

## **PRESENT OUTLOOK OF SUSTAINABLE SOLID WASTE MANAGEMENT: A CASE STUDY OF DHAKA**

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### **ABSTRACT**

*Solid waste management is one among the basic essential services provided by municipal authorities in the country to keep city centers clean. This study analyzed the present solid waste management (SWM) practices in Dhaka. It is the Capital City of Bangladesh, is one of the fastest growing metropolises of the world with an annual average growth rate of 6.6 %. As the highly dense and urbanized capital of Bangladesh, Dhaka city is generating around 6000 tons of domestic waste every day. The study pertaining to MSW Management for Dhaka city has been carried out to evaluate the current status and identify the major problems. It also focused on the capacity of domestic waste management of Dhaka city, technological changes in waste management, problems and its potentials to development. This study suggests for preparing a detailed plan for sustainable MSW management in Dhaka for source separation, large scale investment on composting and Waste to Energy (WTE) projects.*

### **KEYWORDS**

Solid Waste Management; Dhaka City; Waste to Energy

### **INTRODUCTION**

Rapid urbanization, increasing population, and developing living standards have created large amounts of solid wastes all over the world (Samah et al. 2013). Dhaka is a densely populated city of the world. For administrative purposes, Dhaka is divided into two distinct units – Dhaka South City Corporation (DSCC) and Dhaka North City Corporation (DNCC) shown in fig-1. These two units are responsible for solid waste collection and disposal in their respective areas. 3,300 tons/day and 2,700 tons/day solid waste usually generated by respectively Dhaka South City Corporation and Dhaka North City Corporation. Solid waste generation estimates range between 0.29 and 0.60 kilograms per person per day, depending on individual's level of income (DNCC, 2015). A recent study estimated that approximately 70% of the entire city's waste is collected (Helemul, 2016). Uncollected waste is deposited in open spaces, where its accumulation contributes to foul odors, rodents, and clogged storm water and sewer drains. It is often burned deliberately to reduce its volume and by accident, which contributes to a range of health and environmental impacts.

Dhaka City Corporation: North and South

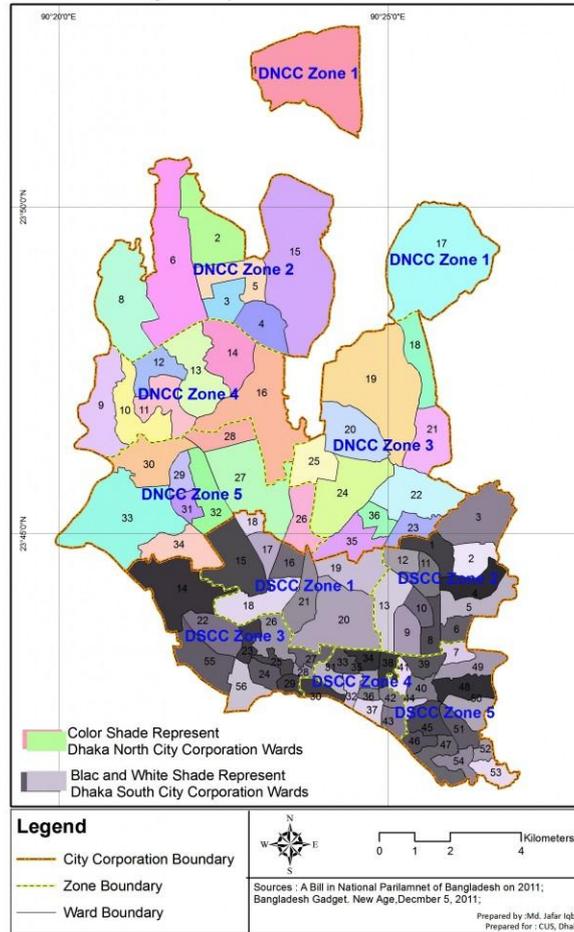


Figure 1: Location Map of the Study Area

The waste stream is more than 80% organic matter and contains a wide variety of substances , such as food waste , paper, cloth , agricultural waste, construction debris , metals, hospital waste, and appliances. Fig. 2 shows the solid waste generation contribution of different sources by percentage.

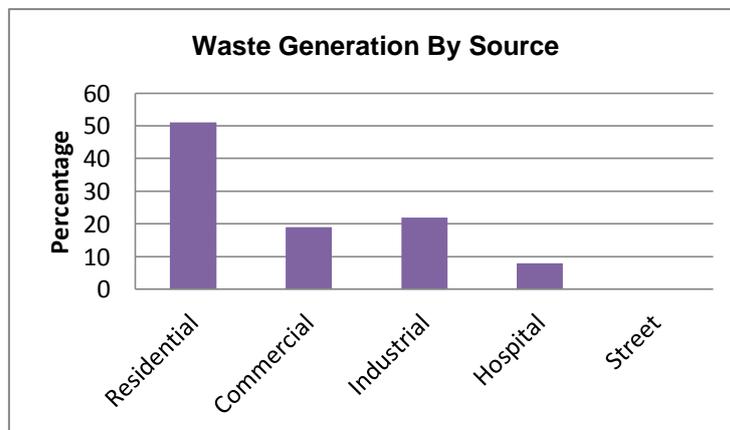


Figure 2: Solid Waste Generation Contribution of Different Sources (%)

Municipal solid waste generation in Dhaka city is highest with respect to other cities of Bangladesh like Chittagong City Corporation (CCC), Khulna City Corporation (KCC), Rajshahi City Corporation (RCC), Barisal City Corporation (BCC), Sylhet City Corporation (SCC), Comilla City Corporation (CoCC), Mymensingh City Corporation (MOC) and Rangpur Metropolitan (RM). Fig.3 shows the respective solid waste generation rates of these major cities of Bangladesh.

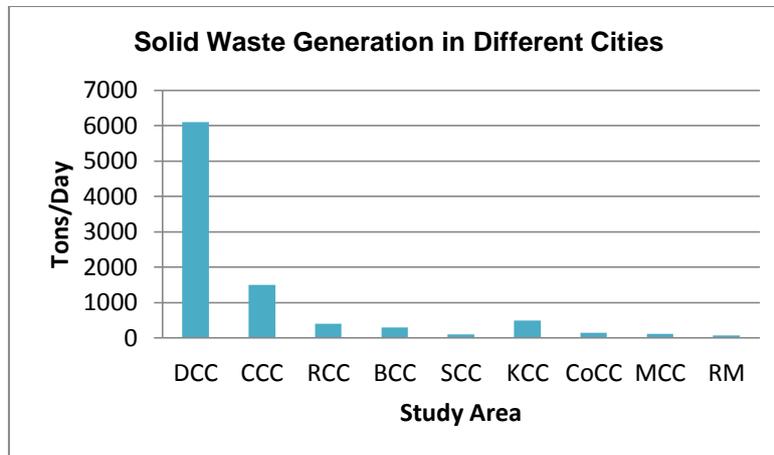


Figure 3: Solid Waste Generation in Major Cities of Bangladesh

Figure 3 describes that Dhaka city's waste generation is highest and it is ever increasing day by day. Therefore, these unmanageable large quantities of solid waste create massive environmental problems that include diseases and economic transmission, fire hazards, odor nuisance, atmospheric and water pollution.

Though solid waste management is one of the imperative essential functions for improvement of urban lifestyle however, this mandatory service of DNCC and DSCC is not efficiently and properly performed by the city authority. This unsatisfactory scenario developed due to lack of financial budget, awareness, improper technology selection and transportation systems. This study conducted to find out the sustainable solid waste management system for Dhaka City Corporation.

## PRIMARY COLLECTION SYSTEM OF SOLID WASTE

Solid waste generated by Dhaka city is collected mainly by covered truck. But Dhaka city waste collection system has a long chronological history which has described in table 1.

Table 1: Dhaka City Solid Waste Collection System

Year	Collection System
1717	Manual night soil collection system
1864	Night soil collection by bullock cart by Dhaka Municipality
1963	Liquid waste collection by DWASA & Dhaka Municipality side by side
1982	Bullock cart system suspended, night soil collection replaced by Septic tank, introduction of open truck for solid waste collection by Dhaka Municipality.
1989	Introduction of night time waste collection instead of day time collection
1993	Demountable container introduced along with closed and open truck.
2002	Open truck replaced by covered truck.

Presently the collected waste is transported from dense neighborhoods to consolidation locations, where it is loaded onto city-owned trucks. Before 2007, these trucks transported the waste to two open dumps outside the city. In 2007, one of the dumps was converted to a controlled landfill (in DSCC), but access is limited by traffic congestion and a large portion of the waste generated in DSCC is consequently transported to DNCC (USEPA CCAC, 2014). The DNCC is planning upgrades to its dump, including adding a leachate management system and a waste-to-energy facility.

## **RECENT INITIATIVE FOR WASTE COLLECTION**

Dhaka South City Corporation has decided to set up 15,000 small bins in its area by the year of 2016. Dhaka North City Corporation also decided to set up around 5,000 small bins. City corporation authority already started placing the waste bins at different major points of the Dhaka city. They are installing the bins on a priority basis - crowded places first. It was a welcome move, but it is not working properly due to lack of city resident's awareness and city corporations' publicity. By this time, lids of many bins have been found missing and their bolts broken. These dustbins were set on footpaths. These bins have been provided in order to keep the roads of the both city corporations trash-free (Newagebd, 2016).

## **RECLAMATION AND REUSE**

In Dhaka city, wastes having some market value are being reclaimed or salvaged in three stages (Ahmed and Rahman 2000). In the first stage, housewives separate refuse of higher market value such as papers, bottles, fresh containers, old clothes, shoes, etc. and sell them to street hawkers. The street children carry out the second stage of salvaging by collecting different items of low market value, including broken glass, cans, cardboard, waste papers, rags, plastics, metals and miscellaneous commercial wastes discarded by households, from waste collection bins. The scavengers at the final disposal sites do the third stage of salvaging when municipal trucks unload fresh refuse.

The reclaimed materials reach the waste and old materials shop from where these are either sold to consumers following some processing, or supplied, as raw materials, to proper processing industries for reuse.

## **COMPOSTING OF SOLID WASTE**

The composition of solid wastes in Bangladesh is favorable for composting, with a higher percentage of organic matter, precisely the right moisture content and C/N ratio slightly higher but adjustable (Ahmed and Rahman 2000).

Experience in many developing countries show that large scale centralized and mechanized composting plants had to be closed down due to high operational, transportation and maintenance costs. Financial and technical viability of composting projects can be achieved if such projects are decentralized, located close to the source of waste generation and, the most vital element, low-cost manual technologies are adopted, taking into consideration the socio-economic condition.

## **ORGANIC DIVERSION OF SOLID WASTE**

Only a small portion of Dhaka's organic waste is diverted before being transported to the city's landfills or deposited in open spaces. However, one private firm is collecting and processing approximately 100 metric tons of organic waste per day, and selling the compost to local farmers. Dhaka city authority has preliminary plans to develop a larger integrated resource recovery center one of the city's landfills to process waste into compost and to generate electricity using landfill gas (Shanghai Manual, 2012).

## **CAPACITY AND DEMAND**

Despite of huge limitations of the City Corporation, it has raised its capacity of waste collection over the time. The domestic waste collection rate has been significantly increased from 35% in 2005 to 70% in 2016 in Dhaka South City Corporation (DSCC). The waste generation in DSCC is 3,300 tons/day. But, it has the collection capacity of total 2200 -2300 tons/day along with collection and recycling of another 300-350 tons/day by Private Sector, while, about 1000 tons of waste are left/day by DSCC, which creates environmental pollution and blocking the drainage system in the city. Each City Corporation has one central Waste Disposal Centre. The DSCC's one is at Matuail, Demra, Dhaka and DNCC's one (50 acres) is at Amin Bazar, Dhaka. The area of Central Sanitary Land Fill

Station of DSCC, Matuail is 100 acres that was started 10 years back with 50 acres of acquired land, which left discarded in 2005 as it was filled up with waste. There was no scope for further disposal of waste there and DSCC truck drivers started disposing waste in adjacent areas. At such a situation, another 50 acres of land were acquired and converted the waste disposal center to a Sanitary Land Fill Station in early 2006. The dump station, from its original ground level has reached to a height of 22 meters, while some areas are still left. The entire places are about to be filled up with waste by the next 1.5 – 2 years (Helemul, 2016).

## SUSTAINABILITY BY WASTE TO ENERGY

Bangladesh Government had a contract with the Government of Italy for a plant 'Waste to Electricity' which, has been cancelled. Government may take initiative regard to establishing such projects for effective management and use of the huge potentials of domestic waste (Asian Power, 2015). Government has begun the process of acquiring 82 acres of land, where City Corporation has a plan to establish a waste to energy plant in 32 acres as soon as possible. The plant will produce pillate with the waste that will be used as substitute of coal. The plant will have a modern treatment center as well. The rest, 50 acres of land will be used for dumping of domestic waste. The plant will use 2000 tons of domestic waste from City Corporations' every day collection and 1200 tons from the Matuail land fill Station for preparation of pillate.

Scientist claims the reserve of natural gases would soon be depleted as their usages increases daily. In developing countries like Bangladesh with fast paced population growth, meeting the daily energy demand is a major challenge. The need to switch to sustainable source is evident (Zhu at el. 1997). The waste materials can be a good source of energy as the amount of waste is increasing every day, and can help in meeting the electrical energy not only in Bangladesh but also in the world.

Municipal solid waste is normally treated as waste, but this waste can be the source of energy. The calorific value of solid waste can be used for heating purposes and electricity can be produced from this energy. WTE can solve the problem of MSW disposal with energy recovery from the waste and can improve environmental quality, lifestyle of city dwellers. More than 70% of the waste is food or vegetable waste with moisture content of more than 60%. It is estimated that, the MSW of Dhaka city corporation has a calorific value of 7.96 MJ/kg (Jhu at el. 1997) which is enough for producing electricity. Consequently, MSW can be used as alternative sources of electricity generation in Dhaka North and South City Corporation. Fig-4 shows a flow chart for waste to energy generation.

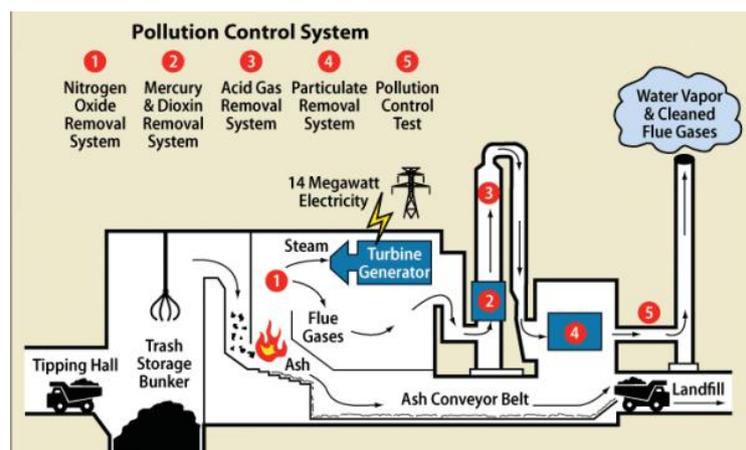


Figure 4: Flow Chart of Waste to Energy Generation Process

Firstly, the energy content of MSW is estimated by using modified Dulong's formula and finally, available electricity that can be produced from this solid waste energy is calculated (Themelis & Kim , 2002).

Modified Dulong's Equation:

$$\text{Heat Energy, } Q = \{337C + 1428(H-O/8) + 9S\} \text{ KJ/Kg} \quad (1)$$

Where,

C = Percentage of Carbon  
H = Percentage of Hydrogen  
O = Percentage of Oxygen  
S = Percentage of Sulfur

$$\text{Stream Energy Available, } E_s = 0.7 \times Q \quad (2)$$

$$\text{Electric Power Generation, } E_p = E_s / 11395 \quad (3)$$

$$\text{Station Service Allowance, } S_A = 0.06 \times E_p \quad (4)$$

$$\text{Uncounted Heat Loss, } U_H = 0.05 \times E_p \quad (5)$$

$$\text{Therefore, Net Electric Power Generation, } E_{NP} = E_p - S_A - U_H \quad (6)$$

Total municipal solid waste generated in Dhaka city is approximately 6000 tons/day. As a result, a net electric power of 34.5 MWh/day could be produced from this amount of solid waste. It could support our national power grid as well as environmental conservation.

## PROPOSED WASTE MANAGEMENT SYSTEM OF DHAKA CITY

There are many processes available in the world such as Incineration, Pyrolysis/Gasification, Anaerobic digestion and Landfill Gas Recovery. Since Bangladesh is a developing country, a simple and less costly process is needed for producing electricity from solid wastes. Incineration is considered as a mature and simpler technology among the other technologies and is commonly used in majority of WTE plants in Asia (Yuan et al, 2008). Incineration transforms heterogeneous wastes into more homogeneous residues and high temperature and continuous air supply is necessary for complete combustion of the MSW. This process produces much higher electricity than other; though some extra fuel is needed to run the process however drying of wastes in rainy season is the only problem in this process. On the other hand, other technologies require dry land and solid wastes of low moisture content. Therefore, the incineration technology may be the best technology in DNCC and DSCC for solid waste management as well as electricity generation. A new waste management system is proposed for DNCC and DSCC after monitoring the existing system as shown in Fig.5.

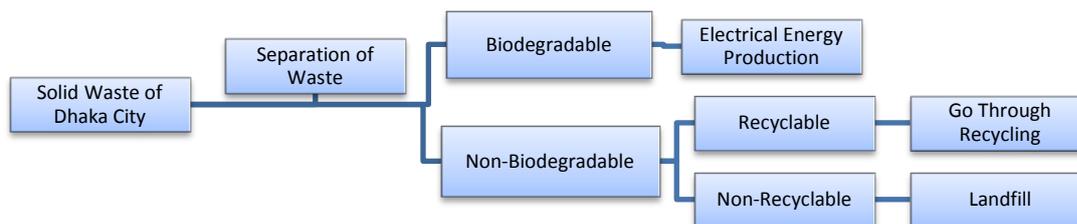


Figure 5: Proposed Solid Waste Management for Dhaka City

## RECOMMENDATIONS

Various recommendations were proposed to improve waste management system through study. According to the study only 70% to 72% of the total generated waste was collected and disposed per day by city corporation authority. The rest of the wastes remain on the road side bins or curbside creating unhealthy environment all around such as bad odor, soiled street and aesthetically problem. To solve the problem DCC need to find a proper solid waste management system in the Dhaka City.

More over NGO's may play a certain role by involving the community in the waste management system. The collection time and frequency should be such that maximum amount of waste is collected from the source. Different area may be covered by different collection time and frequency. If possible a waste recycling plant may be established for better resource recovery from solid waste because a major portion (80% - 90%) of solid waste is organic.

## **CONCLUSIONS**

Solid waste generation in Dhaka city has been continuously increasing due to rapid population growth and economic development. Investigating the present solid waste management it is clearly seen that city corporation authority has to increase their capacity to handle these massive amount of waste. Dhaka city authority is unable to offer the desired level of services with the existing capacity and trend of waste management. Policy makers should promote public-private partnerships to implement infrastructure projects in different stages of municipal waste management such as collection, transport, recycling, composting, waste to energy, etc. A community based solid waste management system involving recycling and composting in conjunction with sanitary landfilling with possible provision for transfer station to account for long distance of landfill sites may be the possible way out of the current inefficient system. Enforcing separation of wastes at source by creating incentives for efficient separation and disincentives for mixing could be great pace towards Dhaka city solid waste management. To reduce the undesirable adverse impacts of overflowing of waste bins and accumulated wastes on roadsides, strict rules must be applied on the management related activities and the level of public awareness should be increased. Waste to energy could be feasible solution for simultaneous energy production and environmental protection.

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## **REFERENCES**

- Ahmed MF and Rahman MM (2000). Water Supply and Sanitation: Rural and Low-income Urban Communities, ITN-Bangladesh, Dhaka.
- APO, 2007, <http://www.apo-tokyo.org/publications/files/ind-22-swm.pdf>
- Bangladesh to source 100MW from solid waste, <http://Asian-power.com/project/news/bangladesh-source-100mw-solid-waste>
- Dhaka North City Corporation (DNCC), Yearly Reports, 2015
- Helemul Alam (2016). Waste bin to make a cleaner Dhaka. <http://www.thedailystar.net/city/waste-bins-make-cleaner-south-dhaka-1215094>
- J. Zhu and M. Chow, "A Review of Emerging Techniques on Generation Expansion Planning," IEEE Trans. on Power Systems, vol.12, pp.1722-1728, 1997.
- K. Yuan, H. Xiao & X. Li, (2008). Development and application of municipal solid waste incineration in China. Nengyuan Gongcheng, 5, 43–46.
- N.J. Themelis & Y.H. Kim, (2002). Material and energy balances in large-scale aerobic bioconversion cell. Waste Management and Research, 20, 234-242.
- Samah M.A.A., Manaf L.A., Ahsan A, Sulaiman W.N.A., Agamuthu D'Silva J.L. Household solid waste composition in Balakong City, Malaysia: Trend and Management. Pol. J. Environ. Stud.22, (6), 1807, 2013

Shanghai Manual: A Guide for Sustainable Urban Development in the 21st Century. , 2012. By:  
*United Nations Department of Economic and Social Affairs*

Trash bins installed in city offer little to users, <http://newagebd.net/251814/trash-bins-installed-city-offer-little-users/>

US Environmental Protection Agency- Climate and Clean Air Coalition Municipal Solid Waste Initiative  
Assessment. 2014