

A Glance on Construction Solid Waste Management in Khartoum

Us. Fairuz Abdel Razig Mohamed, Dr. Awad Saad Hassan Mohamed

Abstract - Construction solid waste is generated on active building sites, consist of materials that vary according to the type of building structure and construction techniques. Usually this type of waste is considered to be inert, but occupy lot of space on disposal due to its bulky volume. Waste management services in Khartoum is not coping with rapid urbanization, and the increase in the building construction industry level. Construction solid waste is still collected and managed with municipal solid waste i.e., general solid waste. A need for increasing the services, and introducing different means to dispose solid waste rather than landfills, will avoid accumulation of construction solid waste in landfills, hence avoiding negative impact on health and environment, beside saving the free land spaces from being used as dumping areas or landfills. The aim of the study is to help in drawing the attention to the ability of understanding the problem of construction solid waste in Khartoum, and provide reasons and guidance to be separately collected and managed separately from municipal solid waste, therefore reducing the volume of solid waste going to landfills. Information from the data collected in the study from the interviews made by the authors to construction companies working in the field of construction in Khartoum, and a feedback from Khartoum Municipality for cleaning operations, beside different experiences from other countries enlightened the author with variable reasons to assist segregation of construction solid waste from Municipal solid waste. Therefore reducing the quantity of waste going to landfill, and the separation of the construction solid waste to be managed in a useful way, rather than just being dumped.

Keywords: Construction Solid Waste, dumping, Landfills, Municipal solid waste , segregation.

I-INTRODUCTION

Construction Solid Waste(CSW) nature is usually a waste of large amounts of different building materials, which is collected and

transferred with Municipal Solid Waste (MSW). This increased volume of solid waste made it difficult to collect, transfer, and dispose at landfill. CSW to be transferred needs special trucks rather than the usual solid waste truck, that is damaged by the sharp and heavy nature of the construction solid waste, and occupies large space to dispose, hence uneconomical in managing it properly.

Lot of researches efforts were made around the world covering different topics about construction solid waste management, as shown in Elsevier journal,(2011),[1], a total of 147papers are issued on the topic of CSW management till the period of the research of Weisheng lu &Hongping Yuan 2011. From Arab countries one paper each for Kuwait and Iraq. This means that still the level of awareness for future arising CSW problem is low. Most of these papers are studied and evaluated.

Usually for low and middle income countries such as Sudan which is generally referred to as a developing country any solid waste is known to be Municipal Solid Waste (MSW). Awareness of segregation is partially there, but the urge to apply it is ignored, for economical reasons and maybe under estimating the problem. In Khartoum capital of Sudan, CSW is managed with MSW. Construction Solid Waste CSW is usually bulky and needs lot of efforts to be dumped. The increase in building industry caused the CSW generation to exceed the provided service. As focused in the UN Habitat studies(2010)[2]." Municipal SW is taken to include waste from households, businesses and institution, construction and demolition waste in small quantities, general hospital(excluding hazardous waste), etc, but not waste from agriculture, mining and large industries which normally handle their own waste." Municipal Solid waste is generated in huge amounts in these countries, and become costly to manage it, but the way of managing it is different from one country to another according to their facilities. Therefore CSW if treated and considered separately from other solid waste, it will be managed more efficiently, and reduce the quantity of MSW. until further solutions introduced rather than dumping, such as reducing, reusing and recycling, which helps in decreasing the amount of CSW waste that goes to landfills in a useful way .

To understand CSW as defined by researchers, (Kofoworala and Gheewala(2006),[3], defined it by its origin i.e. waste arising from construction, renovation, and demolition activities, or it could be defined by its composition, as interpreted by W.Lu.H.Yuan(2011),[1]. in his research. While the European waste catalogue EWC, "provides a

comprehensive classification of C&D waste in line with its composition, although it is concluded as one of the forms of MSW, but it is considered heterogeneous by comparing it with general MSW". In Japan, Nitivattananon and Borongan,(2007),[4], CSW is considered as a construction by product rather than waste, so efforts were made for reuse and recycle. But if landfills is the disposal end point, it makes no difference, to classify CSW, it ends up to be a solid waste that could be of no value. This means that as long as it goes to same process of disposal, then there is no need to classify the waste either by its origin where it is generated or its composition, because it will not help in reduction of waste.

II- MATERIALS and METHODS

A literature review of most of the papers and researches relevant to the study, interviews with construction companies in Khartoum with working experience of minimum five years in the field of construction. And interviews with the people living in residential areas where lot of buildings are under construction. A visit to the Khartoum Municipality for Cleaning Operations for reflecting the authorities concern.

III-ESTIMATION OF QUANTITY OF CONSTRUCTION SOLID WASTE

In order to estimate the ratio of CSW within the general SW, it is as stated in the C&D Waste Guide,(2011),[11], "Building materials account for about half of all materials used and about half the solid waste generated worldwide.". This ratio will differ from country to another according to the type and quantity of CSW generated. and within the same country it differs from one region to other, depending on materials used either local or imported according to whether it's a rural or urban areas. This is obvious in Missouri landfills where EPA's (2009) [6], it was mentioned that, " 5.5 % of the solid waste is construction waste, while in St Louis and Kansas city CSW account for 58% of Missouri total waste, but 88% of the state is construction waste. Likewise, the rural areas account for 34% of the total waste but only 5% of the construction waste." This is due to the variation of building construction materials and building technique from place to another, besides in rural areas there is no difficulty in dumping waste, so the impact is not obvious. "And in the US more than 45% of the municipal waste is construction waste, Green Tulsa (2009),[12]. But as mentioned earlier CSW was defined separately, which proves that when the percent of the waste increases segregation is the logical solution.

Philp Crowther(2014)[13], commented about construction and demolition C&D waste; "in the industrialized countries the C&D industry is responsible for 60% of the total waste stream, the amount of C&D SW generated is estimated to be roughly 180 million tons per year", (McGrath, Fletcher, and Bowes,(2000)[14], also discussed that the amounts of material waste going to recycling are very low, assisted his estimation by the figures

stated by, Kibert, Chini, and Languaell,(2000)[15], which are 20% up to 35% of total CSW. Hence, from the above statistics quantity of CSW is still a problem even with segregation.

From what is mentioned it is obvious that CSW is a waste that has a ranging percent within SW, increasing at regions of high construction, and oppositely on others. But in all cases its quantity cannot be ignored

IV-REVIEW OF DIFFERENT WAYS OF MANAGING WASTE

Examples from experienced countries in managing CSW to review. Although the type of CSW might differ slightly due to the use of different building materials, but their advanced ways of treatment will be useful to discuss in the study. EPA,(2002)[8], estimated US construction solid waste about 130million tons, and Sandler and Swingle, in 2006,[21], found that only 20-30% of CSW is recycled. While Detr,(2000)[9], mentioned that in UK 70million tons of construction material and soil ended up as waste. Therefore, US is a good example, it treated the CSW separately and managed it by recycling the waste. Construction and demolition waste status report in 2011,[7] stated 19million tones of construction and demolition SW were generated in Australia in 2008-2009, 8.5million of it was disposed in landfills, and 10.5million tones were recovered and recycled. That is 55% of the total amount. Last example is Hong Kong, which at the time period from 1993-2004 waste generated annually was more than double, (Poon2007),[10]. This is large amount of waste to be going to landfill. In 2006 the government introduced charging schemes for CSW disposal. This reduced the quantity of waste from 6560tons in 2005 to 2660tons per day in 2008. Several trials were undergoing to reduce the amount of waste going to landfills in Hong Kong, by increasing number of landfills, controlling disposal.

Although these countries managed to deal with CSW separately and began segregation to reduce SW going to landfill, still their efforts are going on towards less or no waste.

V-EXPERIENCE OF NEIGHBORING COUNTRIES ON CSW

A review of some statistics of the quantities of solid waste in neighboring countries to Sudan, that has similar type of solid waste, and CSW. The World Bank Report [5] stated ; "the majority of GCC countries are ranked in the top ten worldwide in terms of waste production per capita, 120 million tons of waste produced, 55 percent of it is estimated to be CSW ". CSW is mentioned as part of MSW in most of developing countries. Neighboring countries have the same type of MSW as Sudan and mostly the same means of disposal.

Table 1, below compares the quantity of MSW waste between these countries. From waste management annual reports of the World Bank Reports (2013)[5], the author gathered data of weight, means of disposal of SW for some of the these countries that have the same type of building

materials, hence similar CSW. Kuwait, one of the GCC countries is chosen in the comparison, has published a paper in the field of CSW. Iraq in 2007[6], a national SWM plan was developed by waste management specialists to handle the huge amounts of waste due to conflicts.

Algeria has adopted strategies to environmental conservation in various sectors in the last twelve years. It began to segregates CSW from MSW, so their experience of segregating CSW could be useful. Egypt is similar to Sudan in types of buildings, and in many other different aspects of life. For comparison to be acceptable and reliable, further data about the population and the land area are considered;

Table1; comparison of SW in neighboring countries, annual World Bank report 2013,

country	Land Area	SW	Weight in ton	Disposal method	population
Egypt	1.001mill km sq	MSW CSW	21million 4million	landfill	82.06mill
Kuwait	17820km sq	MSW	2million	landfill	3.369mill
Algeria	2.382mill km sq	MSW CSW	10.3million 11million	landfill	39.21mill

From table1 above,[7], Egypt and Algeria have the highest quantity of waste and wide land area. Kuwait has minimum SW and land area. Egypt with all that amount of waste was not yet considered a risk for that time. Maybe the beginning of segregation of CSW from MSW helped in reducing the waste going to landfill in a way. Algeria SWM report,[7], in 2001 defined the basic principles that lead to an integrated waste management, by 2004 defined responsibility of each actor on the field. In 2010-2014 there were agreements with foreign partners and international expertise for technical assistance. The wide area helped in reducing the accumulation of SW.

Kuwait is of minimum area and SW in the table, yet was considered by the World Bank report 2008 [5],from the top ten countries in the world, that had the largest amount of waste going to landfills. In 2013 the Kuwait World Bank report warned of environmental impact from landfills, but yet no segregation of waste plans are considered.

Hence, land area is a main factor that affect disposal in landfills, the larger the areas the greater is the number of landfills, the less acknowledgment of the risk, and more delay to the management of waste process.

VI-KHARTOUM CONSTRUCTION SOLID WASTE(CSW)

Khartoum, capital of Sudan, of a population now about 8million, World Population Review, (WPR 2015),[16]. Land area 22.736 square kilometers, were the growth in the building construction sector in Khartoum was triggered by the oil production in Sudan since1982, mostly the productivity and contribution of construction sector in Sudanese economy is between 1995-2007, this is assisted in a workshop about construction industry CI in Sudan, 2011,[11]. The nourishment of construction business in Khartoum lead to new type of waste accumulation in larger amounts of waste material

than before. The CSW is not treated separately, but became part of the MSW. Hence it is collected with the solid waste. In the study the author observed that sometimes construction sites deal with CSW separately and do not include it with the MSW. In the process of cleaning site after the construction ends, the waste is transferred separately, but dumped in any unsupervised spaces away from buildings.

Population in Khartoum was 5million in (2008), [7]. The solid waste generated at that year 2008, ranges between 0.6 and 1 Kg per capita per day, which is about 3200tons. But only 35% of it is transferred to landfills, while the 65% is disposed in open dump, (AFED)[17]. The percent of CSW cannot be estimated here as half of SW as mentioned earlier in C&D Waste Guide,(2011),[11], here the material differs and the type of construction techniques also. In Khartoum, " Till 2003 the building construction were mainly of load bearing structures of brick materials, by 2003 reinforced concrete material structures increased up to 15% of all constructions that uses brick or clay material"(20). The percent of a different type of CSW is getting bigger, even more with urbanization.

Solid waste management project began in Khartoum in 2002 by Khartoum Municipality of Cleaning Operation. Before that waste is collected from certain random points were waste containers are placed by authorities. This is the only collected waste for disposal, waste trucks transfer the collected waste to open uninhabited areas, for dumping. Those who are far from collection points manage their own waste by unauthorized burning or dumping. This is why there are no accurate statistics of quantity of waste in Sudan. Sudan First Communication,2003 [18], stated that ; " Secondary data sources were the main reference for information due to the fact that no organized collection and disposal take place.

As stated by Shadad,2003, [20]" construction industry increased in Sudan during the five years following oil production. And the developing projects of roads, bridges and houses increased using a wide range of building materials, some of it imported." this imported materials hence presents a different waste material to the field of disposal, but since this helped in nourishing the economy, no concern was given to waste output". He also thinks; "The relative stability in Sudanese economy performance and oil production attracts foreign capital to participate in business. After year 2000 the amount spent on construction continues to increase because of the entry of foreign companies and investors" . Here, mainly when mentioning the Sudan mostly Khartoum is the center of focus, being the capital, the largest population, and centre of urbanization.

VII-MANAGEMENT OF CONSTRUCTION SOLID WASTE IN KHARTOUM

The delayed start in managing waste could be due to small volumes of collected waste, or availability of wide areas for land filling and dumping. Solid waste was generally consisting of CSW due to the fact that CSW being inert did not endanger the community,

hence no serious complains arises, and being of small volume made it easier to be dumped at near free areas . The increase in construction projects and high rise buildings, beside the use of imported building materials, introduced a new type and quantity of waste. Therefore more efforts needed in collection, special trucks for transferring, and extra space needed for dumping as long as it is considered with the SW.

At the study it is realized that there is no special trucks for collecting CSW, and the waste collectors avoid collecting bulky solid waste in the waste truck to avoid damaging it. CSW is usually accumulated in front of the site throughout the construction process, and possibly removed at the end of the project, but sometimes it is left there. Big construction companies remove CSW on private expenses, a private service for the waste collection at charge per truckload, but do not supervise its disposal. Construction sites that lie by main roads will have penalties from authorities if they accumulated waste and blocked the traffic, but authority does not control improper dumping, it is most important to avoid main roads block. Contractors mainly leave the job of waste removal from site mostly to labors, because they benefit from it. Labors segregate the useful material from the waste to either possess it or sell it to be reused before removing bulky CSW from the site. Left over of CSW of smaller sizes such as boxes, wires, metals etc are handed over to MSW collecting truck. On the other hand when construction sites are located in residential neighborhoods, accumulation of CSW is a big nuisance to public, beside the dust. From the interviews with people in these neighborhoods, they prefer not to make official complains to authorities about illegal accumulation of CSW from neighboring construction sites. Respect for neighbors is important according to Sudanese culture. But construction companies of working experience ranging from four to ten years (within the duration of building construction growth) are interviewed by the author in the study, only 20% of them got frequent complaints from people living in neighboring houses to the working sites, and over 60% of companies never got complains from public about blocking the roads, or accumulating free spaces with waste materials , or polluting the air, etc. .

To go further in the study and cover a different level, interviews are made with those who are authorized to control solid waste in Khartoum. The eastern sector of KHARTOUM was considered, it has many construction work undergoing. A visit to the Khartoum Municipality for cleaning Operations, that is responsible for the eastern sector to know their concern on the topic. The staff was aware of the problem, some mentioned the financial part of law income supply towards the service of collecting and transferring waste, and public cannot pay high fees to compromise. This lead to hiring untrained labor, less supervisors, and less ability to cover all waste collection points. The unaware and untrained labor are less funded in the management process. These three factors , awareness, finance, training are the key to solid waste management.

Lately, Japan International Cooperation Agency (JICA) [20], in Sudan made agreement with Sudan government in October 2013 to upgrade waste collection vehicles and equipments, they estimated that Khartoum with a population of million in 2008 produces approximately 5000 tons of waste per day of SW, no data of the percentages of CSW are registered. They made agreement to help improving waste collection from 3200 tons per day to 4600 tones, and this is only 65% of the total waste generated. On the other hand JICA is combining technical co operations from 2014-2016 to improve the management capacity of the supervisory Authority for Cleaning in Khartoum State, which is the executing agency of the project. JICA made master plan till 2028 for cleaning Khartoum State.

VIII-PROBLEM OF KHARTOUM IN CONSTRUCTION SOLID WASTE MANAGEMENT

Solid Waste Management includes all activities that help in reducing negative impacts on health and environment, accumulation of solid waste is not considered yet a major problem. SWM is considered as a simple job of collecting waste, putting waste into a trucks and unloading it far from residential neighborhoods. If this process continue, then many towns will face lack of free spaces, blocked streets and drains, flies and rats. Successful solid waste management could not be achieved without , effort and future forecasting of the problem, to be managed before it hazardous, plus learning from other people experiences.

Khartoum CSW is part of SW, undergoing the same process of collection, transferring and dumping. Till now CSW is not treated as a different type of waste. This is affecting the managing process with its increased bulky volume. So when discussing the managing process in Khartoum, it is about SW including CSW. The following points are to conclude the problem,

- Not all waste is collected
- Not all waste transferred to defined dumping area
- CSW is managed within MSW
- No statistics of quantities of CSW , or the percent of CSW in MSW
- CSW that is dealt with separately by construction companies, very rarely reach dumping areas

The question arises, does collection and removal of CSW will be still treated with MSW ?

X-DISCUSSION

In developing countries like Sudan CSW could be of greater percentages due to unsupervised waste treatment and dumping. On the other hand any attempts for reusing or recycling will need segregation of waste from source, and this is a job that no one pay for it.

The efforts for making use of CSW are still very low compared to the generation of waste, which means that even with classifying CSW separately, the problem is not completely solved because it still goes to landfills , such as in Egypt and Algeria, as

mentioned previously. Segregation helped industrialized countries in reducing their waste but their attempts for recycling are still low.

For example, in the case of Hong Kong an improvement in decreasing the quantity of waste was noticed in spite of the double amount of waste mentioned earlier, and this is because at 2004 the problem of solid waste accumulation at landfills was taken serious and a master plan was made with a target of reducing the SW. Segregation was the first step, then recycling. By 2014, in [7], Hong Kong have only 25% of its SW going to landfills. Hong Kong segregate waste that could be recycled, regardless if it was generated from CSW or MSW, and they had good progress to the extent that the waste that goes to landfill is only 25% as in [5]. Hence, as Hong Kong started by segregation of waste at landfills before dumping, this could be more applicable in the case of Khartoum.

The amount of waste stated as CSW for all these countries mentioned in table-1, means that they used segregation from a long time to reduce the waste going to landfills. Therefore with segregation efforts and recycling still efforts will be needed to reduce the percentage of CSW going to landfill after recycling, but segregation and recycling are the basic factors to begin solving the problem of SW.

Khartoum is almost similar in area to Kuwait, but higher in population. Population is considered one of the factors that its increase will raise percent of waste. But still Khartoum not considered by the world bank at risk. Here, maybe the fact that high growth rate in construction industry in Kuwait raised the percent of waste.

Another question arises here, is it more beneficial to segregate waste by classifying it, to MSW and CSW to be managed differently, or just take those materials that goes to recycle from the waste regardless. It became obvious here in Khartoum that segregation is required, but a step before that is collecting and transferring CSW from sites should be done in a separate trucks. The MSW truck should not transfer CSW, even if they are transferred to the same landfill, but should be placed in separate area within the same landfill. This will avoid being mixed with MSW, and make easier to be segregated.

If CSW is separated from SW, this could be controlled separately using the same three key factors above.

-First by introducing awareness to those who are engaged in the construction fields; consultant, contractor, client, and labors.

-Secondly by training waste collectors to know how to deal with SW and CSW.

- Finally, seek funding to support the management process. This could be by encouraging private sectors to recycle SW, and open markets for recycled material, lower their taxes. Also seek more income from construction sites, by payment for removal CSW from site. This will need control and supervision from authorities to press penalties for unremoved CSW at sites.

Automatically, by focusing on managing CSW awareness for separating it from MSW will increase.

IX-CONCLUSION

According to Khartoum state, reaching to the limit of high risk of waste accumulation will be disastrous, more efforts has to be considered. The study of the above examples assist that CSW is better be treated separately from MSW, even if they are in the same landfill (as in Hong Kong), or segregated from source. But it could be uneconomical to start now with segregation at source of generated waste. This needs extra cost, special trucks, trained labor, but if ;

-supervise and guide CSW trucks to transfer waste to specific points in landfill, to avoid mixing

- focus on waste collectors training in segregating useful material,

- to nourish a reuse building material markets.

- Authorities help private sectors to start recycling projects,

- Introducing charges for construction sites if not removing CSW from construction sites

As in a long term plan, train labor, increase public awareness.

Soon waste going to landfills will be less, level of awareness of public will be high, and CSW segregation at source could be applicable and affordable, when it is not included within SW.

Future studies should concern the factors that affect mostly CSW accumulation, whether it is, urbanization, population, or land areas, as obvious from study. These variable factors with the above key factors can give a vision towards how to control the increase in CSW that goes to landfills. The solid waste management system needs inputs, follow-ups, statistics, feedback, and careful consideration of local condition.

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AUTHORS BIBLIOGRAPHY

Us. Fairuz Abdelrazig Mohd.
PhD student, M.Sc in Building Services.
Lecturer at College of Architecture & Planning, Sudan University of Science and Technology, Khartoum, Sudan.
Working experience in private sector, in design & consultant company
Email,fairuzabdelrazig@yahoo.com,
Telephone No. 00249912819175

Dr. Awad Saad Hassan
Associated Professor at Sudan University of Science and Technology. Experience of 30 years of teaching in different engineering colleges in Sudan. Now, Dean College of Architecture and Planning.
Published about 16 researches in journals and conferences.
Email,awadshassan@sustech.com, Telephone No. 0024912353614