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Solid Waste Management in Chittagong City

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Abstract- *In this paper we describe the solid waste management system in Chittagong City and also represents plastic solid waste recycling system specially re-use of plastic (PET) bottles. Nowadays solid waste management is a burning issue. Problem associated with solid wastes management system particularly in the developing countries, are complex. Solid waste treatment differs for developed and developing nations, for urban and rural areas and residential and industrial producers. A few studies have been done in this premise. These relate to solid waste, types of solid waste, the problem related to solid waste, solid waste management system, the overall solid waste management of Chittagong City Corporation, the way of developing and proposing a new system. This paper gives an idea about plastic recycling and reuse of some solid wastes which will be benefited for our country. Bangladesh is a small country with large population. Most people of our country are not conscious about solid waste management system. As a result it harmfully affects us. Supply of raw material for different industrial production is decreasing day by day and also it is getting costly. So we need to recycle various types of waste materials. For which we need a very good solid waste management system that is suggested in this paper.*

Keywords: Details on solid waste, solid waste management in Chittagong City, Plastic solid waste recycling, Re-use of plastic (PET) bottles**.**

1. INTRODUCTION

Rapid urbanization and population growth are largely responsible for very high increasing rate of Municipal Solid Waste (MSW) generation in the urban areas of Bangladesh, one of the densely populated Least Developed Asian Countries (LDACs). This scenario poses a social, environmental and professional threat for city dwellers, urban planners, development authorities and other concerned stakeholders. In Bangladesh, a major portion of population does not have access to waste collection services and only an insignificant fraction of the generated wastes are actually collected by door to-door collection system introduced by nongovernmental organizations (NGOs) and community based organizations (CBOs) in late 90's against tiny payment. Moreover, due to lack of motivation, awareness, commitment, expertise as well as money, a considerable portion of wastes, 40-60%, are not properly stored, collected or disposed in the designated places for ultimate disposal. As a result, the unmanageable increasing quantity of MSW creates enormous environmental problems. The MSW industry has four components: recycling, composting, land filling and waste to energy (WTE) via incineration. Information on the characteristics of MSW is an essential part for the selection of most appropriate system for storage and transport, evaluating equipment needs, determination of the potential for resource recovery, choice of a suitable method for disposal, sustainable management programs and proper planning. Characterization is also important to determine its possible environmental impacts on nature as well as on society. The per capita waste generation and percent composition of various waste components are the two most important types of data for decision makers. This information is necessary in order to identify waste components to target for source reduction and recycling programs, and to programs, and to allow technical professionals to design any waste facility such as material recovery facilities (MRF), WTE (Waste to Energy) projects, sanitary landfills, composting facilities, etc. [1]

In Bangladesh, the urban population has been increasing at a very steep rate, about 6% and is concentrated mostly in six major cities, where nearly 13% of total population and 55 to 60% of total urban population are living. Management of these steeply increasing vast quantities of solid wastes is a very complex process indeed. Due to severe financial constraints, absence of appropriate technology, lack of people's awareness, motivation and participation, ineffective legislation and law enforcement to protect the environment, the whole system is becoming a threat to city dwellers, planners and stakeholders (Alamgir et al. 2007). Like other cities of

developing cities, Bangladeshi cities often collect only 40% to 50% of waste generated, with open dumping the only disposal method available. Insufficient collection, uncontrolled street collection points and improper disposal in open dump sallow refuse to be readily available for informal waste recycling through scavenging/waste picking. This type of waste picking is generally carried out by the poor and marginalized social groups (scavengers/waste picker, locally called '*tokay'*) who involve into it for income generation and some even for daily livelihoods. Although no reliable statistics is available on this activity, Medina (2000) reported that up to 2% of Asian and Latin America's urban population depend on waste picking to earn their livelihood. In fact, formal waste recycling system is still not fully functional in low income cities and thus this disadvantaged group plays the primary role in the informal or extensive recycling process. As waste recovery and recycling are carried out by underprivileged people, social and health issues are now considered as the integral part of the solid waste management in the cities of developing countries.[2]

The general objectives of solid waste management (SWM) are,

- The protection of human being and the environment
- The conservation of resources
- Pre-treatment of waste to reduce after care after final storage.

Under the concept of sustainable development, these goals should be reached in a manner that does not hamper future generations

2. DETAILS ON SOLID WASTE

2.1 What is Solid Waste?

Solid waste means any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded materials including solid, semi-solid, resulting from industrial, commercial, mining and agricultural operations, and from community activities.

2.2 What Is Integrated Waste Management?

As waste management issues gain public awareness, concern has risen about the appropriateness of various disposal methods. Within our modern scheme of waste management, disposal is the last phase. Most people acknowledge that disposal will always be needed (the exception being those advocating zero-waste policies). The most widely used disposal method, the modern landfill. Solid waste professionals realize that the ideal way to reduce the stress on disposal systems is to reduce the amount of waste that is produced. The emphasis in modern solid waste management is on reduction, reuse, and recovery before disposal. These three words are at the center of the discussion of integrated waste management systems. Reduction is using fewer disposable goods. Reuse is using items again after their initial consumer use is past. Recovery is recapturing the material or energy value of the item at its highest point. [3]

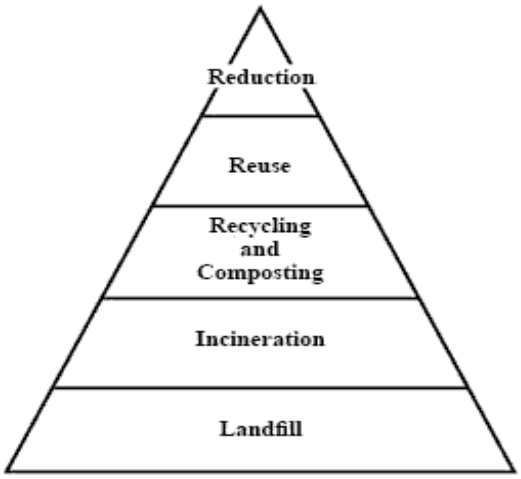

Fig 1: Hierarchy of integrated solid waste management.

2.3 Sources of municipal solid waste:

Treatment plant waste:
The solid and semi solid waste from water, waste water and industrial treatment facilities are included in this classification

Industrial refuses:
Refuse which is collected from industrial area within the city/municipality is called industrial refuse. Wastes of stores, markets, offices, hotels, motels, shops, auto-repair shops are included in this type.

Demolition and construction wastes:
Construction and demolition waste consists of all waste originating from construction, renovation and demolition activities, such as rubble, bricks and tiles rust, junkyard, rubble.

Hospital wastes: Hospitals wastes are biologically hazardous wastes.

2.4 Ecological Impacts of Solid Waste:

Fig 2: Disposing of solid waste is a serious problem

2.5 The Problems of the Direct Incineration:

Waste incineration is one of the important roles of waste management. If there is no space for the landfill in some

cities, the incineration sounds the best way to handle the waste. However, there are some shortages and problems of the incineration.

2.6 The Incineration Hazard to the Environment:

Dioxin Emissions:

According to the report of UNEP chemicals on a global scale, the incineration plant produced a major source of dioxin. For instance, in Japan, 93% of the dioxin air emissions were from incineration plants, that in Sweden are 85%, in UK 79%, in Denmark 70% (UNEP, 1999). But in the recent years, most of the developed countries such as the countries of EU and Japan adopt more stringent emission standards for dioxin emissions control, and it made a significant progress that effectively reduced the dioxin emissions.

3. SOLID WASTE MANAGEMENT IN CHITTAGONG CITY

3.1 Key Elements of SWM:

The Chittagong City Corporation (CCC) is responsible for the collection and disposal of solid waste generated in the Chittagong City Corporation area. Not all the waste that is generated is collected and dumped at landfill sites. The rest of the waste remains uncollected, which makes the future environmental scenarios of Chittagong City dismal and gloomy. Such inadequate and uncontrolled waste management causes serious health hazards and environmental degradation in the city.

1. Collection

The Chittagong City Corporation has about 1832 cleaners employed for street sweeping and the collection of waste found in lakes. This does not cover dustbins, roadsides, open spaces, ditches, etc. After sweeping the streets, the sweepers temporarily store the waste at waysides. From there it is collected by hand trolleys. This small equipment is very suitable for collecting waste from alleys. Usually households bring their refuse to the nearby community bins/containers located on the sides of streets. Recently, house-to-house Waste-collection service has been launched in residential areas such as chand gaon, halishohor, khulshi, west khulshi, sugandha, arakan housing society etc residential areas. It is operated by CBOs or through private initiatives. The households are charged on the basis of the amount collected. Rickshaw vans are used to transport the waste from the houses to municipal waste bins or Containers. Street sweeping is done manually and debris is loaded from the curbside into the hand trolleys and delivered to the collection bins. CCC sweepers and cleaners sweep roads and clean drains and then dump the waste into nearby dustbins or containers using hand trolleys.

The whole system, however, does not operate in an environmentally friendly manner.

2. Transport

For secondary collection from the waste bins to dumpsites, the Chittagong City Corporation has 67 demountable Container carrier trucks to collect the accumulated waste. There are also 72 open/covered trucks. The capacity of the Chittagong City Corporation fleet is of 80 collection vehicles. The trucks used to transport solid waste are evaluated as follows.

- Open garbage trucks: these trucks create a nuisance as they pass through the street. Sometimes efforts are made to cover them after loading the waste.
- Covered garbage trucks: The one- or two-men crews who load and unload the trucks from inside the truck may feel suffocated due to the small space.
- Container carriers: Usually a large space is needed for maneuvering these carriers near the containers. The waste is carried by hand trolley or rickshaw van and loaded directly into the container carrier. The container carrier simply lifts the container onto it. Loading by shovel is not required. Unloading is also done in the same way. Thus container carriers are preferred to open or covered trucks.

3. Disposal

There are a number of ways to dispose of municipal solid waste. Open dumping is the most common and the cheapest method. Therefore it is widely used in developing countries and even in some developed countries. In Chittagong waste collected from the municipal waste container or waste bins is carried to the two dumpsites at Halishohor and Roufabad. The Chittagong City Corporation employs crude waste dumping at the Halishohor landfill site, an uncontrolled dumpsite having no sanitary landfill arrangement. It is estimated that only 50%, about 750 tons of waste, is dumped at the Halishohor and unofficial sites. Of the remaining wastes are used in backyards and landfills, dumped on the roadside and in open space, recycled by the rag pickers, and the remaining recycled at the generation point.

Because of waste dumping, foul odors and air pollution are dangerously affecting the surroundings. Rodents spread germs and pathogens in the area and workers at the landfill are regularly exposed to hazardous diseases. MSW in the presence of moisture gives off organic and inorganic contents which turn into leach ate. A huge amount of leach ate is generated from the uncontrolled dumping as the MSW percolates through the surface and contaminates the groundwater. Consequently, the risk of polluting the underground aquifers increases. There is no provision for the removal or treatment of leach ate. More land, which is very scarce and expensive in and Chittagong around, will be needed in the near future for use as landfill. In addition, a large area around the landfill site is rendered unsuitable for living or other activities. Therefore the present system of unsanitary landfill is unacceptable, and there is an urgent need to build sanitary landfill sites or adopt even better alternative options.

4. Recycling - Garbage Treatment Plant

The only garbage treatment plant of Chittagong city is located at Anonda bazaar, Halishohor. It was established at 9th April, 2004. It has 30 staffs working here. Almost 750 tons of waste is dumped here. Out of these 750 tons of waste only 10 tons are treated. Only the organic wastes are recycled here.

The inorganic wastes are not been recycled. They are often taken by the poor people and children as 'tokay'. They use the inorganic wastes such as plastic bottles, bags, injection syringe, saline bags etc in their day to day life. Sometimes these waste products are reused in the market without any recycling or purification, which is a major threat to public health safety and dignity. Rules and regulations must be introduced and strong maintenance of them must be emphasized.

The treatment plant has two sections –

1) Natural fertilizer plant
2) Choir foam.

3.2 Natural Fertilizer Plant:

Natural fertilizer is produced from the digestion of any organic physic. In this plant 10 tons of organic waste out of 750 tons of total solid waste is used to produce fertilizer per day. From 10 ton of raw materials 2.5 ton of fertilizer is produced.

Table 1: Raw Materials of natural fertilizer

Materials	Percentage
Green vegetables	40%
Cow dung	20%
Saw dust	10%
Straw, coconut powder etc.	30%

3.3 Procedure:

The process of producing fertilizer from solid waste are given below –

i. The wastes that are collected are sorted out. As the plant requires only the organic wastes so inorganic wastes are sorted out and removed. The sorting process requires excess of people and time.
ii. The organic wastes are then gathered for composting by box filling process. In this process they are contained in a cement box of 20ft long and 5ft wide. Wastes are placed there for 40 - 45 days. To remove the anaerobic gases of compost pipes with small holes are injected in the pile of waste as 1 pipe per 1 – 1.5 ft of the length of the box. A special type of spray named EM spray is given to the pile of waste.
iii. Then the wastes are left in the box for 7 – 10 days for maturing.
iv. After maturing, the wastes are put into a machine called "Vibrating Skinner". The main function of it is to remove glass pieces, dirt, etc from the compost.
v. After vibrating skinner the compost become rigid and put into a cutting machine. The cutting machine cuts the compost into particles of 8mm – 10mm size.
vi. Then the resultants are introduced to powdering machine where they are powdered.
vii. The powders then placed in Gan Knotting machine. Here they are sprayed with water homogeneously.
viii. The resultant clay is then dried in a dryer. The dried powders are then packed for marketing.

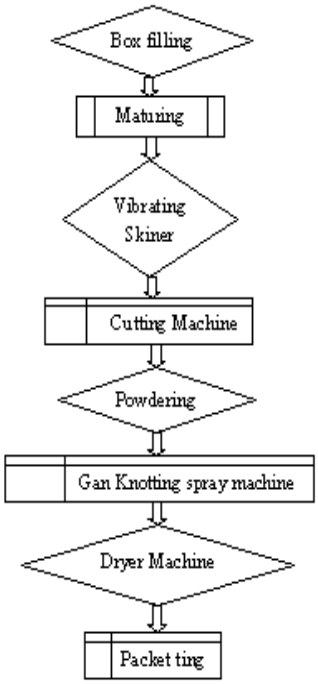

Fig 3: Flow diagram of processing of garbage to produce fertilizer from organic solid waste.

4. PLASTICS SOLID WASTE RECYCLING

Recycling of plastics that used to end up only at city landfills or incinerators is increasing around the world. As with any technological trend, the engineering profession plays an important role. Discarded plastic products and packaging make up a growing portion of Municipal Solid Waste (MSW). The Environmental Protection Agency (EPA) estimates that by the year 2000, the amount of plastics throw away will be 50 percent greater than at the beginning of the 1990s. EPA also says that plastic waste accounts for about one-fifth of all waste in the waste stream. Over the past two decades, recycling of plastics has dramatically increased.

4.1 The Recycling Process:

Step 1 - Plastics collection

Plastics for recycling come from two main sources: post consumer plastics and post industrial plastics. Post consumer plastics are those which have already been used by people. These are the plastics collected in plastics recycling bins and at domestic roadside collections. Postindustrial plastics, on the other hand, are rejects from industry — off cuts, damaged batches etc. These plastics are collected either directly from the industry or collected by the local council, squashed into

bales and sold to a recycler.

Step 2 - Manual Sorting

In theory, every type of plastic can be recycled. In practice in New Zealand only codes 1(PET) and 2 (HDPE) are recycled. The incoming plastic is manually sorted into these two codes and 'other', and the three separate streams sent off to be chipped. It is particularly important that all PVC is removed from the PET stream as the more sophisticated sorting used later on cannot differentiate between these two types of plastic. Any rocks, nails, metal

Table 2: Summary of plastic types

Code	Name	Description	Examples
1 PET	Polyethylene terephthalate	Usually clear or green, sinks in water, rigid, glossy	soft drink bottles biscuit trays
2 HDPE	High density polyethylene	Slightly opaque, low gloss, crackly film	milk bottles supermarket bags
3 PVC	Polyvinyl chloride	Semi-rigid, glossy, sinks in water	detergent bottles raincoats
4 LDPE	Low density polyethylene	Flexible, not crinkly	bread bags six-pack rings shrink wrap
5 PP	Polypropylene	Semi-rigid, low gloss	straws screw-on lids
6 PS	Polystyrene	Often brittle, glossy	polystyrene foam yoghurt containers
7 Other	This includes a variety of copolymers such as ABS .	acrylonitrile Butadiene	margarine containers squeezable sauce bottles

Step 3 - Chipping

Each sorted stream of plastic is then sent separately to a chipper. This is a cylinder of blades somewhat like an old-fashioned lawnmower in a vessel with a 10 mm grill floor. The blades cut the material until it is small enough to fall through the grill.

Step 4 - Washing

The chips are then washed to remove glue, paper labels, dirt and any remnants of the product they once contained. Both the "other" stream and the PET stream are washed at around 90oCfor at least twelve minutes, while the HDPE (which has a much lower melting point) must be washed below 40oC to prevent discoloration. The wash solution consists of an alkaline detergent in water, which removes dirt and grease and degrades protein. The detergent used is an alkaline, cationic detergent (i.e. an alkaline solution containing a cationic surfactant). Dishwashing detergents are usually anionic, because glass, china etc. usually build up a negative surface charge. This means that positively charged dirt particles are attracted to them, so an anionic detergent is needed to remove the dirt. If a cationic surfactant were used it not only would be incapable of removing the dirt, but it would itself stick to the surface to be cleaned, making it greasy.

Step 5 - Pelleting

This is done by melting the chips and extruding them out first through a fine grill to remove any solid dirt or metal particles that have made it through the treatment thus far and then through a die of small holes. If the plastic was simply allowed to extrude from these holes it would come out as spaghetti-like strings and quickly tangle together. However, it is sprayed with water as it comes out (to prevent the plastic from sticking together) and cut off by rotating knives to give small, oval pellets.

4.2 Environmental Implications:

As stated above, plastic recycling prevents damage to the environment *via* excessive land filling and use of non-renewable resources. The process is also largely environmentally safe, with the only effluent being from the wash water. This is recycled in the plant as much as possible to minimize water use and when it is finished with it is still sufficiently clean to be dumped into the sewers.

5. RE-USE OF PLASTIC SOLID WASTE (PET) BOTTLES

5.1 Solar water disinfection:

Solar water disinfection, also known as SODIS is a method of disinfecting water using only sunlight and plastic PET bottles. SODIS is a free and effective method for decentralized water treatment, usually applied at the household level and is recommended by the World Health Organization as a viable method for household water treatment and safe storage. SODIS is already applied in numerous developing countries. [4]

5.2 Issues to consider:

The following are some of the issues discussed in the literature:

- According to the World Health Organization, more than two million people per year die of water-borne diseases, and one billion people lack access to a source of improved drinking water.

- Local education in the use of SODIS is important to avoid confusion between PET and other bottle materials.
- Applying SODIS without proper assessment (or with false assessment) of existing hygienic practices & diarrhea incidence may not address other routes of infection. Community trainers need to themselves be trained first.
- When the water is highly turbid, SODIS cannot be used alone, additional filtering or flocculation is then necessary to clarify the water prior to SODIS treatment.

5.3 Worldwide application:

The Swiss Federal Institute of Aquatic Science and Technology (Eawag), through the Department of Water and Sanitation in Developing Countries (Sandec), coordinates SODIS promotion projects in 33 countries including Bhutan, Bolivia, Burkina Faso, Cambodia, Cameroon, DR Congo, Ecuador, El Salvador, Ethiopia, Ghana, Guatemala, Guinea, Honduras, India, Indonesia, Kenya, Laos, Malawi, Mozambique, Nepal, Nicaragua, Pakistan, Perú, Philippines, Senegal, Sierra Leone, Sri Lanka, Togo, Uganda, Uzbekistan, Vietnam, Zambia, and Zimbabwe. Contact addresses and case studies of the projects coordinated by the Swiss Federal Institute of Aquatic Science and Technology (Eawag) are available at SODIS.

SODIS has also been applied in several communities in Brazil, one of them being Prainha do Canto Verde north of Fortaleza. There, the villagers have been purifying their water with the SODIS method. It is quite successful, especially since the temperature during the day can go beyond 40°C (100°F) and there is a limited amount of shade.

6. CONCLUSION

Over the last couple of decades, there has been a growing recognition of involvement of informal sector to ensure economic, social and environmental benefits from MSWM. In a micro-economic perspective, informal waste recovery have substantial economic benefit as it provides options for small business without capital expenditures. It minimizes the costing of large scale manufacturing industry and stimulates low-cost, affordable and eco-friendly products from recycled products the social aspects of the poor groups attached with the process are crucial for achieving sustainable outcome of MSWM. Though scavenging is an easy accessible employment for the urban poor but the occupation is associated with health risks. Unfortunately, the government policies in most of the developing countries are not supportive for the involvement of informal sector in solid waste management. This could be a professional business for the urban poor with the assistance from related organizations. Waste Management authorities can intervene in the marketing of recyclable products to maximize profits through transportation support, occupation safety, promoting the use of recycled products. To enhance the efficiency and dignity in resource recovery works as well as other social aspects of solid waste management will require modes of co-operation in which governmental agencies, community-based organizations, voluntary groups and the general public can work can work together.

The scavenging community also suffers from limited access to urban facilities (e.g., water supply and sanitation) and social safety networks. As the demand of recyclable products is increasing day by day in order to save resource and energy, scavengers play an important role in the wastes recycling process. On the other hand, informal waste recovery and recycling is particularly important for the cities in developing countries, where public authorities are financially and technically incapable of handling the major portion solid wastes. Realizing the significance of this sector, it is imperative to integrate informal work with the formal MSWM, to help them organize themselves and to add value to their recycled materials before selling them. This can be done by moving up the hierarchy of waste pickers in the waste recovery and recycling chain and to extract higher value from recovered materials. In addition, measures need to be taken to protect livelihoods while working to improve both the efficiency and the living and working conditions of those involved to improve the social aspects of solid waste recovery and recycling, an in-depth understanding over the informal process is essential for the intermediary actors and institutions in bridging the institutional gap between state bureaucracies and informal social fields.

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