

<http://www.pjbs.org>

PJBS

ISSN 1028-8880

**Pakistan
Journal of Biological Sciences**

ANSI*net*

Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Municipal Waste Management and Environmental Hazards in Bangladesh

G. M. Jahid Hasan and Md. Aktarul Islam Chowdhury
Department of Civil and Environmental Engineering,
Shahjalal University of Science and Technology, Sylhet-3114, Bangladesh

Abstract: Municipal solid waste becomes 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^[1] 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 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^[1,2]. 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 been 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 of 1st phase in 1999-2000 and 2nd phase in 2003-2004 in Dhaka, Sylhet, Tangail, Rangamati and Gazipur. This study gives high emphasis on Dhaka 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 5 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 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

Table 1: Manpower and resources of conservancy wings of DCC and other municipalities

Items	DCC	SCC	Tangail	Rangamati	Gazipur
Cleaners/sweepers	5272	185	28	128	35
Supervisory staff	124	7		28	
Motorized vehicle	NGT: 85 container carrying Truck: 104	NGT: 7	NGT: 2 Tractor: 1	NGT: 4	NGT: 3
Non-motorized vehicle	Push Cart (PC): 3000	PC: 20	PC: 31 Van: 3	PC: 80	PC: 5
Container	410				

NGT: Normal Garbage Truck

and Conservancy Officer (HCO) and other conservancy or supervisory staffs 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 laborers (regular/daily basis/master 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 1 shows a list of the existing staffs of the conservancy wings those who are 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. More than 1000 industries in the mega city Dhaka generate toxic and hazardous wastes in and around the city. Solid waste in Dhaka city is augmented by hazardous and toxic wastes from more than 500 clinics and hospitals which generating 0.5% of the total waste^[3]. 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^[4]. 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^[5]. 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 Narayangang, 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.

In other municipal towns (excluding Dhaka city) solid waste is generated from three main sources,

those are 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^[6].

Waste collection and transportation: Most of the urban centers 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 centers of Bangladesh. In Dhaka city only 40-50% of the total generated waste is being collected by DCC and in other urban centers waste collection coverage from bins/accumulation places are in the range of 60 and 70%. Table 2 shows the collection procedures including available facilities of the study regions.

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

Table 2: Collection facilities of DCC, SCC and other municipalities

Items	DCC	SCC	Tangail	Rangamati	Gazipur
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; 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 am at dawn	Collected daily before 9 am	Daily and twice a week from main	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 3: Transport Facilities of DCC, SCC and other municipalities

Items	DCC	SCC	Tangail	Rangamati	Gazipur
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	104; 10 and 94				
Carrying truck	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				

Table 4: Waste recycling in Bangladesh

Items	DCC	SCC	Tangail	Rangamati	Gazipur
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	Publics are not conscious about formal recycling	Still publics are not aware of the benefit of the recycling	Publics' 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 be 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 house	May be possible	Possible	Possible effectively	Not possible
Income 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

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 collects 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.

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 4.

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 2 companies inside DCC (the Bata Tannery at Nayarhat and the new Dhaka Leather Complex) have treatment plants. Not all but a few of textile industries (about 30% of dyeing 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.

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^[7], 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 m³, about 2305 m³ are dumped at Matuail, about 273 m³ at Mirpur and 7.5 m³ 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 BOD₅, 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⁻¹) and chromium (47.19 mg kg⁻¹) in the ash residue of solid waste of Dhaka city^[8].

A few analysis 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^[9]. High moisture content and comparatively low paper and plastic contents disfavours possibility of costly incineration but favors for 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^[10]. 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 reconstructing sanitary landfill is being considered by DCC and CCC. DCC also has program 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

Table 5: Financial aspects of conservancy wings

Items	DCC	SCC	Tangail	Rangamati	Gazipur
Annual budget in 1998-1999 (\$)	Salary and wages: 3,000,000; Power Fuel: 800,000; Supplies: 416,670; O and M and others: 8,335 Total expenditure 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 expenditure 10,335	No separate budget	Total expenditure 5,835
Expenditure in 1998-1999 (\$)	4,166,670	Salary: 71,670 Power and Fuel: 9,170; Cleaning: 2,500; O 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 holding tax	Included holding tax	No tax for conservancy	Included holding tax
WTP for waste holding 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

WTP: Willingness To Pay

Table 6: Financial aspects of conservancy wings of SCC of Sylhet city

Items	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04
Salary of the sweepers, cleaners and laborers (daily basis/master role) (\$)	--	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)

All figures in the parenthesis are the budgetary amount of that year

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 1998-1999 were collected. Table 5 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 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 6 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 hazard and serious threat to surface water, ground water, soil and air, which can be detailed as follows:

1. Uncontrolled solid waste close sewers and open drains, encroaches roadways, diminishes aesthetic quality and causes unpleasant odor 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, 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. The scavengers and waste pickers involved in manual sorting, recycling and resource recovery and exposed to environmental hazards and become prey to many pathogens and diseases.
6. Piles of refuse in waste disposal site during its decomposition process 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^[11].
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. 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 bloods are 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 which pollute air and water courses in the vicinity or adjacent to the city.
10. 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^[12].

CONCLUSIONS

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 @ 350g per person per day in 1995 is attained the value of @ 600 g 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. 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 the 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 recommendation 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 households 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. Block collection may be used in planned residential areas and 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. 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.
5. 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 can be installed.
6. 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.
7. 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 prevail.
8. 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 staffs.
9. 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.
10. 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.

REFERENCES

1. Kazi, N.M., 1999. Citizens Guide for Dhaka. Environment and Development Associates (EDA) and Water, Engineering and Development Center (WEDC), Bangladesh.
2. World Bank, 1998. Solid Waste Management: Sectoral Analysis in Bangladesh. The World Bank, Washington DC, USA.
3. Nahar, N., 1998. Handling, storage, use and disposal of toxic and hazardous materials in Bangladesh. M.Sc Thesis, BUET, Dhaka, Bangladesh.
4. Islam, M.A., 1994. Toxic Chemicals and Hazardous Wastes: Bangladesh context. Department of Environment, Dhaka, Bangladesh.
5. Ullah, S., 1999. A study of hospital waste management in Dhaka city. M.Sc Thesis, BUET, Dhaka, Bangladesh.
6. BCSIR., 1998. Refuse quality assessment of Dhaka city corporation for waste to electrical energy project. Bangladesh Council of Scientific and Industrial Research (BCSIR).
7. DCC., 1999. Solid Waste Management of Dhaka City. Dhaka City Corporation, Dhaka.
8. Rahman, M.M. and M.A. Ali. 2000. Waste Management and Environmental Pollution in Bangladesh. Bangladesh Environment 2000, Published by Bangladesh Poribesh Andolon, Dhaka, Bangladesh, pp: 425-435.
9. Yousuf, T.B., 1996. Sustainability of Solid Waste Management System of Dhaka City Corporation. M.Sc Thesis, BUET, Dhaka, Bangladesh.
10. Enayetullah, I. and A.H.M.M. Sinha, 1999. Community based decentralized composting experience of waste concern in Dhaka. All India Institute of Local Self Government, New Delhi, India.
11. Nasima, A., 2000. Medical waste management: A Review. Bangladesh Environment 2000, Published by Bangladesh Poribesh Andolon, Dhaka, Bangladesh, 444-460.
12. Trivedi, P.R. and G. Raj, 1997. Solid Waste Pollution. Akashdeep Publishing House, Delhi, India, pp: 45.