



Building Construction and Demolition Awareness: Encouraging a Waste Management Mindset in Saudi Arabia

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Abstract Just like any other entity, buildings have a certain life span. Buildings are built with a life expectancy of roughly 80-100 years. Once reaching the end-of-life phase of the life cycle of a building, Demolition plans are drafted out with careful practice taking into consideration safety measures of the execution, extracting hazardous materials, and surveying the building before demolishing and as a result of this process, we are faced with an overwhelming amount of demolition waste that will most likely end up in landfills. This article aims to build awareness to encourage the adoption of future waste management plans in Saudi Arabia. It is divided into two parts. The first part will attempt to give a general review of the Construction and Demolition Waste (CDW), waste management methods, and factors that influence CDW generation. The second part takes a focused economic perspective of CDW.

Keywords Building, Construction, Demolition, Construction and Demolition Waste (CDW), Waste Management, Sustainability, Saudi Arabia

1. Introduction

With the increasing amount of demolition waste due to the growing demand of new building construction along with old buildings reaching the end of their serviceability, it has never been more important to take action when it comes to CDW management. It is stated that the Gulf Cooperation Countries is among the top 10% of waste production in the world. and 55% of the total waste is of CDW, which equates to 120 million tons per year [1]. According to a study done by Nawaf I. Blaisi, lack of motives, awareness and incentives to manage CDW is one of the main issues in CDW waste generation [2]. Awareness here isn't limited to contractors but also client and designs. It is found that designers that are well educated on the topic of CDW are able to minimize waste at the early stages on the designing process. They are also well equipped in influencing clients to be aware in making more conscience decisions. As a result, contractors are more likely to adopt this attitude towards waste [3].

2. Literature Review

Construction and Demolition Waste – Waste Generation

CDW is the waste that is produced by the construction industry that is resulted from the Construction of new buildings, demolition of old ones, and refurbishment of existing buildings. These wastes are composed of a range of materials including concrete, timber, ceramic, metals, and plastic with concrete and ceramic ranking the top materials of waste generated on-site 5.



When we investigate the life cycle of a building, we will find that waste is generated in almost all of its stages. In most cases the waste ends up in unauthorized landfills, in best case scenarios, the wastes is disposed of in special complexes that process consumer and industrial waste or special landfills, and in other cases these wastes are dumped in sanitary landfills which is the traditional approach to CDW [6, 7].

Because of the nature of these materials, CDW has great potential for recycling though only a small portion on CDW is actually recovered and reused. And due to the limitation of the tools and/or methods of to reduce the CDW, the most practical first step towards CDW management is to start with measuring the amount or waste that is generated [5].

There are, of course, various ways to measuring CDW generation but due to the necessity of the data being relevant on an international level, this paper will refer to a study that was conducted in 2013 to determine a set of indicators to measure the CDW that is generated on site, and which was not limited to a specific geographic area. These indicators were estimated based on 6 categories: new residential construction, new non-residential construction, residential demolition, non-residential demolition, residential refurbishment, and non-residential refurbishment.

These categories were based on:

- i. Three types of construction activity (demolition, new construction and refurbishing).
- ii. Two types of end-use (residential and non-residential) [5].

The next phase after waste generation estimation is covered before the waste management process begins is the destination of the place of formation. And according to an analysis, there are two main points, either on the construction site or on the waste treatment facility where waste is recovered, sorted, and crushed [8].

Traditional and Selective Demolition

Another factor that influence waste management is the demolition method. The main difference between traditional and selective demolition is that selective demolition is characterized by the fact that its waste can be separated into mono-materials that have great recovery potential [10].

Selective Demolition, also known as Deconstructive, is gradually gaining popularity in the last few years, not only for environmental value but also for its economic value [10]. This recognition is demonstrated in Portugal where a recent law-decree that make site waste separation compulsory, or when on-site separation is not possible, the waste is transferred to licensed waste operators, and since the waste operator services are directly dependent on the aggregate purity, Selective Demolition gains popularity [11]. The main factor that will define the economical sustainability of the selective Demolition are: cost of labor, tipping fee value, and the market price for selling recovered materials [11]. In addition to the factors mentioned, there are few factors that might affect the quantity of recovered materials, for example, construction type, equipment or tools use and/or time constraints. And time constraints is usually the main issue [11].

Materials and Hazardous Materials

Since quite a few companies keep their waste on site until the end of the project, this creates potential for hazardous material to seep into the ground causing soil, and possibly, water pollution. In some cases, the hazardous materials can also become airborne and spread to the surrounding environment. This can be easily avoided by sorting the waste, recycling what can be reused or recovered and disposing the hazardous materials safely [7].

Construction and Demolition Waste – Waste management Methods and concepts

Measuring the amount of waste that is generated on-site alone isn't enough to reduce or control CDW but it is the first step that will help in the establishment of future waste management plans [5]. Therefore, to achieve responsible consumption and production we must take initiative to develop and implement economically and technologically rational management schemes [8].

In usual cases, the Life Cycle Assessment (LCA) is the principal method in analyzing the impact a building has on the environment but unfortunately the nature of this assessment doesn't cover a fair analysis on the end-of-



life phase of the building [10]. Circular Economy (CE) is a possible solution to fill this gap. CE is an economic system that is based on business models that replaces the End-of-Life concept with reusing, recycling, reducing, and recovering materials [6]. Due to the negative attitude most people have towards recycled products because they associate it with being low of quality, an affective framework is that much more important [6].

A basic CE frame is based on 3 strategies regarding the resources:

- i. narrowing the loop – use less materials to reduce waste generation;
- ii. slowing the loop – lengthening the period of the use of the material; and
- iii. closing resource loops – this strategy can be considered equivalent to the recycling of the material therefore making the Closing Loop strategy the most appropriate strategy in the CDW context [6].

Lean Construction (LC) is another concept that can be used to build upon it a waste management system strategy. The Lean Construction Method is used to aid construction companies to increase the efficiency and quality of the projects while minimizing waste with a process that continues over the course of the life cycle of the project [12]. In simpler terms, it is the design of a production system in such a way that it minimizes waste of materials, time, and effort to produce the maximum value [13]. Therefore, the Lean Construction method is based on two main principles, and that is to reduce waste and increase productivity and effectiveness [13].

According to a study that was done, they were able to identify 32 different LC practices and each had a special focus on different phases of the construction process. This finding offered the conclusion that there is no one-size-fits-all solution regarding LC practices and tools, and that the best solution would be the result of a custom blend of these tools for each given project [15]. The research also emphasized that Visual Design Construction tools greatly aid the reduction of wastes due to its ability to estimated resource efficiency of use and thus the prevention of future waste generation [15].

Comparing these two concepts where Circular Economy manages the production of materials during the End-Of-Life phase of the building service, and Lean Construction focusing of minimizing future waste generation, there generates a notion of their benefits if combined [14]. Though this idea is fairly new, a study that was done, using the content analysis method, explored this idea to analyze the interaction between these two concepts and found that from the LC principle of “reducing the share of non-value-adding activities” had the most interaction with CE practices and from the CE concept of “off-site construction” had the biggest interaction with the LC principle [14]. An additional finding was that the construction phase of the building life cycle was the phase that had the highest number interactions between the two concepts.

CDW Management - Economic Benefits

Due to the process that the material under from the process of recycling, new opportunities would be created because such processes require a specific skill set there for providing job opportunities [17].

And although recycling hold 3rd place in benefit, whereas reducing and reusing came in 1st and 2nd, recycling has great benefit. Based on a study that was done in New Zealand, where a new housing project was given two options, where the 1st option was one that would provide a deconstruction process that would that gave focus on partial recovery and recycling of the waste materials. And the 2nd option would provide a deconstruction process that gave a bigger focus on maintaining the materials for reusability and the reduction of waste. What they found was that the net benefit to society for both options were significant. For the 1st option, the NPV was 6.97 million whereas the NPV for the 2nd option was 14.46 million [17]. These benefits included creating jobs, training on the job, economic benefit of construction materials that were reused, reduction of unwanted noise, traffic, pollution and greenhouse gases, skills gained by workers. And while the second option was more beneficial, the recycling method – option 1, is the only option for many construction materials [17].

According to a study that was based on the System Dynamics SD principles concluded a few factors that depicts the relationships of activities that happen within a model – in this context a waste chain model. And one of these factors is the recycling and reuse which forms the basis for calculating the benefits gained from managing CDW [17].



In applying a waste management plan, based on economic analyses, the benefits don't show until after a period. It shows that when implementing a CDW management plan, the initial cost first has to be taken into account because management needs time and costs [19].

Once the total costs are established, the Net Benefits can be calculated by subtracting the Total Costs from the Total Benefits:

(Net Benefit = Total Benefits – Total Costs)

Based on a case-study that was conducted in Egypt, an economic feasibility model development to help CDW producers and aggregate users decide on whether to transport their waste to landfills or recycling plants – assuming that the plants are not profitable and are managed by the Egyptian government [21]. In this context, they highlighted that the contractors are more likely to transport their waste to recycling plants if it costs them less than if they were to transport it to landfills. And similarly, when choosing to use recycled aggregates. Refer to the equation below: (21).

$$T1 + C1 > Tr + Cr + Er$$

Where:

T1: is the transportation cost per tonne to landfill.

C1: is the disposing cost per tonne in landfill.

Tr: is the transportation cost per tonne to recycling plant.

Cr: is the disposing cost per tonne in recycling plant.

Er: is the separation costs per tonne of waste incurred before bringing waste to recycling plant.

3. Methodology

In this section, CDW management in Saudi Arabia has studied to evaluate the current situation of demolition in buildings. Thus, research methodology was mainly that of literature review. The first part of this paper was conducted as research to better understand the concept of Construction and Demolition Waste, its environmental influences and its economic benefits as well. The research also covered methods that can be implemented for CDW management. The last part of the research covers CDW management here in Saudi Arabia and possible future plans in the field of CDW management. The Second part covers a case study that implements an economic feasibility model that was developed to help stakeholders make their decision between transferring their CDW to landfills of a recycling plant.

CDW Management in Saudi Arabia

Saudi Arabia has had previous experience in waste management but unfortunately most of them don't survive due to poor planning, operation, and construction and /or technical issues [7].

According to a study that was done in the eastern region where 81 companies were surveyed and found that about 53% of the projects apply construction waste plans whereas 47% do not have a plan in place and about 38% of the 53% are mandatory as part of the project contract [7]. And regarding the disposal of these wastes it was found that about 36% of the projects' waste is transferred to landfills by their crew, 31% keep the waste on site until the end of the project, 20% use subcontractors to move the waste from the site to landfills and only a little over 13% reuse in the field [7]. The factors that influence these figures were: project duration, project value, project owners, awareness of Green Building, adhering to the Saudi Code, and type of construction [7].

As a response to this waste management gap in Saudi Arabia, the government has planning to build its first recycling facility for construction debris in its capital, Riyadh, that will be led by the Saudi Investment Recycling Company, a subsidiary of the government's sovereign wealth fund. This initiative is in alignment with the waste management objective that was announced at the Crown Prince Mohammed bin Salman's economic overhaul plan back in 2016 [9]. By 2017 SIRC company was founded. It was headquartered in Riyadh to operate multiple activities across all waste types including CDW, and shift towards a Circular Economy future [22, 23].



4. Conclusion

This paper presented a Construction and Demolition Waste (CDW) method to study and control the potential of demolition. In addition, buildings, like any other entity, have a limited lifespan of approximately 80-100 years. Once a building reaches the end of its life cycle, plans for demolition must be carefully prepared to ensure safety measures are taken, hazardous materials are removed, and the building is surveyed before demolition. Unfortunately, this process often results in a significant amount of demolition waste that is usually deposited in landfills. The purpose of this article is to raise awareness and encourage the adoption of effective waste management plans in Saudi Arabia. The article is divided into two parts. The first part provides a general overview of Construction and Demolition Waste (CDW), waste management methods, and factors that contribute to CDW generation. The second part takes an economic perspective and focuses on CDW.

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