Analysis of Urban Solid Waste Management System of Bangladesh and Germany Waste Management System

Mohammed Omar Sahed Chowdhury and Ashef Ainan Baksh

***Abstract*—Bangladesh is a low-lying riverine country. Unplanned growth of urban population causes audacious generation of solid wastes and strives immense pressure on existing services and environment. At present days, urban solid waste management is considered as most immediate and demanding environmental problems vexing Municipal authorities or urban governments in developing Asian countries like Bangladesh. Cities are now clashing with the serious problems of high amount of waste. The traditional concepts and inferior technologies of collecting waste are becoming incomplete as well as incompetent resulting more than half of the engendered solid wastes remain uncollected, disposed of regionally, forging the environmental view of cities quite murky and disheartening for the future. In waste management system, Germany is a role model for the world and the New German Closed-Cycle management is aiming to curve the waste management into resource management. The main intent of this research study is to categories in the solid wastes, discussing the issues of waste generation, a popular method for solid waste management, gasification schematic and waste-management model for Bangladesh. This study also explains Germany Closed-Cycle Management Act as well as waste treatment facilities, recovery, and disposal rate in Germany. Germany keeps very high-quality to preserve soil, air and water from the emissions integrated with waste storage and treatment.**

***Index Terms*—Solid waste, waste management, Bangladesh, waste recovery, Germany, disposal.**

I. Introduction

Rapid population growth, intractable industrial development gravely de-escalates urban environments, causes extreme strain on natural resources which consequently weaken sustainable urban development. Everyday Dhaka city is harshly producing over 3000 tons of household waste while Dhaka City Corporation collects less than half of it. The rest of wastes remain on open spaces, roadside. Disposal of solid waste stands in place a big and devastating problem because it leads to either land pollution if dumped or deposited in landfills, water pollution if dumped in lowlands and air pollution if burnt. In developing countries, the general practice of solid waste disposal is still unplanned and uncontrolled open dumping which is responsible for dust pollution, odor, and nuisances. Moreover, it is very hard to locate a new landfill to minimize environmental impact. The volume of solid waste production in Dhaka city is escalating in proportion with the increase of population, consequently, the solid waste management system has been found collapsing day by day turning costly and ineffective. More than half of the city's daily produced solid wastes remaining uncollected are being disposed of locally which makes the environmental scenario of the metropolis quite depressing and bleak [1].

In developed countries like Germany, waste management has changed from relatively submissive management of waste emerging to an active management integrating environmental and economic concerns. The new German Closed-Cycle Management Act is pointed to turn the waste management into useful resource management. Today 14 per cent of the raw materials used by the German industry are recovered waste, which directs to a cutback of the extraction levels and of the related environmental impacts. To accomplish the German Kyoto targets on the diminish of climate-relevant emissions, Modern closed-cycle management of Germany contributes with a roughly 20 per cent share. In Bangladesh, lack of financial resources, accelerated growth of industries, incompetent trained manpower, lack of consciousness of the community and irrelevant technology are the major restrictions of solid waste management for the fast-growing metropolis of Dhaka.

II. Historical Background of SWM in Bangladesh

During the British regime in 1820, a Municipal committee was set up to look after the sanitation in Dhaka city, Bangladesh. Consequently, in 1864 Dhaka Municipality was established but SWM sector dropped back more than other city facilities. For that reason, the safeguarding service was borne and conducted by the cleaners, manual labors. In 1963 a water carriage system was made current with a separate set-up known as DWASA for proper sanitation and good quality liquid waste management. In 1982 an evolutionary and significant improvement took place in SWM system. Open trucks were introduced to carry the debris to the dumping site. In 2003, the approximate urban waste generation in Bangladesh was 5650 tons per day which turns annually 2.06 million tons. In 2010, this waste generation has escalated to 8280 tons per day and annum generation is 3.02 million tons. By 2021, the daily and annual waste generation will head to 15110 tons per day and 5.52million tons in annum. The waste generation rate is ameliorating at an alarming rate which is about to reach 47,064 tons per day by 2025. Developed countries follow some robust strategy and concept for recycling waste and minimizing the impact on the environment. There are some major problems of developing countries to improve the waste management strategy because of economic instability, unplanned growth of the industry, and technological lacking [2].

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III. Origin of Solid Waste, Category and Risk Potential

A remarkable percentage of the population has no access to proper waste disposal services, which will result in the problem of waste mismanagement. The total waste collection rate in major cities of Bangladesh such as Dhaka is only 37%, and in different urban areas varies from 37% to 77% with an average of 55% which is not very satisfactory. When wastes are not properly collected, it generates serious environmental hazards to the ecology, water body, and human body [3]. Table I gives an overview of the origin of the waste, category of the waste with risk potential. Kitchen waste, Commercial Waste, Industrial Solid Waste, Institutional Solid Waste, and Construction waste are some major types of solid wastes that are responsible for serious environmental problems.

TABLE I: Waste Origin, Category and Risk Potential

Origin of Waste	Example	Category	Risk potential
Solid waste from Household	Kitchen waste, (Leather, paper).	Combustible or Non-Combustible.	Non-hazardous
Commercial Waste	Metals, plastic bags, wires, glass	Non-combustible Waste	Non-hazardous
Industrial Solid Waste	Wood, ceramic, chemicals	Combustible or Non-combustible	Hazardous/ Non-hazardous
Institutional Solid Waste	Waste from school, office, organization	Combustible or Non-combustible	Both hazardous and Non-hazardous.
Construction waste	furniture, refrigerator	Large waste	Non-hazardous

IV. Waste Generation

As the growth rate of population in Dhaka has been lofty in recent years, the volume of waste generation in Dhaka is escalating. The average income of the people and population is proportional to the amount of waste generation in urban area. Apart from that other factors such as level of education, social and public attitude and climate plays vital role in waste generation.

TABLE II: Solid Waste Generation Growth in Urban Cities of Bangladesh

Year	Total Urban Population	Urban Population (%Total)	Waste Generation rate(kg/cap/day)
1991	20872204	20.15	0.49**
2001	28808477	23.39	0.5***
2004	32765152	25.08	0.5***
2025	78440000	40	0.6**

** Source: ADBI and ADB, 2000, *** Zurbrugg 2002

Table II shows that the solid waste generation in urban cities is getting bigger with population growth as well as per capita GNP. The waste is generating every year at a significant rate which is a big threat to the environment.

Fig. 1 shows that in Bangladesh the highest portion waste is residential waste in all major cities. Commercial waste is in second priority in this case and Institutional, Municipal and other wastes are nominal. The consumption rate per kg/cap/day is increasing at an alarming rate. Due to the increasing population, unstable government policy, insufficient land-use for disposal of waste, and lack of awareness of the people are the major concern for propagating the solid waste management problem in main cities in Bangladesh.

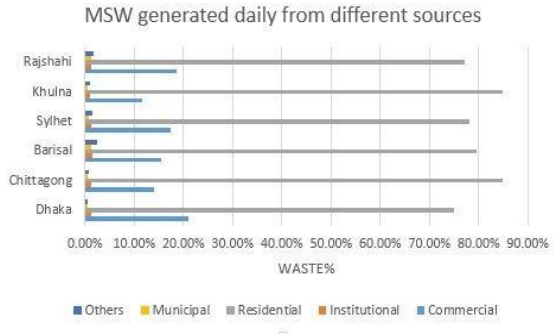

Fig. 1. Total propagation of MSW in main cities of Bangladesh.

V. Solid Waste Management System in Germany

A. Germany Closed-Cycle Management Act

The new German closed-cycle management act is pointed to turn the waste management into resource management. In 1996, the closed-cycle management act came into force in Germany which acts that the consumers and the producers will have to build a comprehensive rethink in the field of waste. The act dictates that whoever produces markets and consumer goods are accountable for the recycling, reuse, avoidance and environmentally healthy disposal emerges from the wastes. A hierarchy of recovery, avoidance and disposal is fixed, putting a chief obligation to circumvent waste in production procedures and to boost low-waste products [4]. Where waste is not recovered, waste must have to be disposed in environmentally-friendly way (Federal Ministry for the Environment, Germany, 1994).

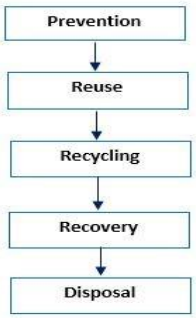

Fig. 2. Waste scale according European and German law.

B. Purpose and Area of Application of the Closed-Cycle Management Act

The purpose of this act is to stimulate closed substances cycle waste management for preservation of natural resources and to assure environmentally suitable disposal of waste. The arm of this act puts in to the 1. Prevention, 2. Disposal of waste and 3. Recycling. While this act does not

apply to the nuclear fuels and other radioactive stuffs within the sense of atomic energy act. This act does not concern to those materials whose disposal is operated by a statutory ordinance armed on the basis of preventative radiological protection act. Gaseous substances not in containers are exclusive of this act. Moreover, materials discharged into waters of the sewage system are out of this act, as well as waste emerging from extraction, preparation, processing of mineral resources (subject to mining) are not concern of this act.

C. Municipal Solid Waste Treatment in Germany

In waste management Germany is an icon for the world. Drainage system of Germany is strongly developed because of their modern technology and intellectual management process. More than 3.5 million people of Berlin are responsible for waste generation every day so that the city can make a chief contribution by implementing modern waste management methods for environmental protection. Over the past two decades, Berlin has filled the target much in this field. There has been a remarkable reduction in the amounts of waste generated, while at the same time more has been recycled. Berlin was the first German federal state to initiate a model for waste separation plan in January 2013, with a single recycling bin for light packaging along with similar materials. Germany use several treatment plant facilities for waste in Berlin and other cities as well. BSR's MHKW Ruhleben Waste-to-energy power station with annual capability of 520,000 tons of waste creates the climax of Berlin waste disposal. Acute substances are fixed as dust in the filters and collected by the flue gas treatment plants.

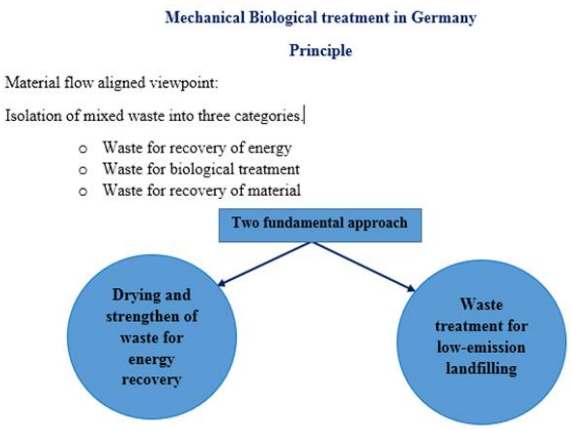

Fig. 3. Mechanical –biological treatment principle.

Fig. 3 gives an overview of mechanical biological treatment for isolating the mixed waste into three categories which are waste for energy recovery, waste for biological treatment and, waste for recovery of material respectively. Mechanical–physical stabilization plants are used for residual waste; Biogas fermentation plants uses dry fermentation method for organic waste. With each ton of paper intake, Paper sorting plant achieves a savings of approx. 640 kg CO_2 –equivalent. Mechanical treatment plants are for municipal and construction waste. Since 2005, ALBA is one of the Europe's Avant-grade sorting and processing plant for light packaging waste like metal, plastic etc. [5].

D. Waste Recovery and Disposal Rate in Germany

In Germany, the sector of waste management provides defendable production with high recovery and recycling rate which continuously assist to save energy and raw materials. Fig. 4 shows the Recovery and Disposal rate in Germany from 2000 to 2015 years where the recovery rate is increasing and the disposal rate is declining which in turn helping to save primary energy and raw materials [6].

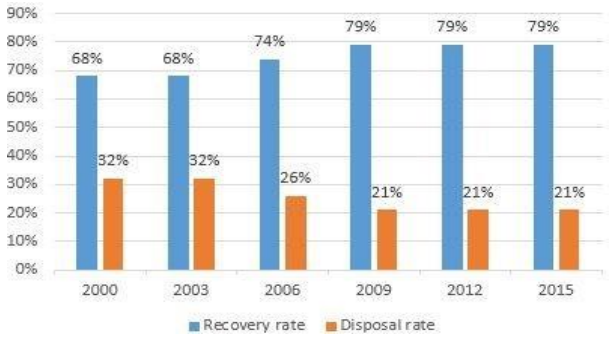

Fig. 4. Recovery and disposal rate in Germany (2000-2015).

VI. Waste Management Method for Bangladesh

A. Public-Private Partnership Approach

Public-private partnerships can be defined as the transfer and control of a good or service presently issued by the public sector either in whole or in part to the private sector. Fig. 5 represents a flow Chart of Multiple Solid Waste Management Value Chain which consists of some activities and units. The public-private partnership approach has introduced conducting the waste by themselves to the street corner bins. In this approach, there are separate bins for biodegradable and non-biodegradable waste. The compact loader is used to transport wastes to the waste storage depots (WSD). Bio-degradable waste is transported to a composting facility where micro-organisms are used and have been established by the private sector. In the sequential chain of a public-private partnership approach, the processing of waste treatment facility consists of three different units such as Material recoverable facility, Composting, and Waste to energy facility. On the other hand, transfer activity includes recyclables collection, organic/biodegradable and insert /reject activities. Sales activity includes some parameters which are the sale of recyclables, sale of compost, and sale of energy.

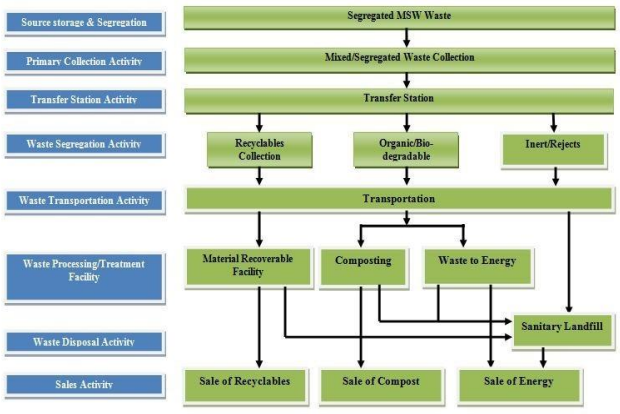

Fig. 5. Flow chart of multiple solid waste management value chain.

Public-private partnership approach demands an extensive participation of private sector in public services and serves as a probable strategic management tool (Hutchinson 1996, Donaldson and Wagle 1995, US EPA 1999). Because of alarming problem of municipal solid waste management in most cities of developing countries, private sector participation in affording solid waste services kicked off as a feedback to the major failure of service delivery by the public sector. (UNESCAP, 2011).

B. Gasification System

Generating highly efficient electrical power from waste through gasification, incineration and methane production is an example of waste to energy production. Fig. 6 shows the gasification system where waste is input in gasification reactor and air is supplied. The steam uses for power and heat production. After chemical and physical process in Flue gas treatment system, synthetic gas moves to Power generator. After air supply power and heat is produced [7].

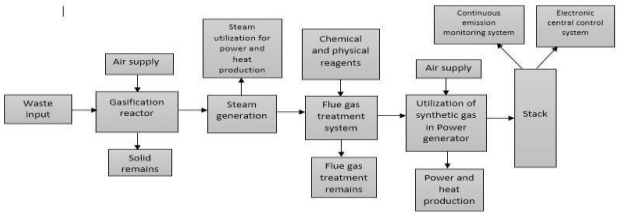

Fig. 6. Diagram of highly efficient electrical power production through gasification system.

C. Waste Management Model for Bangladesh

At present, it is very much important to make proper waste management and disposal plan so that waste can be considered another source for earning money. So, keeping this objective in mind, this study aims to develop a new waste management model for Bangladesh. Fig. 7 describes the model of waste management plan.

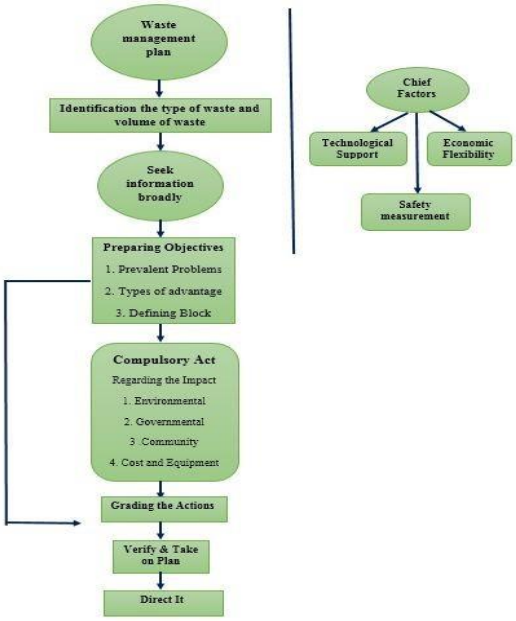

Fig. 7. Waste management model.

In this model, Identification the type of waste, preparing objectives after seeking information briefly and Compulsory acts are chief factors whether technological support, economic flexibility, and safety measurements are the prerequisite for this model. The waste management system in Bangladesh needs to develop for saving the ecology, and the water body of the environment. Moreover, a worker working in waste disposal activities are at high risk for dangerous diseases. Bangladesh government should take immediate step to re-think on this issue [8].

VII. Conclusion and Future Work

Waste Management is an alarming issue for the developing countries like Bangladesh. In our country this problem is terrible. Roust research works are required in this field to find ways to de-escalate the problems emerging from inappropriate solid waste management. Some research works have been conducted in Bangladesh and few studies have also been conducted in other major cities like Chittagong on the issue of waste management. But failure in approaching proper waste management methods and the reason behind inaccurate waste management systems are the major concern to re-think to find the solution to this big problem. [9]

In Bangladesh, the solid waste management is done by DCC (Dhaka City Corporation). But due to the increasing rate of population, it is very difficult task to manage all wastes in major cities. Moreover, the dumping system and open disposal management is not hygienic because of the lacking of present-day technology. The uncollected wastes form excessive drainage problem in monsoon season in Bangladesh. So, it is obvious to follow the integrated Germany waste management system as Germany is role model in waste management system in worldwide. [10] In order to boost waste management of Bangladesh the following recommendations can be options:

1) Improving resource recycling technology, inspiring green production and promoting the reuse rate renewable resources.
2) Establish robust policy and long-term strategic framework hinged on modernized perceptive of environmental situation in Bangladesh.
3) Promote scientific and plausible waste management system for accumulation, transport, dispose and recycling of waste.
4) Exploring the probabilities of integrating waste solutions with power production – gasification, incineration, methane generation.
5) Motivating enterprises to energetically participate in resource recycling, resolving land issues for initiating factories, and providing them enough economic inducement.
6) Enlarging pollution prevention and management to assure nil pollution from operations and derivative wastes.
7) Fostering the development of ecological treatment facilities for recycling.
8) Controlling recycling fund balance to assure secure operation mechanism.
9) Finally, campaigning program, increasing awareness among people about recycling and hygiene should be arranged.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Engineer Mohammed Omar Sahed Chowdhury conducted research on solid waste management system of Germany (purpose and application of closed-cycle management act, municipal solid waste treatment system, waste recovery and disposal rate in Germany). Engineer Ashef Ainan Baksh conducted the research on literature of solid waste origin, category, risk potential, waste generation and propagation rate in main cities of Bangladesh as well as on waste management method for Bangladesh (public-private partnership approach and gasification system). Moreover, Mohammed Omar Sahed Chowdhury and Ashef Ainan Baksh wrote this full paper in a group and proposed a waste management model for Bangladesh with future tasks.

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