly and updated based on the scale of project.

The interviewee has insisted on the governmental action regarding the issue of construction waste reduction as it will be one of the settled commitments for all construction team to follow, which I highly agreed with this aspect, rather than forcing construction team for incentives in a country where they feel comfortable and stable from the financial side. The steady increase of construction waste and the neglect by the constructors to reduce the waste will lead the government to decreeing waste management laws and regulations. ACE precedes the importance of increasing the awareness and labors knowledge about the habits that needs to be avoided and followed during the construction process. This point should be amendment as part of the sustainable solutions proposes for this research.

6.3.3 Feedbacks from BAC

Table 6.4 illustrates my interview with Mr. Qutaiba Khalil, Safety Engineer with Burj Al-Arab Consulting Company (BAC).

Date: 08-06-2015.

Location: Burj Al-Arab Head Office – Al-Muroor Street – Next to AL-Masood tower.

Table 6.4: Feedbacks form BAC regarding the proposed solutions on waste reduction.

| Major Issues | Recommendations and effectiveness |
|---|--|
| Site waste management plans SWMP | <ul style="list-style-type: none"> A site waste management plan (SWMP) should be developed at early stage. A SWMP creates an estimate for waste and the different ways it will be managed. |
| knowledge and awareness among construction professionals | <ul style="list-style-type: none"> Lack of knowledge and little apprehension of the effects of the accumulation of construction waste is one reason why there is a culture of disposing waste. |
| Government Role | <ul style="list-style-type: none"> The regulations provide guidelines for disposing waste, volumes of waste allowed and the various disciplinary measures in case the procedures are not followed. Mandatory procedure by the government will be more effective for all sectors to be followed. |
| Waste Avoidance | <ul style="list-style-type: none"> Disposal contractors collect the waste at the site, transport it and dispose of it efficiently. Most of the waste is taken away and put to use in other activities. This decreases the volume of waste at the construction site; allows professionals to handle, sort and treat the waste and reduces the effects that the waste has on the environment. |
| Attitude and behavioral factors in controlling waste management | <ul style="list-style-type: none"> Not all labors are aware about the behaviors that will help in reducing the waste. One of the simplest things that workers don't know about the materials that can be recycled and the materials that considered hazardous. This relates to the minimal background of workers that leads in mixing up all the wastes together. |

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| <p>Material Procurement and Handling</p> | <ul style="list-style-type: none"> • Logistics management entails the acquisition of the raw materials and their transfer to the construction site. Involves choosing the best means of transportation of the equipment and construction material, choosing the most proficient routes of supply, choosing the most skilled company to deliver the provisions while incurring little to no wastage from source to destination. Good logistics management will reduce damage of material and equipment, reduce costs and greatly prevent wastage. Arranging deliveries to fit the construction plan reduces the challenge of storing materials onsite longer that is required. |
| <p>Waste reduction within the design stage</p> | <ul style="list-style-type: none"> • This aspect might be effective by ensure flexibility in design to meet the changing needs of the client. Recycled materials can also be included in the design. All these measures will ensure efficiency in the construction process therefore reducing the amount of waste that will come out of the construction process. |
| <p>Other Recommendations</p> | <ul style="list-style-type: none"> • Encourage the construction teams to reduce the amount of waste by the government by facilitate other issues or by applying some regulations and fines. |

Mr. Qutaiba Khalil from BAC interview was of great value added to the proposed sustainable solutions for this research. Training designers, site workers and clients on the different methods of waste prevention, re-use and recycling is one way of tackling this complication before any work progress taking place at the construction sites and ensure that there is one person at least who will be responsible on the safety issues and the housekeeping control on-site.

In my opinion I think that construction companies and government agencies could partner to train them on the benefits of waste prevention and minimization and later offer incentives to construction firms that efficiently apply the acquired procedures in their design and implementation. The interviewee stating also that on the worksite, quantities of waste allowable should also be implemented.

The interviewee stated that taxing of landfill waste is another regulation that can be implemented. The policies of providing intensives and taxes will enhance the waste

management practices during construction unlike with my opinion of having payment method than mandatory procedures set by the authority.

6.4 Solutions to increasing levels of construction waste:

These include processes and procedures to prevent, reduce and manage construction waste. Of the three, waste prevention is of the highest importance. Curbing the amount of waste produced from the beginning conserves the environment and reduces financial expenditure

6.5 Revised Sustainable Solutions after the Feedbacks Received From the Interviewers:

After selecting the findings concluded from the results analysis of the survey questioners and the case study, the main findings were also evaluated by interviewing different professional from the construction industry and assess the factors selected to ensure its effectiveness and validity within UAE construction practices as shows in table 6.5.

Table 6.5: Revised key factors after receiving the feedbacks for the interviewers

| Major Issues | Recommendations and effectiveness |
|--|---|
| Site waste management plans SWMP | <ol style="list-style-type: none"> 1. Plan procedure should be followed while implementing the SWMP such as: site preparation, plan implementation and quality assurance for an effective and productive plan. 2. Recycling construction waste procedure should be followed by explaining the procedure of collecting the waste through different waste skips and make proper segregation in order to be sent directly to the waste destination by the waste hauler. 3. Make the WMP mandatory for all construction projects through the government enforcement as part of the construction procedure. |
| Knowledge and awareness among construction professionals | <ol style="list-style-type: none"> 1. This point is being rated on the top of the sustainable solutions that need to be first implemented. 2. Mandatory workshops/ trainings to be issued by the authority. 3. Brochures to be distributed among workers for the purpose of segregating the waste. |

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| <p>Government Role</p> | <ol style="list-style-type: none"> 1. Provide strict guidelines and roles on the amount of waste being generated for each construction project. 2. Provide taxes on the waste going landfills based on the amount generated. 3. Provide recycling wood destination in the Emirate of Abu Dhabi, as there is no wood recycling destination and it is not possible to transfer the waste between the emirates. |
| <p>Waste Avoidance</p> | <ol style="list-style-type: none"> 1. Good awareness and signs on skips is necessary to ensure everyone understands where waste materials should be placed. 2. Waste streams should be segregated at the construction site for removal by the waste hauler. 3. Adequate storage requirements on site are needed to maximize the potential of wide range of materials to be segregated for recovery. 4. Limited facility to reuse excess materials on site. |
| <p>Attitude and behavioral factors in controlling waste management</p> | <ol style="list-style-type: none"> 1. Increase the awareness between the workers. 2. Implement mandatory workshops / trainings of the waste reduction strategies. 3. Assign one responsible person to check over the workers while collecting and segregating the waste. |
| <p>Material Procurement and Handling</p> | <ol style="list-style-type: none"> 1. Assign procurement team in order to manage the procurement process on-site. 2. Provide timetable of delivering the materials on-site based on the work progress. 3. Sign a contract with the transportation Company to take back the materials unattended on the site. 4. Make sure of the quantities delivered to the site. 5. Proper storage for the materials to prevent them from the weather and any other damage resources. 6. Place the materials in an area where it won't interrupt workers circulation. |
| | <ol style="list-style-type: none"> 1. Standardize the design of building materials. |

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| Waste reduction within the design stage | <ol style="list-style-type: none">2. Appropriate site planning to provide enough space for material storage and segregation area.3. Recycled materials can also be included from the design stage. |
|---|---|

In Conclusion, the discussion chapter gave the researcher the opportunity to identify major problems that confront the construction industry in UAE as far as the management of waste is concerned. This was an important part of the whole study given the fact that acknowledgement of the problem alone was not going to be sufficient to guarantee that they will be solved. For there to be right solutions provided to the problems, it was important that the problem will be understood in detail. This was the rationale that led to the first part of the chapter where the current status of waste management in UAE construction sites was discussed. The discussion showed a very bleak situation where the need to be a global leader in the provision of infrastructure for the growth of businesses, trade and commerce has become a hindrance to guaranteeing quality delivery in terms of waste management on construction sites.

Chapter 7: Conclusion and Recommendations

7.1 Conclusion:

This part exhibits the conclusion of the research study, which has been directed through different methodologies and extensive literature review stated the same problem in different countries under different conditions.

This study is important since it provides useful insights to building designers, building material suppliers, waste management organizations and building contractors as it enlightens them on the need to identify and utilize environmentally viable, sustainable solutions. Many aspects being raised and discussed in order to provide series of sustainable solutions that will suit UAE conditions, climate and legislations.

Educational, social and environmental aspects have been assembled together to create a complete frame of providing alternatives and solutions for the current status of construction waste within UAE construction practices.

Some of the most feasible actions or solutions for reducing construction wastes include reviewing and implementing the SWMP in detail, recycling of the material and resources, monitoring and evaluation of construction activities, government policies and regulations regarding waste management, and acquiring of the services of waste disposal companies. All of these steps can prove very effective for the cause of bringing reduction in the construction waste; thus, they can be termed as the most appropriate and sustainable solutions towards reduction of the construction waste at construction sites in the United Arab Emirates.

Another point raised is related to lack of knowledge and employee training regarding efforts towards waste prevention. Training and awareness is considered the focal point that concluded from this study as it creates a forceful jump in minimize the waste production. This point needs attention because when employees will be provided knowledge regarding waste prevention, they will be able to apply it to their due responsibilities which will result in increased efforts towards waste prevention from every department of the construction company. It can be said that training of the designers, site workers, and construction clients is one of the effective methods of tackling the issue of increased wastes.

The research has further found that one of the reasons behind such a huge increase in the construction waste is the poor construction policies and off-cuts that result from poor construction planning and design. The point here is that planning and designing are two such steps in a construction project on which the success of the whole project is based. When these steps are given the due level of attention, the chances of waste production go down. On the

other hand, poor construction policies designed from poor planning leads to the failure of the project, which not only affects the projected profits for the construction companies but also increases the amount of construction waste. Therefore, these two phases should be given the utmost importance while managing any construction project.

Some solutions have also been identified regarding reduction in the level of construction waste. Those processes are related to prevention and reduction and management of the construction waste. Although all of these methods are equally important for the purpose of stopping the increase in the amount of construction waste, but waste prevention appears to be somewhat more important than others. Recycling is a very effective method of making expensive used material available for reuse. Companies can use this method to cut down their construction costs and increase the gap between actual construction cost and the profit gained. Therefore, the need of today for the UAE's construction companies is to use recycling as a sustainable solution to reduce the amount of construction waste as much as possible.

Some other methods of waste prevention concluded from this research include logistics management, incentives and training, and improving construction methods. Logistics management refers to the acquisition of construction material and its transfer to the construction site. Now, some key steps should not be ignored regarding logistics because they are associated directly with minimization of waste. These steps include selection of the most appropriate methods of equipment and material, selection of the most appropriate transportation routes, and selection of the most skilled supplier company for the delivery of required material. All of these steps are targeted towards ensuring minimization in the environment pollution and prevention of waste production at the construction sites.

Waste generators at the initial project design to the last phase of construction can be properly stored and dealt with on a professional level by professionals. Addressing and analyzing the cause of waste helps construction companies to eliminate environmental problems. While the waste management status of construction sites in the UAE is threatened by malpractice on the side of ignorant contractors, proposed sustainable management plans can still help to reduce construction waste by enhancing waste management platforms supported by the government.

Finally, serious action by the professionals and the government will help dramatically reducing the construction waste generated during site in UAE with relation to associated problems by adopting formal strategies. Increase awareness and enhance background knowledge are the main factors in creating massive mutation in the construction industry and hence cleaner environment. Therefore, improving the current status of construction waste by implementing

site waste management plan will create significant reduction in waste production. However, cooperation and participation of all construction professionals and labors are also essential aspects in determining the optimal solutions and its effectiveness of such matter.

7.2 Limitations:

This study gets directed on the manageable development for the construction waste in the UAE. Construction waste reduction covers one part of the development business and the ventures receiving supportable practices in waste reduction are limits to the research. The non-accessibility of basic information grids in UAE to direct the definite detailed analysis, are additionally regarded as an impediment to this research.

7.3 Recommendations for Future Research:

Further research on the accompanying gets suggested in UAE construction sites in order to fill the gap of knowledge. Thorough research might become ruined a task that incorporates all parts of the development business.

Research on building the waste management process benefits in details through several phases such as site plan implementation and quality assurance of the plan application need to be investigated.

The case of construction waste has serious related problems to the environment, which should be reviewed by the Environmental agency in order to propose a roles and restrictions for the construction stakeholders to be followed and this would have greater value to the topic.

The Emirates of Dubai and Abu Dhabi have been studied the issue of waste and start initiating a roles in this field, the other emirates municipality should take the step in order to address instructions and laws and to be viable among all UAE emirates.

Other elements that will support the study of construction waste reduction in UAE are:

- Likely challenges on the implementation of effective site waste management plan should be studied in details in a multi-cultural environment.
- A cost benefit dissection while implementing an effective SWMP among contractors and project managers.
- The expected benefits of the proposed sustainable solutions in diverting the amount of construction waste sent to recycling destinations from landfills.

- Improve the requirements of starting any construction projects by implementing mandatory workshops for the construction staff to be attended as part of the construction procedure.
- Examine such sustainable solutions for a period of time to prove its feasibility and validity to be as a reference aid in the future.

Chapter 8: References

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