

# Municipal Waste Management and Environmental Hazards in Bangladesh

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**Abstract:** Municipal solid waste is a serious environmental hazard and social problem in Bangladesh. Currently a gigantic volume of solid waste is generated every day in the district towns of Bangladesh and unfortunately solid waste management is being deteriorated day by day due to the limited resources to handle the increasing rate of generated waste. In order to check the waste management situation a detailed survey in different cities of Bangladesh has been done in this study. Although a significant amount of municipal waste is collected by community based organizations, conservancy wings of the cities can not dispose more than 50% of the generated wastes. This study reflects the adverse impacts of pollution through solid waste and deteriorating situation of municipal solid waste management in capital city Dhaka, divisional city Sylhet, greater district town Tangail and Rangamati and new district town Gazipur.

**Key words:** Solid waste, conservancy wings, recycling, community based organizations, environmental hazards, DCC and other municipalities.

## Introduction

In Bangladesh, solid waste generation during the last decade of the previous century has increased enormously at an average annual rate of 8.96% per capita per year (Kazi, 1999) while the solid waste management and hygienic disposal capacity of the municipal authorities is miserably lagging behind. Solid waste sectoral analysis carried out by the World Bank, EDA and WEDC and also information collected from Dhaka City Corporation (DCC), Chittagong City Corporation (CCC), Khulna City Corporation (KCC) etc. reveals that the waste generation rate for the capital city Dhaka is 0.6 kg/capita/day; port cities Chittagong and Khulna and old divisional city Rajshahi with population greater than 1,000,000 is 0.5 kg/capita/day; new divisional cities Sylhet and Barisal of population greater than 500,000 is 0.4 kg/capita/day;

greater district towns of population greater than 100,000 is 0.3 kg/capita/day; municipality towns of population around 50,000 is 0.2 kg/capita/day and rural communities of Bangladesh is 0.15 kg/capita/day (Kazi, 1999; World Bank, 1998). High growth rate of population as well as influx of rural people for seeking job and shelter in the district towns have accelerated multi kind of problems; specially megacity Dhaka faces serious environmental degradation and health risks due to vast amount of generated solid waste. Municipal Solid Waste Management (SWM) has failed to keep pace with the gigantic amount of Solid Waste (SW) produced in the urban areas. Deteriorating SWM is facilitated by insufficient workforce of conservancy wings of city corporations and municipalities. In order to evaluate the existing status of SWM situation in Bangladesh the study was conducted in two phases: first in 1999-2000 and 2nd phase in 2003-2004 in Dhaka, Sylhet, Tangail, Rangamati and Gazipur. This study gives high emphasis on Dhaka

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city due to its huge population and gigantic volume of generated municipal waste and medium emphasis on Sylhet city due to its geographic location and divisional status.

### Findings of the SWM Study

The study was mainly concentrated to investigate the municipal solid waste management situation in five cities of Bangladesh. In order to carry out the study a detailed survey on the existing facilities of SWM components such as manpower resources and management systems (e.g. waste generation, collection, sorting and separation, cost involved etc.) of the concerned utilities have been considered. Processing and analysis of survey results, interviews, collected data and gathered information reveals the following results and findings.

#### Conservancy Wings

SWM in Dhaka city was mainly organized by Dhaka City Corporation (DCC), in Sylhet city by Sylhet City Corporation (SCC) and in other cities and towns by respective municipalities. SWM in DCC, SCC and other municipalities is operating under the conservancy wings executed by Chief Conservancy Officer (CCO) or Health and Conservancy Officer (HCO) and other conservancy or supervisory staff under the direct supervision of the Mayor/Chairman of the city corporations and municipalities. Besides those, there is a suitable number of conservancy inspectors and adequate number of sweepers, cleaners and labourers (regular/daily basis/muster role) for serving SWM. DCC and other municipalities have a number of garbage vehicles, push carts and drivers for collecting waste from dustbins located in the selected areas. Table 2 shows a list of the existing staff of the conservancy wings engaged in SWM and also other resources (vehicles, containers etc.) of DCC, SCC and other municipalities.

#### Waste Generation

There is no accurate data to identify the amount of solid waste generated in Dhaka city and other municipalities. Based on the sources, generated solid waste of Dhaka city can be categorized into major categories such as domestic waste, commercial waste, industrial waste, hospital waste, tannery waste etc which are described below.

*Domestic Waste:* Dhaka city households generate food and vegetable waste, paper, packages/cartons, rags/clothing/textiles, polythene/plastic, rubber, garden waste

(grass, leaves and plants), wood (limbs and sawdust), furniture (wooden, steel, cane and aluminum furniture), bamboo, metal and metallic cans, leather, glass, stones, bricks, ceramic, debris, dirt, dust and ashes etc.

*Commercial Waste:* It includes food waste, paper, packages, polythene/plastic, cloth/textile etc. Commercial waste is originated in wholesale, retail or service establishments such as trade offices, shops, markets, hotels, restaurants of commercial areas etc.

*Industrial Waste:* More than 1000 industries in the mega city Dhaka generate toxic and hazardous wastes in and around the city. According to survey results, waste from textile industry contains yarn, cloth, packing materials etc.; paper and pulp industry effluent contains wastewater sludge, ash, bark, wood, paper ash etc.; electroplating industry effluent contains metals and lime sludge; effluent from paint industries contains packing materials such as rejected paint cans; effluent from pesticide and insecticide industries contains packing materials, filter dust, sludge etc.

*Hospital Waste:* Solid waste in Dhaka city is augmented by hazardous and toxic wastes from more than 500 clinics and hospitals generating 0.5% of the total waste (Nahar, 1998). The generation of hospital waste per patient per day is about 4 to 10 kg depending on the type of hospitals, manpower, socio-economic condition, climate etc (Islam 1994). According to the Directorate of Health, an estimated hospital waste of 1 kg/bed/day and an extra 2000 kg/year per clinic/hospital are also generated in Dhaka city. The average hospital waste generation rate for hazardous waste and non-hazardous is about 0.169 and 1.16 kg/bed/day (Ullah, 1999). From field survey it is estimated that 20% of the hospital waste generated in the city includes saline bags, x-ray water, syringes, vials, needles, empty packets and bottles of which syringes, vials and needles are infectious and hazardous and quite likely infect the waste collectors. Hospital waste generation is increasing rapidly with the increase of number of hospitals and clinics, but none of the hospital and clinics (except 3 or 4) has the safe disposal facility.

*Tannery Waste:* Conducted study gave an emphasis on waste collected from 149 tanneries of Hazaribag area inside the DCC and other 100 tanneries and leather industries located in Narayangani, Tongi, Joydebpur and Nayarhat located at the fringes of Dhaka city. The tanneries of Hazaribag generate 115 and 75 tons of solid waste during peak and off-peak time generally dumped into DCC dustbins. Survey shows that tannery waste

contains waste hide and leathers, sulfuric acid, chromium, ammonium sulfate, ammonium chloride, calcium oxides, lime and chromium sludge, fleshing, shavings, trimmings etc.

In other municipal towns (excluding Dhaka city), solid waste is generated generally from three main sources: domestic household waste, commercial and market waste and street sweeping and drain cleanings. The analysis on domestic waste indicates a very high content of organic matter (80 to 90% by wet weight) and moisture content, small fraction of paper (2 to 10%), textiles and cloths (1 to 2%) and other materials such as glass, wood, straw bones etc. Dust, sand and other inert materials also may contribute 5 to 10% of municipal waste (BCSIR, 1998).

Chemical composition of refuse collected from final disposal of Jatrabari (recently filled up and abandoned), for residential, commercial, industrial and mixed waste has been made and represented in Table 1 (ibid). The analysis shows the high moisture content, ash and inorganic carbon, and comparatively low hydrogen, nitrogen, oxygen and sulfur in the refuse of DCC dumping sites. Moisture content is very high ranging from 50 to 60% by weight due to high organic content in the waste.

### Waste Collection and Transportation

Most of the urban centres in Bangladesh have limited access to collection vehicles and thus door to door collection is not practiced by municipalities. Households and the management of different institutional, commercial and industrial establishments are expected to carry their waste into dustbins or communal collection points but are sometimes observed to deposit on roadsides, footpaths, open drains, into storm drains or low lying areas. Recently Community Based Organizations (CBOs) are being involved in municipal waste collections in Bangladeshi towns and cities. The municipal fleets are however not large enough to manage the daily waste output in all urban centres of Bangladesh. In Dhaka city only 40-50% of the total generated waste is being collected by DCC and in other urban centres waste collection coverage from bins/accumulation places are in the range of 60 and 70%. Table 3 shows the collection procedures including available facilities of the study regions.

Both covered and non-covered garbage trucks of capacity of 5 tons, 3 tons, 2 tons and 1.5 tons are generally used to transfer and transport municipal solid waste in different cities and towns of Bangladesh (Table 4). Push carts, handcarts and garbage vans are also used to collect refuse and to some extent to transfer and transport refuse

**Table 1: Chemical Composition of DCC Solid Waste in % by Weight**

<i>Constituent</i>	<i>Residential waste (%)</i>	<i>Commercial waste (%)</i>	<i>Industrial waste (%)</i>	<i>Mixed waste (%)</i>
Moisture content	50	54	60	59
Carbon	26.06	17.81	9.9	12.7
Hydrogen	3.53	1.92	2.0	2.25
Nitrogen	1.62	0.46	0.58	0.62
Sulfur	0.01	0.02	Negligible	Negligible
Oxygen	0.78	3.79	2.52	3.43
Ash	18	22	25	22

**Table 2: Manpower and Resources of Conservancy Wings of DCC and Other Municipalities**

<i>Items</i>	<i>DCC</i>	<i>SCC</i>	<i>Tangail</i>	<i>Rangamati</i>	<i>Gazipur</i>
Cleaners/Sweepers	5272	185	28	128	35
Supervisory staff	124	7		28	
Motorized vehicle	NGT: 85 nos. Container Carrying Truck: 104 nos.	NGT: 7 nos.	NGT: 2 nos. Tractor: 1 no.	NGT: 4 nos.	NGT: 3 nos.
Non-motorized vehicle	Push Cart (PC): 3000	PC: 20 nos.	PC: 31 nos. Van: 3 nos.	PC: 80 nos.	PC: 5 nos.
Container	410 nos.				

*Note: NGT: Normal Garbage Truck*

**Table 3: Collection Facilities of DCC, SCC and Other Municipalities**

<i>Items</i>	<i>DCC</i>	<i>SCC</i>	<i>Tangail</i>	<i>Rangamati</i>	<i>Gazipur</i>
Number of Dustbins	2000 of 3-ton concrete bins, 2500 of 1 ton CI Sheet bins.	200 concrete bins.	160 concrete bins.	78 concrete bins.	140 concrete bins.
Container	410 nos.; 10 are of 5 and 400 are of 3 tons.				
SW collection	Manual/ Mechanical	Manual	Manual	Manual	Manual
Frequency of SW collection	Collected daily before 8 a.m. at dawn.	Collected daily before 9 a.m.	Daily and twice a week from main and other roads.	Daily, twice and once a week from main, secondary and branch roads.	Collected twice a week.
Amount of collected SW	Approximately 4,500 tons daily.	80-100 tons daily.	Not measured.	Not measured.	Not measured.

**Table 4: Transport Facilities of DCC, SCC and Other Municipalities**

<i>Items</i>	<i>DCC</i>	<i>SCC</i>	<i>Tangail</i>	<i>Rangamati</i>	<i>Gazipur</i>
Driver	189	7	3	7	2
Normal Garbage Truck (NGT)	85; 35, 25 and 25 are 5, 3 and 1.5 ton truck; 42 are covered and 43 are uncovered.	7; 3 and 4 are 5 and 3 ton truck; 3 are covered and 4 are uncovered.	2; 1 is 5 ton and the other is 3 ton; 1 is covered, another uncovered	4; 1, 2 and 1 are 5, 3 and 1.5 ton truck; 1 is covered and rests are uncovered	3; 1 is of 3 ton and 2 are 1.5 ton truck; all uncovered
Container Carrying Truck	104; 10 and 94 are 5 and 3 ton truck.				
Tractor			1 of 2 ton		
Garbage Van			3 of 100 kg		
Push Cart	3000 of 5.5 cft.	20	31 of 10 kg.	80	5
Container	410; 10 are of 5 ton and 400 are of 3 ton.				

from dustbins especially in densely populated congested areas. In Dhaka city, carrying trucks of 5 and 3 tons carry garbage containers filled up by the household refuse located at the selected waste generation points. In a few towns, tractors of 2 tons and 1 ton are also in use for transporting garbage. Mismanagement and unskilled handling and improper transportation by the unfit vehicles hamper the waste collection and transportation in DCC.

### Recycling

In Bangladesh, wastes of some market value are being reclaimed in three stages. In the first stage the housewives

and maid servants separate the refuse of higher market value such as old newspaper, used writing paper, empty bottle, old container etc at households and sell them to the street hawkers; such salvage activities have some economic benefits and are in practice in all households of low to average income. The next stage of salvaging is carried out by poor slum children or scavengers popularly known as Tokai who collect the refuse and commercial waste of low market value such as broken glass, cans, paper, cardboard, plastic, rubber, rags, metals etc. from dustbins and street sweeping accumulation points. In the third stage of recycling, refuse pickers collect the refuse items of low market value at the final disposal sites. In

all stages only inorganic wastes are recycled leaving behind the organic part.

The recycled materials generally reach the old materials shop and refuse dealers through the street hawkers and refuse collectors; refuse dealers' separate the materials in proper form and sell them to the market as well as supply them to the appropriate processing/remolding factories. The processed materials are recycled through the market. Commercial and industrial areas and construction works produce salvageable materials such as cloth and leather trimmings, building materials, waste board and paper, metal pieces etc., which have good market value but not usually collected by garbage trucks. The reclaimed mild steel bars and angles are used in minor construction works. Broken stones and bricks are used for making khoa. The debris of demolished concrete and mortar is used for stabilizing roads and filling lowlands. The salvageable part of street sweepings are reclaimed; leaves, stems and grass are dried and used as fuel for cooking leaving the dirt debris and decomposable materials which are collected by garbage trucks for final disposal. Recently recycling of solid waste in a systematic way is included in the project for generation of biogas from solid waste in a few selected sweepers' colony of DCC. Personnel and executives of DCC, SCC and other municipalities feel that organized and formal recycling will improve the SWM significantly. Survey and interview results of recycling are shown in Table 5.

### Treatment and Final Disposal of Waste

Gigantic volume of DCC solid waste is not treated. Tanneries and leather industries do not have treatment facilities for effluents, which discharges toxic and hazardous substances directly to the rivers and municipal dustbins. Only the Bata Tannery at Nayarhat and the new Dhaka Leather Complex has treatment plants. Not all but a few of textile industries (about 30% of dying and printing units) use lagoons for waste treatment. Occasionally few of the electroplating industries use alkali treatment for metal recovery and neutralization. Some of the pesticides and insecticides industries (about 25%) apply neutralization, solid waste incineration and bag filtration for waste treatment. No treatment facilities are available for treating medical waste in hospitals/clinics except three or four hospitals including ICDDR hospital located in Dhaka city. Field survey reveals that wastes from the industries are dumped into DCC/municipal dustbins and nearby low-lying areas without treatment due to the poor or non-enforcement of pollution control laws. However field interview shows that majority of the industries (about 60%), clinics and hospitals (about 85%) of Dhaka city are ready to treat their waste if they are properly supported and guided by the Government while the rest are not ready to install waste treatment facilities for avoiding extra financial involvement; in Sylhet city almost all hospitals (about 95%) are ready to install mini-incineration plants in their own compound.

**Table 5: Waste Recycling in Bangladesh**

<i>Items</i>	<i>DCC</i>	<i>SCC</i>	<i>Tangail</i>	<i>Rangamati</i>	<i>Gazipur</i>
Formal/Informal Recycling	Informal recycling by householders, Tokais and NGOs.	Informal recycling by householders.	Informal recycling by householders and NGOs.	Informal recycling by householders and NGOs.	Informal recycling by householders and Tokais.
Public Consciousness	Most of the city people are not conscious about recycling.	Public are not conscious about formal recycling.	Still public are not aware of the benefit of recycling.	Public interest on recycling is growing day by day.	Public has no idea about formal recycling.
Involving Tokais	Tokais can be easily organized in recycling by DCC.	Tokais are not available in Sylhet.	Tokai can be easily involved by municipality.	Tokai can be involved by municipality.	Tokai can be organized by municipality.
Involving Publics	Already happening in household stage.	May be possible.	Possible.	Possible effectively.	Not possible.
Income from Recycling	Householders, Tokais and waste pickers earn significantly.	Not identified by municipality.	NGOs earn a good amount of money.	NGOs earn a good amount of money.	Tokais earn a good amount of money.

In Bangladesh, final disposal is not done in a planned way. In Dhaka city solid wastes are disposed off by land filling using crude dumping methods. Due to non-availability of any sanitary landfill for ultimate disposal, collected solid waste is directly dumped in low-lying areas in and around Dhaka city. Dumped wastes are dressed by pay loaders, excavator, tyre dozer, chain dozer etc. According to DCC report, 1999, six dumping sites at Kulsi, Chalkbari-Mirpur, Gabtali-Mirpur, Lalbag Shosanghat, Mugdapara and Jatrabari have been abandoned after filling them to their capacities. Presently solid waste is being dumped at three dumping sites at Matuail about 3 km outside from the DCC area, Mirpur and Islambag of Lalbag inside DCC area. Of the total estimated daily total disposal of approximately 2585 m<sup>3</sup>, about 2305 m<sup>3</sup> are dumped at Matuail, about 273 m<sup>3</sup> at Mirpur and 7.5 m<sup>3</sup> at Islambag. These sites would be filled up by the year 2001/2002 and DCC has already selected three new dumping sites at Matuail, Boliapur and Gazipur. In other cities and towns, municipal waste is dumped at open disposal sites generally located outside the city or towns; in Sylhet, two dumping sites at Lalmatia and Monglabazar are located outside the city; only dumping site of Rangamati is located at 5-6 km from densely populated area of the town while only dumping sites of Tangail and Gazipur town are situated outside the town. In absence of sanitary landfills, toxic and explosive gases like methane and carbon oxide are generated within the dumping sites. Analysis of leachate sample collected by drilling bore holes at five dumping sites shows the potential groundwater contamination by leachates which have very high concentrations of BOD<sub>5</sub>, COD, chloride and fecal coliform. In addition, the leachates have very high concentration of a number of toxic heavy metals such as lead (174.76 mg kg<sup>-1</sup>) and chromium (47.19 mg kg<sup>-1</sup>) in the ash residue of solid waste of Dhaka city (Rehman & Ali, 2000).

A few analyses carried out on domestic waste of Bangladesh indicate a very high content of vegetable matter (80 to 90% by weight) and a high moisture content. Mixed solid refuse of Dhaka city contains very high moisture content (on average 45-55%), high ash and organic contents (on average 84.37%) representing high fertilizer value of waste and potentiality for conversion of waste into good compost (Yousuf, 1996). High moisture content and comparatively low paper and plastic content disfavour possibility of costly incineration but favour composting. In this regard, to develop an appropriate but low-cost technique of composting of municipal waste, Waste Concern's pilot demonstration plant was established at Mirpur, Dhaka which produced

environmentally safe product with less capital (Enayetullah & Sinha, 1999). From the experience of Waste Concern, another composting plant is being constructed in Khulna city by 'Pradipan', another NGO working in the field for SWM. Plan for constructing sanitary landfill is being considered by DCC and CCC. DCC also has programme for installing incineration plants for burning infectious medical wastes. Currently government is planning to implement Waste to Electrical Energy Project from gigantic volume of waste in Dhaka and Chittagong.

### **Community Involvement in Solid Waste Management**

Failure and inefficiencies of local government necessitate community involvement and participation in solid waste management where all the inputs of SWM are collected from the community itself. In many places of Dhaka city, many individuals and groups have come forward and organized their own collection systems to improve the local situation of SWM. Most of the local initiatives collect waste from door to door through rickshaw vans and carry it to the nearest dustbins which helps to keep the area clean as well as to generate additional employment and income for urban poor. Local initiatives in solid waste collection were first introduced in 1987 at Kalabagan area of Dhaka city. Based on the success of Kalabagan project, a number of small size community based waste collection schemes were replicated in many areas such as Katalbagan, Shamoly, Mirpur, Banani, Uttara areas of this city. It is reported that over 130 such local initiatives actively operate in more than 100 local wards of DCC, 40 wards of SCC and the municipalities of the city and are providing services to more than 10,000 householders of the city. By this time local initiatives are exercised for collecting solid waste in Chittagong and Khulna city.

### **Financial Aspects**

Survey results reveal the poor financial status of SWM in Bangladeshi cities and towns. Annual budget, total expenditure, salary and wages of the conservancy wings of DCC, SCC and other municipalities in the financial year 1998-99 were collected. Table 6 shows that in DCC and SCC, salary and wages is more than 70% of the total budget, power and fuel cost is around 10% of the budget and remaining 10 to 20% of the budget is consumed for operation and maintenance (O and M) cost; in Tangail and Gazipur salary and wages exceeds the annual budget which means no allocation from own budget is available for development of SWM facilities if no extra fund is

**Table 6: Financial Aspects of Conservancy Wings**

<i>Items</i>	<i>DCC</i>	<i>SCC</i>	<i>Tangail</i>	<i>Rangamati</i>	<i>Gazipur</i>
Annual Budget in 1998-1999 (\$)	Salary and wages: 3,000,000; Power and Fuel: 800,000; Supplies: 416,670; O and M and others: 8,335; Total budget: 4,175,000.	Salary and wages: 71,120; Power and Fuel: 9,400; Vehicle repair: 6,335; O and M and others: 8,985; Total budget: 95,835.	Total budget: 10,335.	No separate budget.	Total budget: 5,835.
Expenditure in 1998-1999 (\$)	4,166,670.	Salary: 71,670; Power and Fuel: 9,170; Cleaning: 2,500; O and M and others: 6,670; Total budget: 96,670.	Cleaning: 4,000; Maintenance: 3,500.		Cleaning: 1,250; Maintenance: 835.
Conservancy Tax	2% of the holding tax.	Included in holding tax.	Included in holding tax.	No tax for conservancy.	Included in holding tax.
WTP for waste collection (\$)	0.33 per month per holding.	0.33 per month per holding.	0.17 per month per holding.	0.25 per month per holding.	0.20 per month per holding.

*Note:* WTP: Willingness To Pay

available from government or donors. No separate conservancy tax is collected in municipalities except DCC who collects conservancy tax at the rate of 2% of the holding tax. Only the people of DCC and Sylhet have willingness to pay a reasonable amount of conservancy tax for improved SWM system. People are ready to pay \$0.167 to 0.33 per month per holding for the cost of door to door collection. In addition Table 7 shows the different costs for SWM in Sylhet city. It is obvious that every year budget for different items is increasing and in recent years the rate of increase is very high due to lack of proper management.

### **Environmental Impact and Health Hazard**

There are potential risks to health and environment from improper handling such as collection, storage, recycling and disposal of municipal solid waste. Unplanned management of the gigantic accumulation of solid waste in Bangladeshi cities and towns causes significant environmental health hazard and serious threat to surface water, ground water, soil and air, which can be detailed as follows:

1. Uncontrolled solid waste closes sewers and open drains, encroaches roadways, diminishes aesthetic quality and causes unpleasant odour and irritating dust.

2. Inadequate and unhygienic collection and disposal of waste at open dumps increases the risk of epidemics of infectious diseases, encourages the spreading of gastrointestinal and parasitic diseases, primarily caused by pathogens and hazardous materials carried by windblown dust, proliferation of insects and rodents.
3. The waste collection bins usually remain open and the garbage in the open refuse-bins attracts rats and vermin. Such scattered garbage always increases the risk of epidemic of infectious diseases such as hepatitis, typhoid and diseases like typhoid fever, anthrax in animals, tetanus, gangrene, pneumonia etc. by spreading infectious pathogens from health-care waste.
4. Health care waste from hospitals and clinics dumped into dustbins without any treatment infect waste pickers and collectors by spreading germs of different diseases and toxic contamination.
5. Smoke generated from wastes of open dumps is a significant irritant and causes affected populations to have an increased susceptibility in respiratory illness.
6. The scavengers and waste pickers involved in manual sorting, recycling and resource recovery are exposed to environmental hazards and become prey to many pathogens and diseases. Piles of refuse in waste disposal site during its decomposition process

**Table 7: Financial Aspects of Conservancy Wings of SCC of Sylhet city**

<i>Items</i>	<i>1997-98</i>	<i>1998-99</i>	<i>1999-2000</i>	<i>2000-01</i>	<i>2001-02</i>	<i>2002-03</i>	<i>2003-04</i>
Salary of the sweepers, cleaners and labourers (daily basis/muster roll) (\$)	–	14,770 (20,000)	18,520 (20,000)	24,770 (25,835)	21,600 (25,835)	– (26,670)	– (33,335)
Cleaning of drains (\$)	24,385	21,835 (30,000)	45,000 (41,670)	51,550 (53,335)	49,670 (83,335)	– (75,000)	– (133,335)
Cleaning of other wastes (\$)	13,650	26,835 (41,670)	19,135 (41,670)	33,335 (41,670)	28,850 (83,335)	– (75,000)	– (133,335)
Purchase, maintenance and fuel cost (\$)	11,370	11,785 (16,670)	19,670 (20,000)	31,735 (33,335)	26,500 (41,670)	– (41,670)	– (125,000)

*Note:* All figures in the parenthesis are the budgetary amount of that year

generate several gases, the most important among which are methane, nitrogen and occasionally hydrogen sulfide; if burnt, methane and carbon dioxide gas is released. Methane and carbon dioxide gases cause potential green house effects (Akter, 2000).

7. Pathogenic microorganisms, heavy metals and chlorinated hydrocarbons typically contaminate the soil underlying the solid wastes and groundwater sources.
8. Markets' slaughterhouse waste and the Muslim ritual Eid-ul-Azha waste not disposed properly are another health hazard and environmental threat in DCC and other municipalities. The study shows that more than 70% of the cattle of the markets' slaughterhouses and about 90% of the cattle during Eid-ul-Azha are slaughtered on the roadsides and sometimes even on the street and the lanes. After the slaughter, cattle wastes are dumped in nearby drains, ditches, and blood is buried in small ditches. Such disposal of cattle waste creates not only public nuisance but also causes transmission of diseases by vectors.
9. Majority of the industries in Dhaka city disposes their waste to DCC/municipal dustbins or discharges to the nearby rivers Buriganga, Sitalakhya, Turag, Balu etc. which pollute air and water courses in the vicinity or adjacent to the city.
10. The waste from mushrooming garments industries, although not toxic if disposed off anywhere become rotten during rains and attract flies, mosquitoes, rodents and vectors of many diseases. The bulky garment waste creates significant public nuisance in and around the residential areas.

11. Specific danger of the concentration of untreated heavy metals from industries due to open dumping affect food chain causing a problem between solid and other waste. Industrial effluents containing heavy metals discharged to the drainage system contaminate the sludge leaving the treatment plants; these metals taken up by the plants growing on land which deposit sludge creating risks to the grazing animals and the men who consume these animals (Trivedi & Raj, 1997).

## Conclusion

The conducted study showed the deteriorated situation of SWM in Bangladesh. It is very difficult to handle the bulk volume of waste in different cities and towns due to the uncontrollable migration of rural people to urban areas for better life. Waste generation rate is being increased; for example in Dhaka city, waste generated @ 350 per person per day in 1995 has attained the value of 600 per person per day in 2000. In spite of the involvement of CBOs, collection efficiency is not up to the standard. Municipalities or city corporations can not collect and dispose more than 50% of the total waste generated. Even in Dhaka city only 42% of the total generated waste is collected by DCC and the rests (more than 55%) are put and thrown to roadsides, footpaths, open drains, open spaces and low lying areas etc. Clogs and encroachment of the drainage system cause severe environmental degradation. Collection and transportation of garbage is seriously hampered by poor operation and maintenance of the garbage vehicles. Even in DCC one-third of the available garbage vehicles are out of service at any time. No planned and formal recycling of waste



by municipalities and city corporations are done; however householders, scavengers and currently a few NGO have started recycling and reuse of paper, bottles, containers, metals, glass, cloths, shoes, polythene bags etc for their own economic benefits. Solid wastes are dumped in open areas through crude dumping without any treatment or sanitary land filling. Inadequate and uncontrolled management of waste causes serious health hazard, environmental degradation i.e. air and water pollution and public nuisance in Bangladeshi cities and towns. Besides lack of awareness among the people and the failure of the municipalities and city corporations in increasing the public level of awareness and taking proper initiative, augment the SWM problem significantly. SWM utilities have no adequate financial ability to implement any SWM projects without the government allocation or donor's financial aid. Finally, it can be concluded that the following recommendations be implemented to reduce environmental pollution and health hazard due to solid refuse significantly in the cities and towns of Bangladesh.

### Recommendations

SWM in Dhaka city needs major improvement in storage, collection, transport, recycling, treatment and disposal to reduce adverse impact on environment and public health. In Dhaka, it is not possible for a particular group of actors such as the conservancy wings of DCC and the municipalities alone to handle the solid waste management, make the process sustainable, keep the city clean, reduce the environmental pollution and to improve the environmental health and public life. Rather, city dwellers, community based organizations, DCC, municipalities and other stakeholders should come forward together to combat the solid waste problem. Planned and organized recycling initiated by CBOs and fostered by DCC and municipalities should be introduced involving householders, tokais etc. Due considerations should be given to the public initiatives and local people's participation at every stage of solid waste management to make it sustainable. In this regard, the following recommendations should be implemented to minimize solid waste pollution and to upgrade the deteriorating solid waste management system in Bangladeshi cities and towns.

1. Poly bags or covered small bins/containers of different colour and shape designated by DCC and municipalities should be put at every household or refuse generation source to keep food/vegetable

waste, paper/cardboard, plastics/polythene, glass/ceramic, ferrous/non-ferrous materials, rubber, wood, bamboo etc separately. CBOs should take initiative for waste separation in households.

2. Door to door collection using tricycle/rickshaw van should be stimulated by municipality ward commissioner, local elite, CBOs, private entrepreneur etc. Communal collection using garbage van can be introduced for collecting waste from communities of government colonies, planned housing areas; for communal collection, householders should keep the poly bags of sorted refuse at fixed communal storage sites over a distance. Block collection may be used in planned residential areas such as Gulshan, Banani, Baridhara, Uttara, Dhanmondi etc; for block collection, householders should deliver their stored wastes to the garbage vehicles at the fixed time of collection. Refuse chute can also be used for storage and collection of garbage from high rises buildings.
3. Collection and transfer vehicles both motorized and non-motorized should be increased to handle collection and transportation of refuse homogeneously.
4. In order to improve the efficiency of solid waste disposal system on site processing techniques e.g. hand sorting and recycling by scavengers should be initiated by reducing the volume and altering physical forms of solid waste.
5. Recycling and reuse should be given priority to reduce waste generation volume and lessen treatment and disposal cost. Planned recycling in the waste generation point, dustbins and transfer stations should be introduced. Tokais and labourers in muster roll should be used for recycling. 'Waste to Electrical Energy Project' should be implemented using gigantic volume of solid waste of mega city Dhaka.
6. Solid waste should be treated by composting for organic waste (food, fruit, vegetable etc.) to produce soil conditioner, sanitary land filling for non-organic waste and incineration for hospital waste and industrial hazardous waste installing medium sized and mini incineration plant in industries, hospitals, clinics etc. To improve waste disposal system of slum areas, biogas plant should be installed.
7. Dustbins should be rearranged and reconstructed in accordance with the demand of localities following proper planning and standard design. Due

consideration against heavy toxic metals available in the leachate should be given in future design of solid waste dumping sites to protect precious groundwater.

8. Community based social organizations, clubs, local elites, NGOs should be involved in solid waste management function by promoting their active participation in collection, recycling and low cost treatment as well as for raising awareness among public about health and environmental hazards due to improper disposal of wastes.
9. Interest of the concerned authorities in solid waste management should be enhanced and management capabilities of conservancy wings must be strengthened by ensuring proper operation and maintenance of garbage trucks, containers, dustbins, and other conservancy resources as well as the effective supervision of the SWM sweepers and staff.
10. In order to reduce health hazard among the garbage crews and waste collectors, they should be provided with protective clothing, gloves, masks, boots, shoes etc. during loading and unloading the wastes.
11. In DCC, conservancy tax should be raised to create own income source of conservancy wing in order to implement small size development projects without depending on government and the donor agency. In other cities and towns separate conservancy tax for solid waste management should be introduced.
12. Efficient financial management should be ensured to reduce the expenditure significantly. In this regard environment audit at a certain interval can be a good option.

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