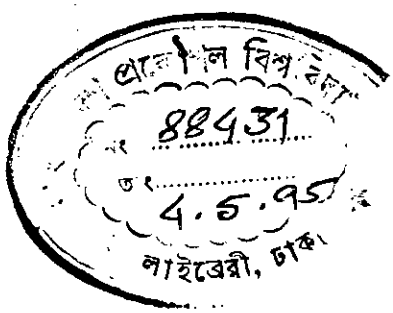
A STUDY OF SOLID WASTE MANAGEMENT FOR ENVIRONMENTAL IMPROVEMENT OF DHAKA CITY



IFTEKHAR ENAYETULLAH

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THESIS ACCEPTANCE FORM

A STUDY OF SOLID WASTE MANAGEMENT FOR ENVIRONMENTAL IMPROVEMENT OF DHAKA CITY

THESIS APPROVED AS TO THE STYLE AND CONTENT BY

DR. MIR SHAHIDUL ISLAM
Professor,
Department of Urban and
Regional Planning,
BUET, Dhaka.

CHAIRMAN OF THE EXAMINATION COMMITTEE
(SUPERVISOR)

DR. MIR SHAHIDUL ISLAM
Head, Department of Urban and
Regional Planning, BUET, Dhaka.

16/2/95

MEMBER

DR. M.A. MOHIT
Associate Professor,
Department of Urban and
Regional Planning, BUET, Dhaka.

MEMBER

DR. M. FEROZE AHMED
Professor,
Department of Civil Engineering
BUET, Dhaka.

MEMBER

ABSTRACT

Solid waste management has become a matter of major global concern as evident from the conclusions given by the Colloquium of Mayors held at the United Nations in New York in August, 1994, which was attended by 135 Mayors from different countries of the world, including Bangladesh. There, they identified twelve most severe urban problems - insufficient solid waste management ranked third, preceded by inadequate housing while unemployment topped the list.

The population of Dhaka city has been increasing rapidly. During the period 1981-91, the population of DCC area increased from 2.20 to 3.583 million, representing a rise of 62.86 percent. Rapid growth in population is, obviously, creating quick rise in generation of solid waste of the city. Waste generation during 1985-91 period has increased at an average annual rate of 4.33 percent per capita per year, while the capability of DCC's solid waste management and its hygienic disposal is miserably lagging behind. More than half of the city's daily generated solid waste remains uncollected and are disposed of locally, making the environmental scenario of the metropolis quite gloomy and dismal for the future.

Realising the gravity of the situation, this study has been undertaken with the expectation that it would help prepare a sound and effective action plan for solid waste management. In other words, this study aims at environmental improvement of the capital city.

This study finds that there is an urgent need and scope to improve solid waste management system of Dhaka city and recommends both macro and micro-level measures to improve it for eventual betterment of the environment. At macro-level, the National Government can play the role of a 'facilitator' to improve overall management system; while at the micro-level, DCC can improve their institutional, financial and technical capabilities and can take the help of CBOs and NGOs to improve the present waste disposal condition of different residential areas of the city. At the same time, DCC at micro-level can give some of its responsibility to CBOs to handle solid waste collection.

This study, however, highlights the conclusions that improvement of waste disposal situation of the city can be achieved through joint involvement of the community, NGOs and DCC. Looking from environmental and sustainable development viewpoints, this study underlines the necessity of recycling of organic waste which forms the major portion of the solid waste of the city for the sake of waste volume reduction and environmental protection.

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ABBREVIATIONS

ADB	:	Asian Development Bank
AIT	:	Asian Institute of Technology
BBS	:	Bangladesh Bureau of Statistics
BCSIR	:	Bangladesh Council of Scientific & Industrial Research
BUET	:	Bangladesh University of Engineering & Technology
CBO	:	Community Based Organizations
CUS	:	Centre for Urban Studies (Dhaka University)
DCC	:	Dhaka City Corporation, (Previously Dhaka Municipal Corporation)
DMAIUDP	:	Dhaka Metropolitan Area Integrated Urban Development Plan
DOE	:	Department of Environment
FAP	:	Flood Action Plan
GOB	:	Government of Bangladesh
HSD	:	Housing & Settlement Department
JICA	:	Japan International Coorperation Agency
MLGRDC	:	Ministry of Local Government Rural Development and Co-operatives
LGED	:	Local Government Engineering Department
NGO	:	Non-Governmental Organization
Pourashava	:	Municipality/Municipal Authority
PWD	:	Public Works Department
RAJUK	:	Rajdhani Unnayan Katripakha (Previously Dhaka Improvement Trust)
SWM	:	Solid Waste Management
UDD	:	Urban Development Directorate
UNCHS	:	United Nations Centre for Human Settlements
UNCRD	:	United Nations Centre for Regional Development
UNDP	:	United Nations Development Programme
WHO	:	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Solid Waste Management (SWM), is today considered to be one of the most immediate and serious environmental problems confronting urban local governments in developing countries. This is mainly due to rapid urbanization taking place on an enormous scale in the cities of Asia, Africa, and Latin America. Cities currently account for two-thirds of population growth in the developing world. By the year 2000 close to two billion people will live in sprawling urban areas such as Mexico City, Bombay, Cairo, and Dhaka (Bartone, 1990).

The cities are the major factors contributing to the economic output, employment and income of developing countries. Rapid population growth and uncontrolled urban expansion, severely degrade urban environment, place serious strain on natural resources and consequently undermine equitable and sustainable development. Inadequate management and disposal of solid waste is an obvious cause for the degradation of the environment in most of the cities in developing countries (Schertenleib, et. al., 1992a). Most of the cities in the developing world are unable to cope with the vast amount of solid waste produced by its people. Many cities face serious environmental degradation and health risks due to uncollected domestic waste on streets, public areas, clogged urban drainage system by indiscriminately dumped wastes, and by contamination of water resources near uncontrolled dumping sites. In many developing countries only half of the population is served by sewage and solid waste disposal system (Bartone,1990,p.2).

A study (Lohani, 1986) has shown that solid waste management problems would significantly increase in South Asian countries during the last two decades of this century (1980-2000) and would be a major environmental issue for some time to come.

1.2 STATEMENT OF THE PROBLEM

The cities and towns in Bangladesh are under increasing population pressure due to migration of rural people to urban centres. The annual growth rate in DCC area is 4.75% (UNDP, 1993, p.9). According to a study (Islam, et. al., 1990), the projected population of Dhaka city by the year 2001 AD would be around 8.9 and 7.9 million considering high and low growth rate respectively. The quantity of solid waste generated in Dhaka city is increasing proportionately with the increase in population but the increase in service facility is lagging far behind. As a result, there is a disequilibrium between demand and supply of services and infrastructure and the backlog is increasing at a rate faster than urban population growth. According to another study (Siddiqui, et. al., 1992) a three fold increase of infrastructure will be required by the year 2000, even to maintain existing standard of waste disposal. From the studies of different consultants engaged by Government of Bangladesh the amount of solid waste generated in DCC area was 1040 tons per day in 1985-86 (UNDP, et.al., 1985) while the amount was 1540 tons per day in 1991 (JICA, 1991). The continuing growth in generation of solid waste and disposal of solid waste is a serious issue challenging

the Urban Planners in a fast growing metropolis like Dhaka. Approximately 50% of the solid waste generated within DCC area is never collected. Some are disposed in vacant lots, low-lying areas, pond or rivers but a large percentage is deposited into road side drainage ditches, storm sewers and khals. Uncontrolled disposal of solid waste has contributed localized flooding through clogging of drains. Around 10 to 15 percent of the volume storm sewer contains solid waste (Louis Berger International Inc. et.al., 1991, p.3.4).

As a result of this uncontrolled disposal of solid wastes, degradation of the quality of urban environment has become a major concern to planners and the importance of efficient urban solid waste management is being increasingly recognized.

The present system of waste management in Dhaka city is environmentally ineffective and a hazard to public health and the operators (UNDP et. al., 1992 p.3). According to Louis Berger International Inc.et.al,(1991), the solid waste dumps of Dhaka city are unregulated and insanitary, resulting in adverse impacts like degradation of water quality, attraction of disease-carrying insects and rodents and overall degradation of environment.

Agenda 21, the blue print for action plan towards sustainable global development, adopted by participating nations, including Bangladesh, during United Nations Conference of Environment and Development (UNCED), held in Rio-De-Janerio (Brazil) in June 1992, requires all countries to establish waste treatment and disposal criteria so that by 2025 they are all to dispose of all kinds of waste, including solid waste, according to international guide-line.

If proper solid waste management plan is not taken for the growing metropolis of Dhaka, it will cause severe degradation of urban environment and pollution problem. As such, solid waste management is one of the key areas of concern for urban sanitation and cleanliness for healthier metropolitan development. It is, therefore, highly desirable to study solid waste management system of Dhaka city for better planning and management of solid wastes form environmental view point and sustainable development.

1.3 OBJECTIVES OF THE STUDY

The broad objective of the study is to improve the solid waste management of Dhaka city. The major objectives of the study are :

1. To study the existing system of solid waste management of Dhaka city with emphasis on domestic waste disposal system;

2. To identify nature and magnitude of problems faced by households regarding waste disposal;

3. To evaluate effectiveness, social acceptability and affordibility of different techniques of solid waste disposal system ; and

4. To formulate a set of planning policies for improving solid waste management of Dhaka city.

1.4 SCOPE AND LIMITATIONS OF THE STUDY

Due to limitations of time and resource, the study has mainly concentrated on different aspects of domestic solid waste management. Domestic waste constitutes the major portion of waste stream of Dhaka city. The study has identified, reviewed and analyzed different aspects of solid waste management which are generation, collection, disposal and recycling.

The study is based on primary information (interviews, observations, questionnaire survey and informal talks), and secondary information collected from various agencies. Detailed discussions on existing solid waste management of Dhaka city and current practices of waste disposal of households have been provided along with identification of problems, efficiency and drawbacks of the present system. On the basis these studies and discussions recommendation have been formulated for efficient management of system.

CHAPTER 2

SOLID WASTE AND ENVIRONMENT

This chapter discusses the issues closely related to the topic under study. It is divided into two major parts - first deals with the definition, type, quantity and characteristics of solid waste; the second examines the impacts of solid waste on the environment, highlighting the necessity of proper waste management.

2.1 DEFINITION OF SOLID WASTE

A waste is a material which is thrown away or aside as worthless. The definition of solid waste encompasses all those wastes which are neither waste water discharges nor atmospheric emissions (Cointreau, 1986). According to WHO (1971), solid waste is defined as useless, unwanted or discarded materials and are not free flowing. Solid waste is the term now used internationally to describe non-liquid waste materials arising from domestic, trade, commercial, industrial, agricultural as well as from public services.

2.2 CLASSIFICATION OF URBAN SOLID WASTE

The solid waste generated in urban areas is derived from various sources and are commonly classified according to their origins, such as :

a) Household or Domestic Waste ;
b) Commercial Refuse ;
c) Institutional Refuse ;
d) Street Sweepings ;
e) Construction Debris ;
f) Industrial Waste ; and
g) Sanitation Residues.

a) Household or Domestic Waste: It is also referred to as residential refuse. In developing countries upto two thirds of this category consists of organic kitchen wastes. The balance is composed of sweepings, rags, paper and cardboard, and small portions of plastic, rubber, leather, bone and metals. In poor neighbourhoods, traditional cooking can also produce ash, and where sanitation facilities are limited, the waste might also include faecal matter. In wealthy areas, discarded furniture, used appliances and garden wastes are included.

b) Commercial Refuse: This category consists of wastes from stores, offices, restaurants, warehouses and hotels. The wastes typically consist of packaging and container materials, used office supplies, and food wastes. In developing countries, market is an important source of commercial waste, much of it is organic matter. Most of the commercial refuse in developing countries is handled by the municipality.

c) Institutional Refuse: Schools, government offices, hospitals, police barracks and religious buildings are included in this category. Paper is the predominant waste from most institutional sources except those containing residences, such as barracks, where the proportion of food waste will be significant. Waste collection from institutional premises often entails the use of separate collection method to that used for households.

d) Street Sweepings: Street sweepings consist of sand, stones and litter. In developing countries, street sweepings may also contain appreciable amount of household refuse, drain clearings, human and animal faecal matter.

e) Construction Debris: Construction and demolition activities generate a variety of residual building materials which can contribute significantly to quantities of waste. Construction wastes differ considerably from household wastes and alternative heavy duty vehicles and equipments are used for disposal.

f) Industrial Waste : Industrial waste from processing and non-processing industries and utilities are generated in quantities and characteristics directly related to the number of industries and their nature. Packaging materials, food wastes, discarded metal, plastic and textiles, fuel burning residuals, and spent processing chemicals are among the wastes in this category. In most of the developing countries, municipalities allow industrial wastes to be disposed within their landfills without charging any tipping fee to cover the costs of disposal.

g) Sanitation Residues: In developing countries where sewerage is not the major means of managing human excreta and sullage, there are sanitation residues from privies and latrines. The so called night soil which accumulates in these regular removal may some time be serviced by municipality.

2.3 QUANTITY AND CHARACTERISTICS OF SOLID WASTE

A study (Bhide, et.al. 1983, p.17) has shown that quantity and characteristics of solid waste depend upon number of factors such as food habits, cultural traditions, socio-economic and climatic conditions. Refuse characteristics and quantity vary not only from city to city but even in the same city itself, from area to area and also seasonally. Cointreau (1986, p XI.), found the nature of municipal solid waste is a function of relative consumption and production activities within countries, according to their stage of economic development. Table 2.1 shows range of municipal refuse generation rates, compositional values,density characteristics for cities in countries of low-income, middle-income, and industrialized.

Table 2.1 Patterns Of Municipal Refuse Quantities And Characteristics For Low, Middle, And Industrialized Countries.

	Low Income Countries	Middle-Income Countries	Industrialized Countries
Waste Generation (kg/cap/day)	0.4 to 0.6	0.5 to 0.9	0.7 to 1.8
Waste Densities (kg/cubic meter)	250 to 500	170 to 330	100 to 170
Moisture content (% of wet weight at point of generation)	40 to 80	40 to 60	20 to 30
Composition (% by wet weight)			
Paper	1 to 10	15 to 40	15 to 40
Glass, Ceramics	1 to 10	1 to 10	4 to 10
Metals	1 to 5	1 to 5	3 to 13
Plastics	1 to 5	2 to 6	2 to 13
Leather, Rubber	1 to 5	Nil	Nil
Wood, Bones, straw	1 to 5	Nil	Nil
Textiles	1 to 5	2 to 10	2 to 10
Vegetable/Putrescible	40 to 85	20 to 65	20 to 50
Miscellaneous inerts	1 to 40	1 to 30	1 to 20
Particle size % greater than 50 mm	5 to 35	Nil	10 to 85

Source: Cointreau, (1986, p. xii)

From the table several conclusions can be drawn regarding solid wastes of low-income countries ;

1) waste densities are high, generally two to three times higher than those in industrialized countries

2) moisture contents are high, generally averaging about three times higher ;

3) composition is largely organic with portion of vegetable materials typically higher ;

4) there may be a substantial amount of dust and dirt in cities where sweeping and open ground storage is a part of collection system ;

5) particle size is much smaller, often exhibiting less than half of the materials in the over 50 mm range than would be seen in refuse from industrialized countries.

2.4 IMPACTS OF SOLID WASTE ON ENVIRONMENT

The word 'environment' which is derived from old French word 'environ' means 'encircle'.Human beings right from the time of birth are encircled or surrounded by people, animals, plants, air, water, land, soil, solar energy and other physical objects. All these are part of human environment. Environment is thus the sum of all social, biological, physical, and chemical factors which compose the surrounding of human beings (Ahmed, 1994). The World Commission on Environment and Development (WCED) known as Bruntland Commission defined Environment as"where we all live" and sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Environment as a productive system provides basic supports that are required for flourishing all forms of lives, materials that are harvested, energy that is harnessed, services for transportation and recreation and aesthetic for spiritual renewal.

Today, urban SWM is considered to be one of the most immediate and serious environmental problems confronting urban governments in developing countries (Schertenleib, et.al., 1992a). This is mainly due to rapid urbanization taking place on an enormous scale in developing countries. Rapid urban growth accompanied by increasing population growth and uncontrolled industrial development, however, severely degrade urban environment; place serious strain on natural resources, and consequently, also undermine equitable and sustainable development. Inadequate management of solid waste is an obvious cause for degradation of the environment in most cities of the third world. Solid waste is problem because it is the material that is not wanted by the producer who, of course seeks to dispose of it at the lowest possible cost. It is, therefore, task of society to ensure that disposal is carried out in such a way that it does not seriously damage the environment. The environmental impacts of inadequate management of solid wastes are described below:

2.4.1 Public Nuisance Impact

Uncollected solid waste is a public nuisance. It clogs sewers and open drains, encroaches on roadways, diminishes aesthetic, and causes unpleasant odour and irritating dust.

2.4.2 Public Health Impact

Public health can be affected when solid waste is not adequately contained at and collected from living and working environments, because:

1) the organic portion of solid waste ferments and favours fly breeding ;
2) the garbage in refuse attracts rats; and
3) the pathogens may be conveyed to man through flies and dusts.

Within a matter of hours in a warm temperature, sterile organic matter can be a potentially lethal source of toxic or disease producing organisms. The organisms do not have to be originally present in waste material as the environment is normally well provided with spores, bacteria, viruses, insects, vermin and other vectors awaiting a favorable site on which to multiply. The mere presence of these cultures of potentially disease producing organism in solid wastes has been not enough to cause a major health hazard. The blame for disease transmittal must be placed especially on the flies, mosquitoes and rodents (Trivedi et.al.,1992). The diseases that spread through flies, mosquitoes and rodents are given in (Appendix A-1). It is estimated that 90% of urban house-fly population breeds in the contents of open trash barrels. Rats also rely on readily available scraps of food such as those which are kept in open trash barrels (Trivedi et. al., 1992 p.68). Inadequate collection and disposal of solid waste is a major factor in the spread of gastrointestinal and parasitic disease, primarily caused by the proliferation of insects and rodents (Schertenleib, et.al., 1992a).

Public health also can be affected with solid waste if disposed within an open dump. In open dumps there is ready access to the waste to domestic animals and subsequently, potential spread of disease and chemical contaminants through food chain. From an open dump wind-blown dusts may carry pathogens and hazardous materials. Smoke generated from wastes at open dump is a significant respiratory irritant and can cause affected populations to have a much increased susceptibility to respiratory illness.

2.4.3 Water Pollution

The infiltration of rainfall or surface water in solid waste dumps or landfill can produce "leachate". If this leachate enters surface or ground water, it will cause severe water pollution.

2.4.4 Land Contamination

The most obvious contamination of land is caused by windblown litter and clandestine dumping in open area along road ways. This contamination causes an aesthetic impact, which can result in diminished civic pride and loss of property value.

2.4.5 Air Pollution

The most obvious air quality problems associated with waste collection and disposal are dust, odours and smoke. The air quality problem, most associated with solid waste collection, is dust created during loading operation. Dust is a nuisance and an eye irritant. However, it may also carry pathogenic microorganisms which could be inhaled when airborne. There is typically a putrid smell from hydrogen sulphide gas and other gases created by anaerobic biodegradation of wastes within dumps or land fill which can also pollute the air.

2.5 CONCLUSIONS

Solid waste is the term now used internationally to describe non-liquid waste material arising form domestic, trade, commercial, industrial, agricultural activities and from the public services. An apt definition of solid waste is "matter in wrong place", implying that a material becomes waste only when a specific owner ceases to have a use for it. There are potential riks to health and environment from improper management of solids wastes. For the general public, the main risk to health are indirect and arise from the breeding of disease vectors, primarily flies and rats. It is obvious, therefore, that solid waste management deserves due attention because inadequate and improper management not only poses health hazards but also gives rise to serious environmental pollution.

CHAPTER 3

LITERATURE REVIEW

In this chapter relevant literature has been reviewed to get a better understanding of elements and technologies available for solid waste management (SWM). It also describes recent trends and practices observed for improvment of solid waste management system in some Asian cities.

3.1 ELEMENTS OF SOLID WASTE MANAGEMENT

Storage of solid waste in the household, collection of household refuse, transportation of the waste to the processing or disposal facilities are the main elements of solid waste management system. Following section deals with the elements of solid waste management.

3.1.1 STORAGE

On site storage for solid waste can be either individual or communal, using a portable and manually loadable container, a mechanically loadable container or a concrete box fixed on a ground. A large storage size is required for a communal container, while an individual storage is sized to accommodate the waste generated by a family for normally two or three days. Plastic or metal bins used for household storage of waste are very common throughout the developed countries. Often plastic and reinforced paper bags are used in developed countries.

3.1.2 COLLECTION

Different methods used for collection of solid waste are:

a) Communal Collection ;
b) Block Collection ;
c) Curbside Collection ; and
d) House to House Collection

a) Communal Collection

In this system, house holders discharge their waste at predetermined locations containing some form of communal storage facility, and refuse collection vehicles visit these sites at a frequent interval, usually once daily to remove accumulated waste. The principal advantage of this method of collection is that it reduces considerable number

of sources from which waste has to be collected. However, when communal storages are widely spaced a great deal of wastes are deposited in the street. While the use of large communal storage appears to be a fairly simple solution, it may transfer much of the burden of refuse collection on street cleansing service, and actually increase the total cost, because it is cheaper to collect waste direct from a house than to sweep it from the street (Trivedi et.al. 1992, p.109). In most of the third world countries this type of collection system is followed.

b) Block Collection

In this system of collection, a collection vehicle travels a predetermined route at prescribed intervals, usually every two or three days, and stops at selected locations where a bell is sounded. Upon hearing the bell, householders bring their refuse container and hand them over to the crew, usually consisting of two men, which empties the container and returns them to the householders. This type of waste collection is practiced in Mexico City and in Burma.

c) Curb Side Collection

This type of collection system requires a regular service and a fairly precise time table. Residents must place their bins on the footway in advance of the collection time and remove them when emptied.

d) House To House Collection

In this type of collection system the householder does no work, the collector enters the garden or courtyard, carries the bin to the vehicle, empties it and returns it to usual place. This type of collection system is practiced in developed countries. Door to door collection system only proves productive when collection is infrequent, typically once a week.

Table 3.1 gives a comparison of various method of solid waste collection.

Table 3.1 Comparison Of Various Methods Of Solid Waste Collection

DESCRIPTION	COMMUNAL COLLECTION	BLOCK COLLECTION	CURBSIDE COLLECTION	HOUSE TO HOUSE COLLECTION
Householders co-operation in carrying refuse bin	Yes	Yes	Yes	No
Householder co-operation in emptying refuse bin	Yes	Optional	No	No
Need for scheduled service	No	Optional	Yes	No
Susceptibility to scavenging	Very high	None	High	None
Average crew size	1-2(portable) 2-4(stationary)	1-3	1-3	3-7
Complaints regarding trespassing	No	No	No	Yes
Level of service	Poor	Fair	Good	Good
Collection cost	Low	Medium	High	Very high

Source : UNCHS (HABITAT), 1988, p.10.

3.1.3 TRANSPORTATION

A variety of vehicles are available for collection and haulage of solid wastes. Manually driven handcarts are used for collection of solid waste from narrow streets. Although they are in-expensive, the distance which can be traveled is very short. Bicycles, tricycles, and motorcycles can be used to transport waste-containing carts and barrows. They can travel a longer distance than the manually-driven carts, but the distance is still limited and the travelling speed is slow. Often Agricultural Tractors are used in conjunction with trailers to transport solid waste. According to a study (Ogwa 1989, p.74) the most commonly used vehicles for collection and haulage of solid waste in Asian urban areas are fixed-bed and tipper trucks, because these trucks can travel unlimited distance with 40-70 km/hr. speed. While frequent maintenance is required for these vehicles and fuel costs are high, they can transport a large volume of waste per vehicle. Compactor and haulable trucks are used in many metropolises. Both compactor or haulable trucks are in most cases foreign made and therefore very costly.

Table (3.2) gives a comparison of solid waste transportation options with respect to operational parameters.

Table 3.2 Solid Waste Transportation Options And Their Characteristics.

Parameter	Manual Hand cart	Bi/Tricycle Cart	Animal Cart	Tractor Trailer	Fixed Bed Truck	Tipper Truck	Compactor Truck	Haulable Truck
Distance Traveled	< 2km	< 10 Km	< 10 Km	< 15 Km	Unlimited	Unlimited	Unlimited	Unlimited
Speed	Very slow	slow	slow	Relatively slow	Fast	Fast	Fast	Fast
Applicable width of street	Narrow	Narrow	Moderate	Wide	Wide	Wide	Wide	Wide
Volume per vehicle (typical)	.5-1m^3	2-3m^3	4m^3	4m^3	8m^3	10m^3	12m^3	20m^3
Labour requirement	1 Collector	1 Driver 1 Labor	1 Driver 2 Loaders	1 Driver 2 Loaders	1 Driver 3 Loaders	1 Driver 3 Loaders	1 Driver 3 Loaders	1 Driver
Purchase cost	Very low	Low	Low	Relatively low	Moderate High	High	Very High	Very High
Maintenance	Very low	Low	Low	Low	Moderate High	High	High	High

Source : Ogwa, 1989, p. 78

3.1.4 TREATMENT AND DISPOSAL

Solid waste disposal is a problem precisely because the waste is not wanted by the producer. But solid waste can damage the environment and affect people's health, so it cannot be disposed of carelessly. One positive approach is to recycle the waste, thus turning waste to profit, as well as conserving the environment. Current waste disposal philosophy is to endeavour to treat all wastes as resource materials; some for recycling, some for conversion to fertilizer or as a source of energy and the balance for land reclamation. (Trivedi. et.al., 1992).

Solid waste pollution has always been more advanced in the largest cities. Disposal problems become difficult with increase of population density. Simultaneously there is greater production of waste per unit area, and a decreased proportion of land available for disposal. Therefore, the history of solid waste pollution is largely connected with the histories of largest cities.

SOLID WASTE DISPOSAL OPTIONS

The options available for disposal of solid wastes are

a) Open Dumping ;
b) Sanitary Landfilling ;
c) Incineration ; and
d) Composting.

a) Open Dumping

Disposing of solid wastes in open dumps is the most common method used in developing countries. Much of the uncollected solid waste is disposed in a similar manner. The term dump means the uncontrolled deposit of waste.

Advantage Of Open Dumping

The only benefit from open dumping is that it is low-cost waste disposal method.

Disadvantages Of Open Dumping

There are many disadvantages of this method. Some important disadvantages are :

1) The waste is exposed to flies and rodents ;
2) It is a source of nuisance from the smell and unsightly appearance ;
3) The loose refuse is dispersed by the action of wind ;
4) Drainage from dumps contribute to the pollution of surface and ground water; and
5) Often open dumps are on fire, this not only causes nuisance to near by homes but also adds to air pollution.

b) Sanitary Landfilling

Sanitary landfilling is a method of disposing of wastes on land without creating nuisance or hazard to public health or safety.

Advantages Of Sanitary Landfill

The advantages are as follows :
1) The method is cheap and easy to operate ;
2) Public health problems are minimized because flies, rats, and other pests are unable to breed in covered refuse ;
3) There is no air pollution from burning of wastes and none from dust or odors ;
4) Fire hazards are very small ;
5) There is less chance of water pollution ; and
6) Sanitary landfill, if properly planned, can be used later for construction sites or recreational facilities such as parks and golf courses.

Disadvantages Of Sanitary Landfill

There is a danger of ground water and surface water pollution, if the landfill site is improperly chosen or if it is dug too deep. But this danger can be avoided by proper site selection. Moreover, Sanitary landfill requires large area of land.

c) Incineration

Incineration is the process of reducing combustible waste to an inert residue by high-temperature burning. Incineration involves the burning of solid wastes at high temperature to leave ashes, glass, metal and unburned combustibles amounting to perhaps one-fourth the original weight, which must be then disposed of in a landfill. The important factors to be observed have been the maintenance of a minimum temperature of 850°C in the combustion chamber to burn up the smoke produced and the presence of grit extractors to remove finely divided dust before it gets discharged into atmosphere.

Advantages Of Incineration

Advantages of this method are :
1) The main advantage of incineration compared to other conventional methods of waste treatment and disposal is that large reduction in the volume of material requiring final disposal and the less severe constraints on land disposal of incinerator ash compared to those of untreated solid waste ;

2) Under certain circumstances, the heat energy released from combustion of the waste may be beneficially used or converted to another from of energy ; and

3) Incineration is often an appropriate treatment and disposal process in areas of high population density, where land for disposal of untreated waste may be unavailable.

Disadvantages Of Incineration

Incineration can present several economic, ecological and technical disadvantages such as :

1) High construction cost ;
2) High operation and maintenance cost ;
3) The need for skilled personnel to operate and maintain the plant ;
4) Difficulty in using generated heat ;
5) Destruction of potential recyclable material in the waste;
6) The need for expensive control measure to prevent air and water pollution ; and
7) Among different methods of solid waste disposal, incineration is the most expensive one.

d) Composting

Composting can be defined as biological decomposition of the organic constituents of wastes under controlled conditions. This process can take place in the presence or absence of oxygen. Compost system could be classified on three general bases, namely oxygen usage, temperature and technological approach. When oxygen usage has been the basis, the division has been aerobic and anaerobic. When temperature forms the basis, the division become mesophilic and thermophilic. Finally, if technology is the basis the

classification has been into "open" or "windrow" and mechanical or "enclosed" composting.

Advantages Of Composting

Advantages of composting are listed below :

1) Reduction of volume and weight of waste to be disposed of;
2) Reduction of emissions, such as odours and leachates;
3) Recovery of resources, with possible reduced disposal;
4) The most important use of compost is its application to land, as a fertilizer, soil conditioner or it can be used as a means of land reclamation.
5) Application of compost to land improves the quality of soil making it more productive;
6) Compost increases soil aeration ;
7) Compost makes heavier soils easier to till ;
8) Reduces soil erosion ;
10) When compost is used in conjunction with chemical fertilizer, it makes the phosphorus more readily available and also prolongs the nitrogen availability to plant;
11) Compost also improves the quality and longevity of soil, reduces health risk of having pathogenic material in the environment; while improved aesthetic quality of surroundings is difficult to quantify but it is quite important in ensuring adequate maintenance of environment;
12) Compost may be used on land for purposes like agriculture, horticulture, homegardening landscaping, landfill, forestry or commercial farming ; and
13) It has a buffer effect as a protection against very large application of chemical fertilizer.

Disadvantages Of Composting

The disadvantages of composting are

1) In a mechanical plant, the construction cost is high ;
2) Maintenance and operational cost is also high in mechanical plant;
3) There might be difficulty in marketing the product ; and
4) Sufficient space is required for storage of compost and installation of compost plant.

3.1.5 RECYCLING

According to Cointreau (1985), solid waste can be recycled in many ways. We can categorize the ways in which solid waste can be recycled into three levels for recovery and reuse :

Level 1: After sorting and cleaning, discarded items are reused. Sorting and cleaning in this step is generally done by hand in developing countries. In this level, after sorting and cleaning, the discarded item is reused without changing the form and function of the item. A common example is reusing (after sorting and cleaning) a packaging container such as a can, bottle or box.

Level 2: In this level waste material is sorted, cleaned, processed and recycled into a new material or product of comparable composition. For example, broken glass or cullet used for manufacturing new beverage containers or paper used to produce new paper product.

Level 3: In this level the waste is converted into a different material or form of energy. Compost made from organic waste, or biogas produced through anaerobic digestion of organic waste are example of this level of recycling.

3.2 SOLID WASTE MANAGEMENT - EXPERIENCE OF SOME ASIAN CITIES

The following section deals with the recent development in solid waste management in some Asian cities. This section also describes how many Asian cities are trying to solve the growing waste problem for better environment.

3.2.1 WASTEWISE PROJECT, BANGALORE, INDIA

In 1990, the Waste Wise Project was launched by Auslem Rosario, through Mythri Trust with funding for one year from Terre Des Hommes of Switzerland, Karnataka State Council for Science & Technology later took responsibility for finance and technical assistance. The project has some specific economic, social and environmental goals like

1) Resource recovery by recycling of organic and dry recyclable waste and decentralization of handling waste with a view to employment generation;
2) Possibility of social mobility and articulation of poor section on SWM issues ; and
3) Avoidance of illegal disposal of wastes and change the attitude and perception on waste, environmental sanitation, greening and promotion of sustainable environment for all.

According to Furedy (1992, p.44), Waste Wise initiated a project in an affluent to middle class residential area of Bangalore Jaynager Block IV. In the project area the households are given baskets to hold dry waste and told to segregate compostable materials and insanitary wastes. Former waste pickers are employed to pick the waste from the project households. They are equipped with handcarts and baskets and are trained by a supervisor paid by Waste Wise. The collectors visit each house daily, take the organic waste to compost site at a local park, donated by Banglore City Corporation, sell the dry recyclable and dispose of residues in communal bins. Households pay a small fee per month for this service (Rs. 5/- to 10/-). The collectors are paid Rs. 300/- per month from the fees collected and also get payments for tea and food. The collectors also earn about Rs. 15/- a day through sale of recyclable materials.

Although the collection of wastes from door is appreciated by residents of the area, few households refuse to pay for the convenience, since they consider their property rate should cover waste services. The Bangalore City Corporation has supported the project but the officials are taking "wait and see" attitude rather than active partnership (Furdey, 1992, p.46). Another problem which the organizers of Waste Wise faced was the orthodox Hindu families usually expect waste to be removed early in the day, which did not fit with the usual timing of the waste collectors. The Waste Wise has been seeking business corporations support, liaising with other NGO's and reporting results through international network like the CITY NET group of ESCAP.

This conceptually innovative project combines a general understanding of local waste problems of Bangalore with a practical sense of what is feasible for community based waste management in better off neighbourhoods.

3.2.2 CIVIC EXNORA, PROJECT, MADRAS, INDIA

In Madras, an organization called 'CIVIC EXNORA' can be found similar to Waste Wise of Bangalore. This Exnora was founded by M.E. Nirmol, a Branch Manager for the Indian Overseas Bank in Madras. The solid waste thrust was begun through helping residents in elite and middle class areas to form Civic Exnora Units (Furedy, 1992, p.48). The units adopt roads for cleaning and other improvements, such as tree planting. Collectors known as "street beautifiers" and who may be former waste pickers have been selected and trained to collect waste from households and either deliver them to municipal vehicles or deposit them to transfer points. They are paid by the households, through the street organizations. Households pay Rs. 15-20/- per month for this service. One street unit might collect Rs. 800/- each month; of this Rs. 600/- will go on wages, Rs. 100/- will be used to pay off bank loans, and the remainder will go into a sinking fund in case of defaults. The street units buy or rent bicycle carts for the collectors with small bank loans (Furedy, 1992, p.49). Street cleanups and regular street sweeping have also been organized in this way. There is discussion on expanding clean-ups and waste removal from slum and squatter areas, which would be financed by extra donations from well-to-do-neighbourhoods. More than 60,000 people are receiving house to house waste callection services on some 500 roads in about 80 neighbourhoods organized by 150 Civic Exora units. The goal of social advancement for waste pickers, although not an initial concern, is becoming important in some areas. Besides the regular work basic literacy classes are arranged by some of the chapters. Exnora has also begun to promote source separation in some project neighbourhoods. Experiments have begun in back yard composting.

According to Furedy (1992, p.49), the system can work effectively if most household keep up their payments. Where too many have defaulted the street unit has lapsed. In some cases, the breakdown has occurred due to Madras City Corporation's failure to pick up wastes from transfer points. As the Civic Exnora units have no means of transporting wastes to dumps, the transfer points rapidly become a nuisance without regular service from municipality.

3.2.3 HOME GARBAGE PICK, NEW DELHI, INDIA

A Private company named "HOME GARBAGE PICK" was launched in August 1992 in New Delhi by a Retired Captain J.K. Verma. It is the first private venture of its kind in India for collecting garbage from households for a prices and transporting it to its own recycling center (Pandey, 1992).

The home garbage pick boys move from door to door from 9 am to 2 pm everyday. The residents keep their garbage in polythene packets provided by the company and handover these packets to the boys. The residents have to pay Rs. 5/- in advance as a membership fee and a maximum of Rs. 40/- per month for garbage picking. The residents where these home garbage collection is done are satisfied with the efficiency of the company.

3.2.4 ECOVILLES PROJECT BANDUNG, INDONESIA

A project named "ECOVILLES" has been undertaken by the Center For Environmental Studies of Bandung Institute of Technology. The main concept was from Professor Hasan Poerbo and his plan was to establish co-operatives of former waste pickers and collectors in different residential neighbourhoods of a city. The primary collection of all wastes would be done by members of the ecovilles, operating through co-operatives. They would sort out recyclables and compost the organic materials in their settlements, leaving only useless residues to be picked up by the municipal staff and transported to the dumps. The project could not be implemented in Bandung since the municipality was not convinced of its practicality. This project was not possible in Bandung but in Suraboya it was possible with the help of funding by Ford Foundation.

3.2.5 DECENTRALIZED COMMUNITY BASED COMPOSTING, PROJECT JAKARTA, INDONESIA

A recent experimentation with decentralized composting in neighbourhood has been carried out in Jakarta. Here, household were not asked to separate dry and wet wastes, but waste pickers engaged by the project collected wastes, from transfer points, composted the organic and sold the recyclable to waste dealers. Residues were returned to transfer points for municipal collection. These experiments begun as a result of an elaborate proposal for decentralized SWM called Integrated Resource Recovery from Indonesian cities in which each neighbourhood would have station called "Garbage Industrial Estate" at which organic and in-organic recyclables would be separated and organic would be composted. The main goal of this project is to improve solid waste management for better environment of neighbourhoods.

The Jakarta experiment concentrated on technology of compost making and did not attempt to implement the social goals of the integrated resource recovery plan.

3.2.6 CASH IN TRASH, PROJECT, SANJAUN CITY, PHILIPPINES

A project of source separation of dry recyclable material in SAN JAUN city was introduced by the Metro Manila Council of Women Balikatan Movement, Inc. (MMWBW), a regional women's organization. Some of the members of MMWBM were worried about increasing solid waste management problem of Manila, as city authorities could do no improvement. The "Cash in Trash" project was first proposed by Leonda Comacho (now chairperson of MMWBM), as a pilot project in 1978. Registered "eco-aides" were equipped to buy recyclable materials door-to-door (at set price) and to sell these to "eco-centers". The project was carried by a government center but it was not successful.

In 1983, Leonardo Comacho initiated the San Juan "Linis-Gouda" (clean-beautiful) project. At first they were unsuccessful to persuade the city authority but later on after having co-operation from the households, they were successful and avoided the failures occurred previously. One of most important part of this project was to execute the collection and trading through the existing waste dealers, not setting up new "redemption center." As an incentive to co-operation from the dealers and to reassure them that this project unlike the "Cash in Trash" one works through the dealers, rather than trying to by-pass them, the project organizers researched the markets for new kinds of wastes coming from households and put the dealers in touch with prospective buyers. Thus the dealers were able to expand their scope of business. About 60 percent of the 18,000 household of San Juan participated in this project and about 50 tons of recycleables were collected per month without any harassment (Furdey, 1992, p. 48).

3.3 CONCLUSIONS

From the discussions it is evident that the level of service in communal collection system is poor and better service can be attained by house to house collection system. In case of transportation non-motorized vehicles can be used for short haulage and also narrow roads while motorized vehicles be preferred for long travel distance and wider roads. For the final disposal of wastes, the low cost method is sanitary landfillings, while incineration and mechanized composting are the methods for waste reduction and recycling. These methods of disposal are expensive than sanitary landfilling but have some advantage like reduction in final volume of wastes to be disposed on land.

From the experiments of different developing countries, it is clear that both community based organizations (CBOs) and municipal authorities needs to co-operate with each other in-order to improve solid waste management for better and sustainable environment. We can also observe that the organizers of CBOs faced difficulty in getting co-operation with municipal authorities. They were also handicapped by the problems like lack of access to resources and political commitment. For example, the Civic Exonora units faced problems as the municipal authorities failed to transport waste from collection points. Similarly, in Ecoville project, the organizers faced difficulty in convincing the municipality about the projects practicality in Bandung.

CHAPTER 4

METHODOLOGY OF THE STUDY & INVESTIGATION TECHNIQUES

This chapter describes the research strategy adopted and steps followed to achieve the objectives of the study as outlined in chapter 1.

4.1 TYPE, SOURCE & METHOD OF DATA COLLECTION

The information and data required for this study were collected from various sources, both primary and secondary, detailed in the following sections

4.1.1 LITERATURE SURVEY

In order to get a better understanding of solid waste management, relevant literature has been reviewed and data have been collected from secondary sources, according to need and availability. During literature survey, information has been collected from books, journals, reports and documents concerning solid waste and environment. Literature survey is quite important for the present study as the topic is rather new in our context.

4.1.2 QUESTIONNAIRE SURVEY

The primary information was mainly collected from questionnaire survey. For this, two types of questionnaire were prepared; one for the concerned agency (DCC) and the other for households as the DCC and households are both involved in solid waste management of Dhaka city.

4.1.3 PHYSICAL OBSERVATION SURVEY

In addition to the use of questionnaire for primary data collection, a physical observation schedule was also used for recording the impression of field observations and photographs were also taken as found necessary.

4.1.4 DISCUSSIONS AND CONSULTATIONS WITH ORGANISATIONS OFFICIALS

Different offices were visited and officials were consulted to gather their views, and suggestions for the improvement of SWM system of Dhaka City. Different offices which were visited and consulted are World Health Organization (WHO), World Bank(WB), Asian Development Bank (ADB), Department of Environment, (DOE), Dhaka City Corporation (DCC), Public Health Engineering Department (PHED), Rajdhani Unnayan Kartipakkha (RAJUK), German Cultural Centre, Local Government Engineering Department (LGED) and Dhaka Water and Sewerage Authority (DWASA).

4.2 SELECTION OF STUDY AREA

Due to limitation of time and fund, it was not possible to survey the whole of Dhaka city. For this reason two areas were selected for study of the solid waste disposal practice and problems faced by households,. The selection criteria was one from planned and one from unplanned residential area of Dhaka city. 3% of the total households from each area were covered by the survey.

4.2.1 DHANMONDI RESIDENTIAL AREA

Dhanmondi Residential area is located in Zone 5 of Dhaka City Corporation with total registred household of 2185 and a population of 15242. The streets of Dhanmondi are wide and planned. Access of DCC conservancy trucks in Dhanmondi area is easy. The density of Dhanmondi area is less compared to Free School street of Kathalbagan.

4.2.2 FREE SCHOOL STREET, KATHALBAGAN

Free School Street region of Kathalbagan is an unplanned area with narrow lanes and bylanes. This area is also located in Zone 5 of DCC with total registered household of 2569 and a population of 15,471. The density of this area is higher than Dhanmondi. Access of DCC conservancy truck is difficult due to narrowness of lanes and bylanes.

In addition to questionnaire survey conducted in these two areas, physical observations were made in different parts of the city and also at the major dump sites at Jatrabari, Mugdapara and Mirpur.

4.3 METHOD OF DATA ANALYSIS & REPRESENTATION

Computer software, Statistical Package for Social Sciences (SPSS) has been used as the main tool for analysis of the collected data. Simple frequencies, percentage and cross tabulation have been done for the present study. The findings of the study are presented in tabular form.

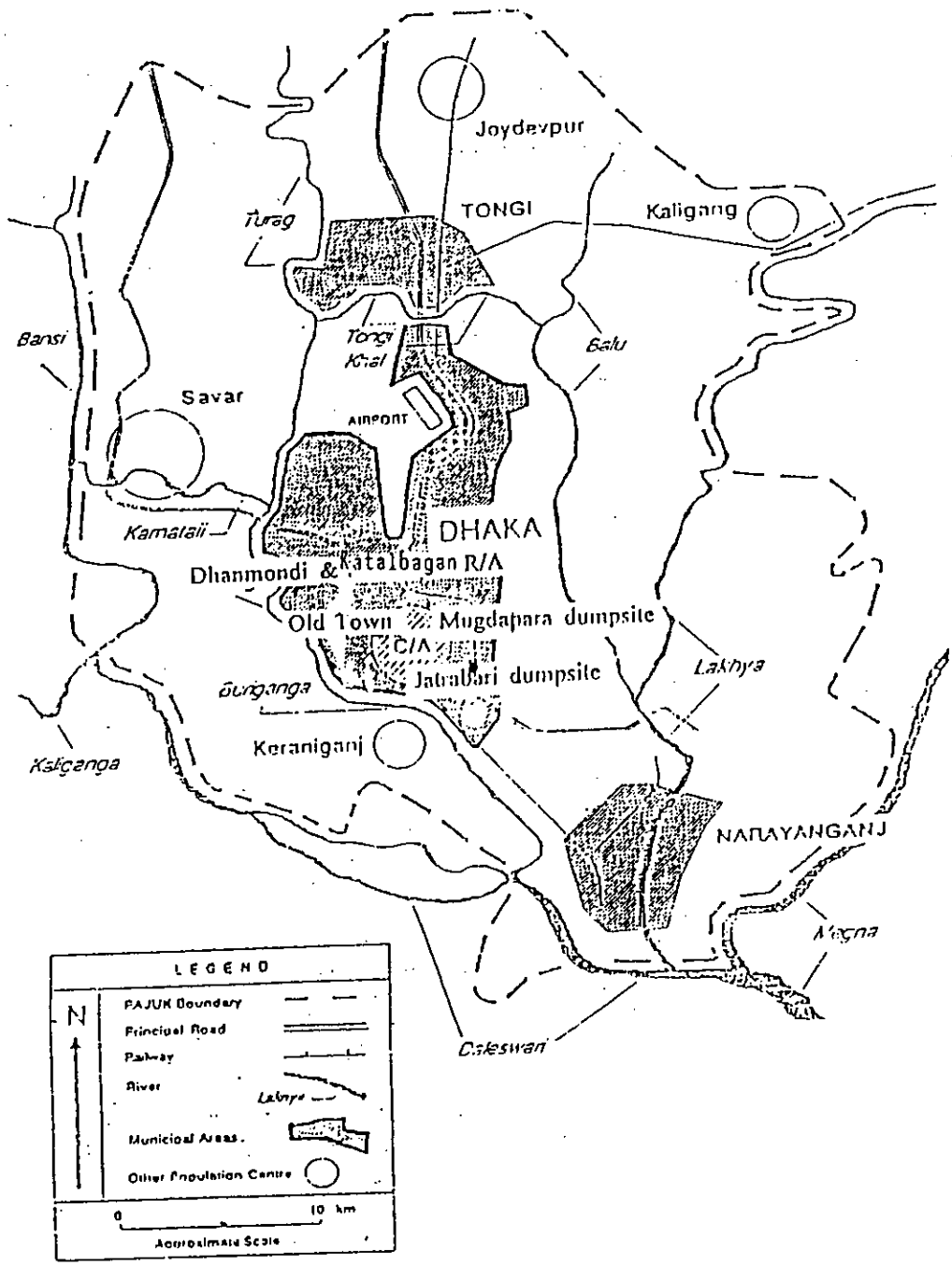


Fig 4.1 Map of Dhaka Metropolitan Area Showing the DCC Jurisdiction area.

Source: UNDP, et. al.(1992)

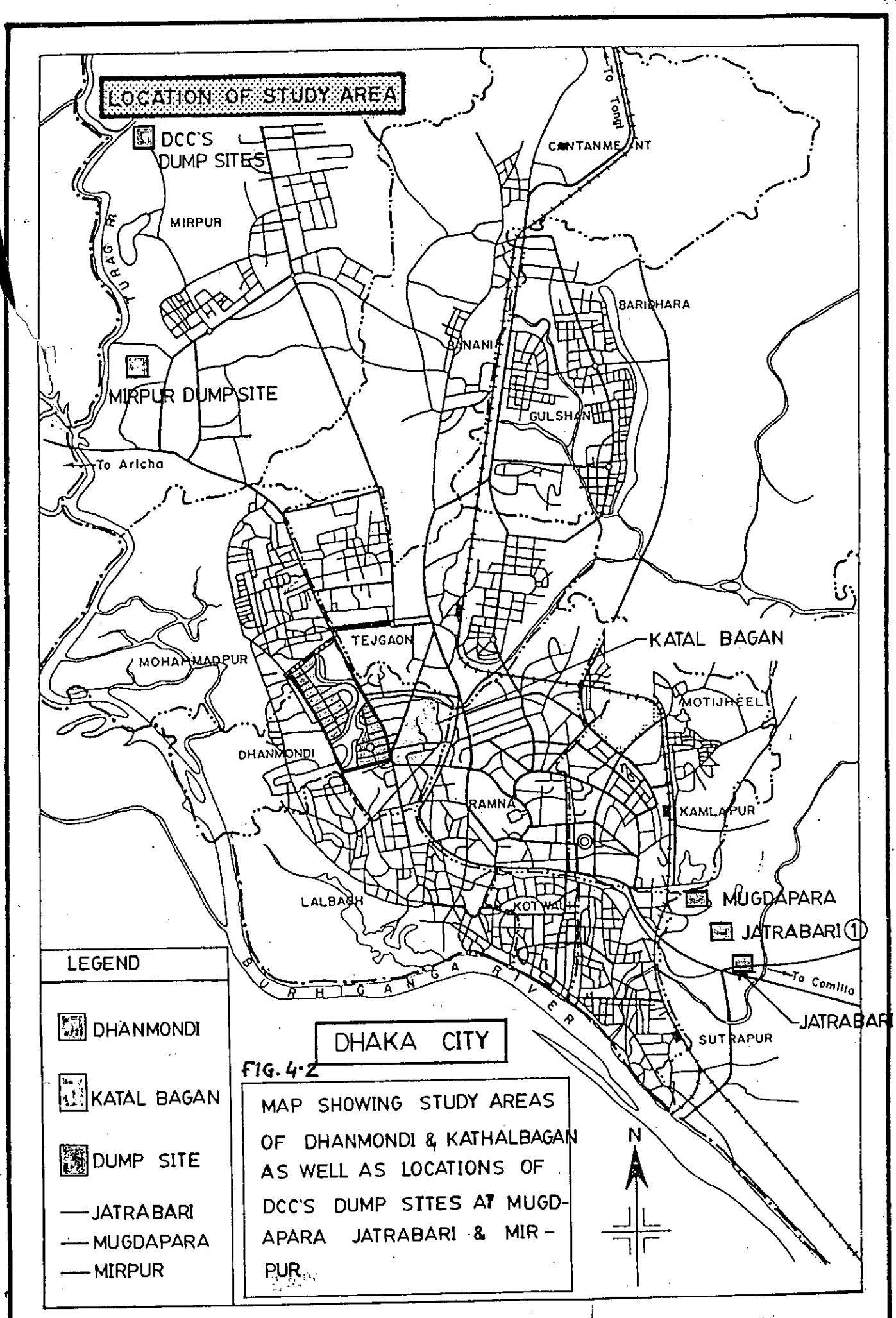


FIG. 4-2

MAP SHOWING STUDY AREAS OF DHANMONDI & KATHALBAGAN AS WELL AS LOCATIONS OF DCC'S DUMP SITES AT MUGDAPARA JATRABARI & MIRPUR

CHAPTER 5

SOLID WASTE MANAGEMENT OF DHAKA CITY

This chapter discusses the present solid waste management system of Dhaka city. Dhaka City Corporation (DCC) is the only formal organization of the Government responsible for solid waste management of Dhaka City. It is, therefore, very important to understand and study the role, constraints and problems of Dhaka City Corporation (DCC), along with few recent initiatives by nonformal organization in connection with improvement of solid waste management system of Dhaka city. As such the following section discusses the organizational, financial and technical aspects of SWM by DCC and also recent development in the field by non formal organization.

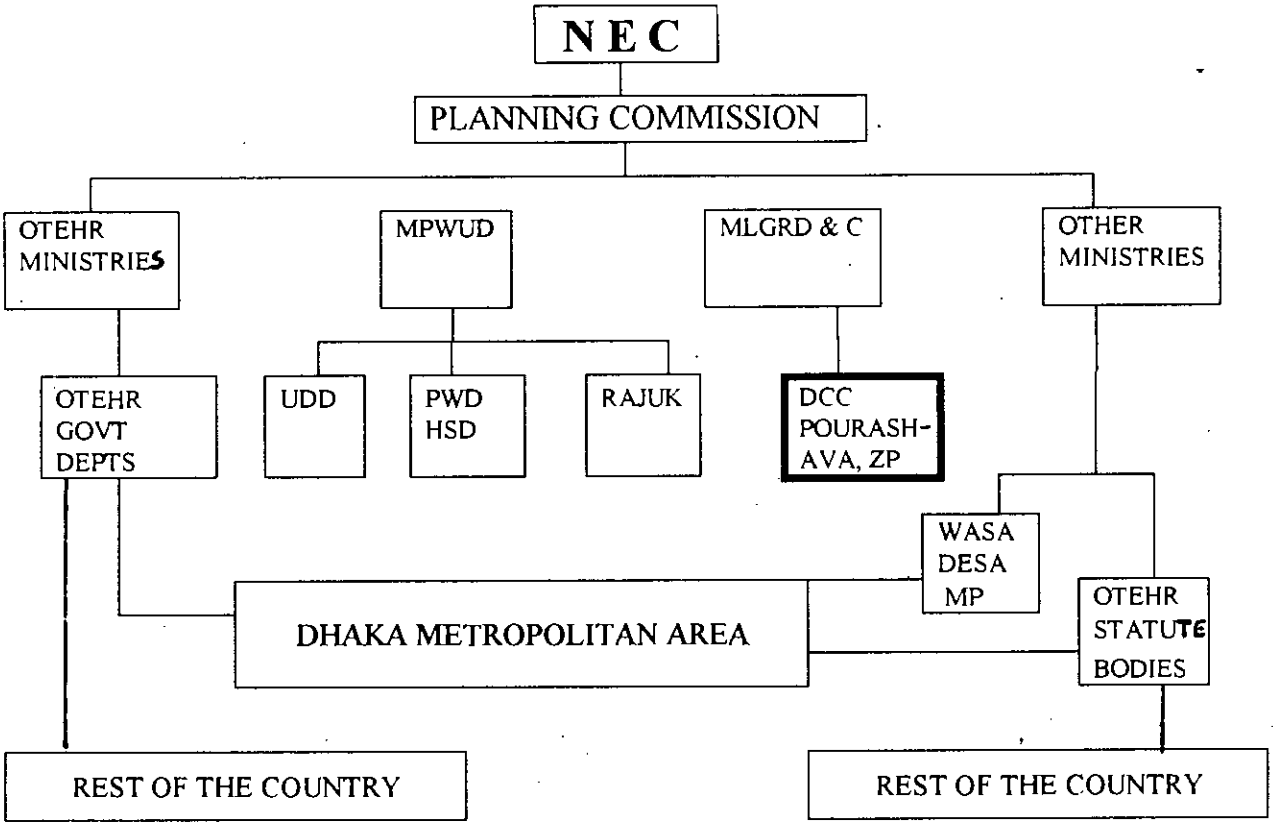
5.1 INTRODUCTION

According to Pourashava Ordinance 1977, the responsibility of SWM lies with the concerned Pourashava or Municipality. Municipalities have been established in all sixtyfour districts and major thana centers of Bangladesh. The number of municipalities at present are 110. Dhaka, Chittagong, Khulna and Rajshahi municipalities have been upgraded as City Corporations. Management of solid waste for Dhaka city rests with Dhaka City Corporation (DCC).

5.2 DHAKA CITY CORPORATION

Dhaka Municipality was established in 1864 and was upgraded to city corporation (DCC) in 1990. DCC is responsible administratively to the Ministry of Local Government Rural Development and Co-operatives (MLGRDC). The existing planning & development institutions in Dhaka Metropolitan area is shown in Fig (5.1). The demand for urban service in Bangladesh is increasing very rapidly. Between 1981 and 1991 the urban population growth in Bangladesh was 4.4% and during the same period the population growth rate in DCC area was 4.75% (UNDP, 1993, p.9). This rapid increase in population is causing pressure on agencies responsible for urban services. Dhaka City Corporation is responsible for providing a number of urban services, which include solid waste management, road construction and maintenance, street lighting, surface water drainage,construction and management of parks and markets, public health and sanitation, provision of burial and burning ghats. Recently slum improvement projects are entrusted to DCC.

The area under jurisdiction of DCC is 344 sq.km with a population of 35,83,000 (BBS, 1993b). Since 1830 upto 1993 there have been only two worth mentioning improvements that took place in the field of SWM. The first one was in 1982, when bullock cart for collection and transporation of solid waste was replaced by open trucks and later on was in 1989 by



NEC : National Eccnomic Council
MPWUD : Ministry of Public Works & Urban Development
MLGRD & C : Ministry of Local Government, Rural Development and Cooperative
UDD : Urban Development Directorate
PWD : Public Works Department
HSD Housing & Settlement Directorate
RAJUK : Rajdhani Unnayan Kartipackha
DCC : Dhaka City Corporation
ZP : Zilla Parished
WASA : Water and Sewrage Authority
DESA : Dhaka Electric Supply Authority
MP : Metropolitan Police

FI G 5.1 Existing Planning and Development Institutions in Dhaka Metropolitian Area.
Source : GOB, et.al, 1981.

introducing night time collection instead of day time in some parts of Dhaka city (Shamsuzoha, 1993a).

5.2.1 ORGANIZATIONAL AND INSTITUTIONAL ASPECT OF DCC

DCC is headed by a Mayor who is an elected representative of the people and is organized into five principle areas of responsibility which are engineering, conservancy, revenues, accounts and health under the Chief Executive Officer (CEO), who is deputed by the Government. CEO is responsible for management and works within the system to check and control various activities on behalf of the government. The various activities of DCC are managed by nine independent divisions.

Refuse collection and disposal from DCC area is the responsibility of the Chief Conservancy Officer (CCO) who manages it with the support of a Deputy Conservancy Officer and two Assistant Conservancy Officers. The Chief Conservancy Officer (CCO) is also assisted by ten Conservancy Officers who are provided with Conservancy Supervisory Inspectors (CSI). The Conservancy Supervisory Inspectors get the work done through Cleansing Inspectors (CI.) and cleaners. The organogram of Conservancy Division of DCC is given in Fig 5.2.

The DCC area covering 344 sq.kms is divided into 90 wards and grouped into 10 Zones (Fig 5.3) Each zone has a Zonal Office under an Executive Officer who is incharge of a zone. Each zone has several divisions which are Engineering, Revenue, Conservancy and Health. The Conservancy Division of a zonal office is responsible for refuse collection within the zone. Each zone has a Conservancy Officer (CO) who is assisted by Conservancy Supervisory Inspectors (CSI) and Cleansing Inspectors (CI.).

5.2.2 MANPOWER

At present a total of 4221 workers (Appendix A-2) are engaged by the Conservancy Department for collection and disposal of refuse and this number is increased by 296 in the monsoon (Bhide, 1990). Most of these workers are muster roll employees (part-time labourers). The Conservancy Department has the largest manpower for street sweeping, garbage collection and disposal. Still the ratio of workers per thousand population is 1.17, considering the population of DCC area 35,8,3000 which is low as compared to the requirements of 2-5 (Trivedi, et.al., 1992, p.91) workers per thousand population for satisfactory manual collection and disposal of garbage.

5.2.3 PRESENT LAWS AND REGULATIONS

The present legal foundations for SWM are the Conservancy laws (applicable in the DCC area) and the 1977 Environment Pollution Control (EPC) Ordinance. These legal foundations though give a general guide line about the duties and responsibilities of DCC vis-a vis the responsibility of the public, do not cover the solid waste operations comprehensively

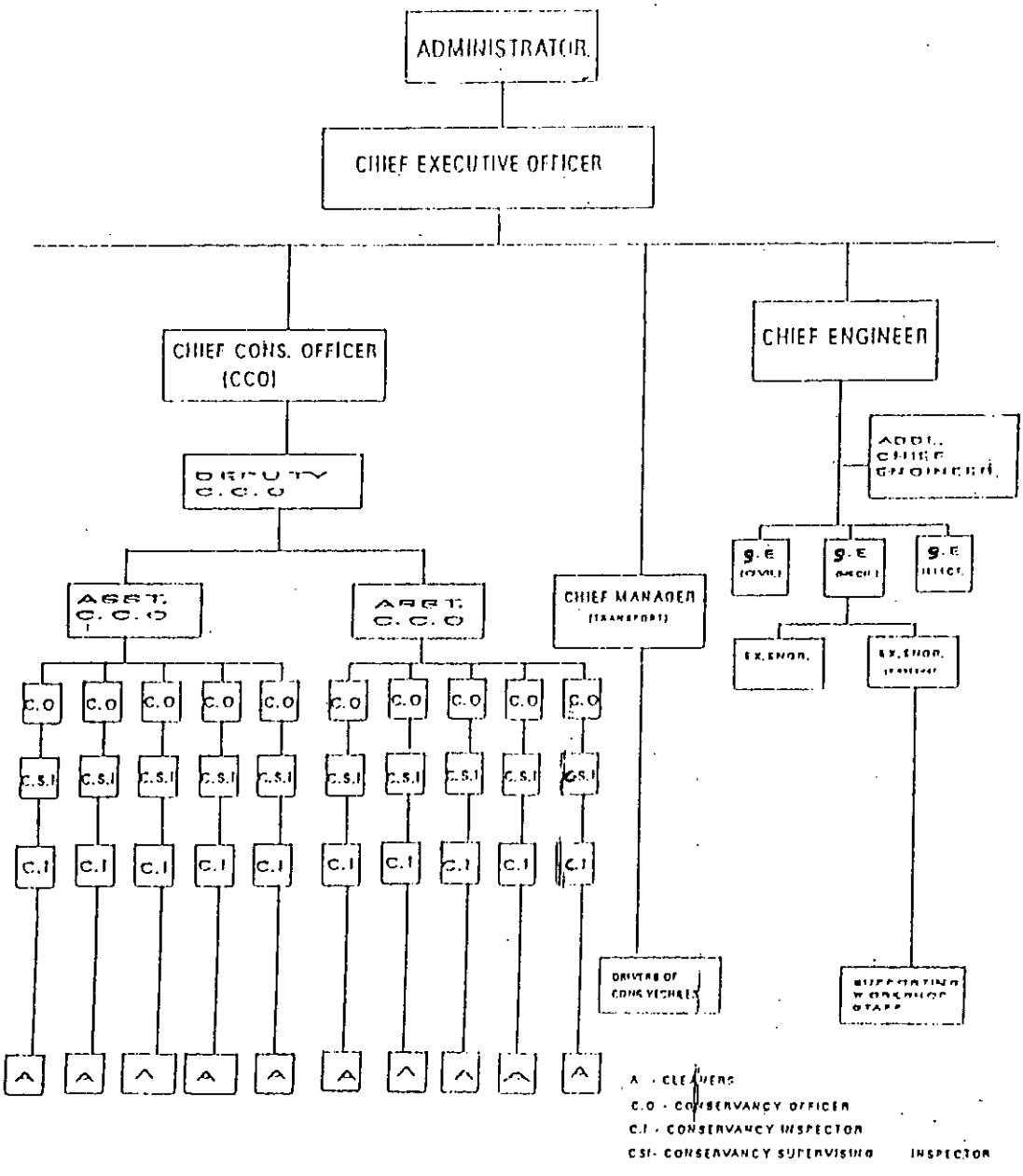


FIG. 5.2 ORGANOGRAM OF SOLID WASTE MANAGEMENT IN DCC

Source: Bhide, (1990)

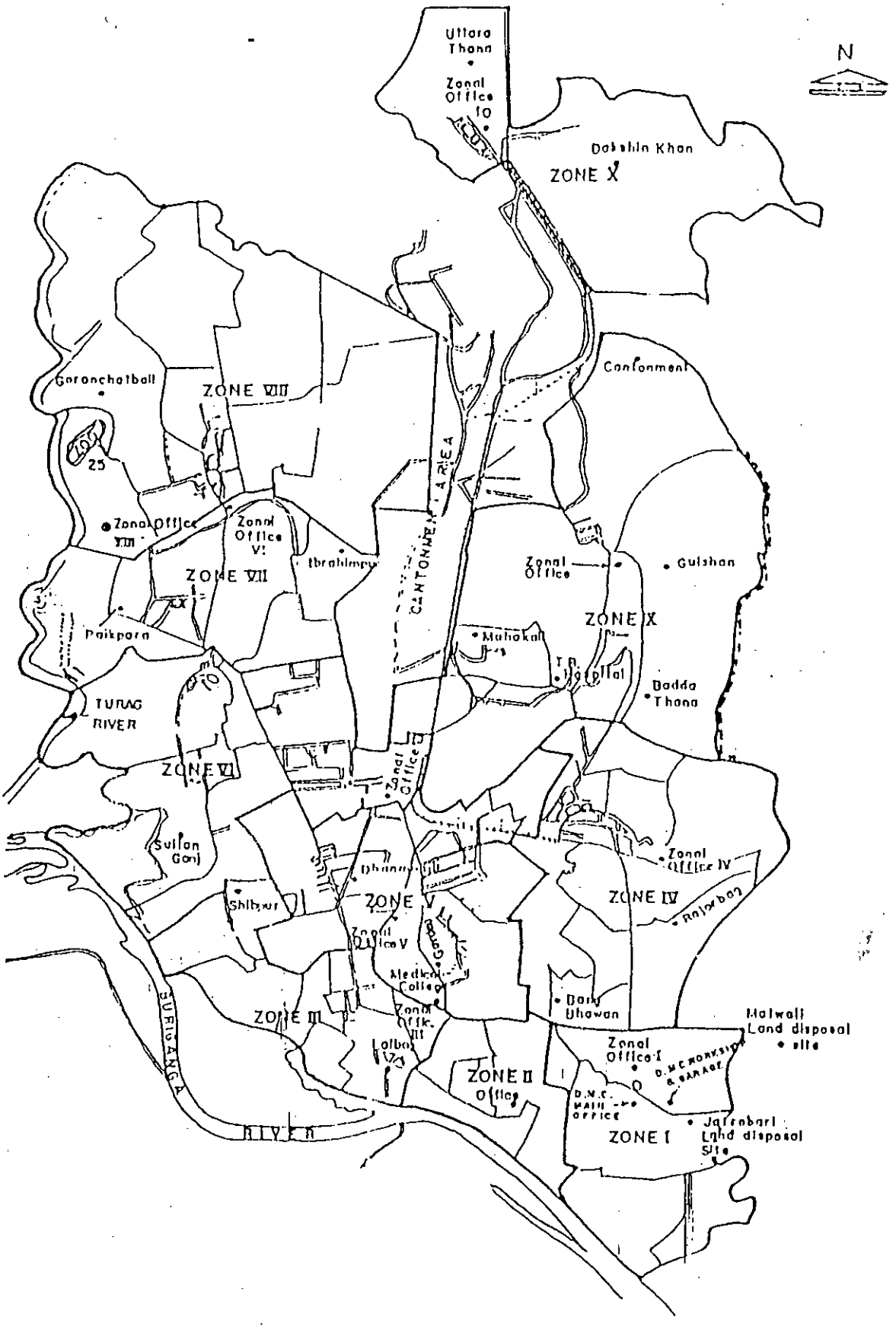


FIG. 5.3 Map of the DCC area showing different zones of DCC

Source : Bhide, 1990.

(Shamsuzzoha, 1993a). Recently adopted Environmental Policy (1992) of Government of Bangladesh also does not cover matters relating to solid waste operation in detail. It simply intends to restrict disposal of municipal, industrial or agricultural waste in rivers, ponds and drains; discourages open truck transporation and day time collection of waste, by adopting proper legislation and enforcement of the legislation by relevant authorities of Department of Environment and Local Government Authorities. Important issues like disposal method, criteria for selection of landfill sites, minimum staffing, and infrastructure requirements are found lacking in the aforesaid Policy.

The legal framework in Bangladesh is not in a position to fully protect the environment (Islam 1992b). The main relevant part of the present law is contained in paragraph 78 of the Dhaka Municipal Corporation Ordinance XL, 1983 which states that :

1. The corporation shall make adequate arrangements for the removal of refuse from all public streets, public latrines, urinals, drains, and all buildings vested in the corporation and for collection and proper disposal of such refuse.

2. The occupiers of all buildings and lands within the corporation should be responsible for the removal of refuse from such buildings and lands subject to the general control and supervision of the corporation.

3. The Corporation may cause public dustbins or other suitable receptacles to be provided at suitable places and where such dustbins or receptacles are provided the corporation may, by public notice, require that all refuse accumulating in any premises or land shall be deposited by the owner or occupier of such premises or land in such dustbins or receptacles.

4. All refuse removed and collected by the staff of the corporation or under their control and supervision and all refuse deposited in the dustbins and other receptacles provided by the corporation shall be the property of the corporations (Bangladesh Gazettee, 1983).

DCC is not performing its obligation according to the present law contained in Dhaka Municipal Corporation Ordinance, 1983 which states that all buildings and land, vested in the corporation are supposed to be effectively served by garbage disposal system. Therefore the present situation whereby significant public land and buildings are not effectively served by the garbage collection system, represents a breach of the ordinance and could in theory render DCC or its officer liable to legal actions.

5.2.4 FINANCIAL ASPECTS

The financial matters of DCC is looked after by Revenue and Accounts Sections. The Revenue Section is responsible for the assesment and collection of local taxes, charges, rents and license fees is headed by Chief Revenue Officer and the Accounts Section, responsible for

budgeting, accounting and payments is headed by Chief Accounts Officer. The responsibility for overall financial management of DCC is a shared function between the Chief Revenue Officer the Chief Accounts Officer and the Audit Sections.

1) Revenue Of DCC

Dhaka Municipality was established under the District Municipal Improvement Act, 1864. That Act specified certain sources of revenue for municipality, the principal revenue source being a tax on the annual valuation of lands and buildings, a type of tax which is still in use. As the municipality became a Corporation, its jurisdiction increased and so did its sources of revenue. DCC has a number of sources of revenue, both local and external. The most important local revenue source is taxes and charges based on property values (commonly known as municipal taxes) followed by market rents, fees, road cutting, parks, burning ghats, tax on transfer of immovable property, rent on DCC equipments, and other taxes and fees etc. External sources of finance are general and specified government grants and loans.

All property in Dhaka is subjected to holding tax. Only the beneficiaries of street lighting and conservancy service are liable to pay separate rates for these services. Municipal taxes on property, based on rental values are long established in Bangladesh. Taxes based on property's annual rental value (ARV's) are now the largest source of DCC's revenue, yielding up to 50% of the local revenue (UDD, et.al.,1985 p.26).

At present, three different taxes and rates are levied on ARV's by DCC. One general tax called the holdings tax and two separate rates for specific services, one for street lighting, and another for conservancy (solid waste collection and disposal). Currently, the taxes and rates based on property values are 2% on conservancy, 3% on lighting and 7% on holding.

The present method of charging conservancy tax as a proportion of general property tax imposes limit to taxation. A recent study (Louis Berger, et.al. 1991) has outlined a number of problems associated with DCC's present municipal tax system. Firstly, the basis of municipal tax being the annual rental value of the property is prone to easy manipulation through false documentation, often in collusion with the Tax Assessors. Secondly, lower level tax officials are poorly paid and trained and have few career prospect. As a result inefficiency and corruption have assumed epidemic form in the system. The maximum level of municipal taxes are set out in Municipal Corporation Model Tax Schedule by the Government which specifies holding tax at 7%, lighting charge at 3% and conservancy charge at 7% of ARV (Siddiqui, et.al, 1991). At present, taxes are levied by DCC for holding and lighting according to the maximum Model Tax Schedule but conservancy is not realised according to the Tax Schedule rate of 7% but only at 2%. Such low rate of conservancy charge indicates less priority given to this sector. Moreover in the second five year plan (1980-85) of GOB there was no allocation on SWM and in third five year plan (1985-90) the allocation for SWM was US$ 1.40 million only (ADB, 1987) This also indicates less importance given to this sector by the Government. Almost 89% of DCC's income was generated from local sources in 1991-92 and it came down to 73.04% in 1993-94 fiscal year

(Table 5.1). DCC is now to rely increasingly on its locally generated finances as direct loans and grants are reduced. According to UNDP(1993), the urban local bodies, including DCC are not utilizing their revenue powers effectively and their system of resource mobilization needs to be streamlined and made more effective.

Table 5.1 DCC's Sources of Revenues

Source of Revenue	1989-90 (Tk.in core)	1990-91 (Tk.in core)	1991-92 (Tk.in core)	1992-93 (Tk.in core)	*1993-94 (Tk.in core)
1.Revenue from own sources	69.13(65.91%)	83.13(78.88%)	124.85(88.92%)	132.68(78.71%)	181.62(73.04%)
2. Loans	29.98(28.58%)	17 (16.13%)	10.5(7.49%)	22.38(13.27%)	13.01(5.23%)
3. Grants	5.78(5.51%)	5.26(4.99%)	5.05(3.50%)	45.27(20.91%)	54.02(21.73%)
Total	104.89(100%)	105.39(100%)	140.4(100%)	168.57(100%)	248.65(100%)

Source : Louis Berger International et.al., 1991 Appendix-II, p.2.

* Original DCC Budget report 1993-94.

2) Expenditure Of DCC

In terms of expenditure, DCC allocates a substantial proportion of its resources for its traditional functions like street cleaning, solid waste collection and disposal, street lighting, and road maintenance etc. In 1993-94 budget DCC has allocated Tk. 11,80,32,582/- (DCC, 1993) for solid waste management based on the above allocation, the per capita per year expenditure for solid waste for the year 1993-94 is Tk.33 only. According to UNDP et.al., (1992), the per capita expenditure for solid waste for the year 1991-1992 was Tk. 26 only. The per capita per year expenditure in Dhaka is very low compared to other Asian cities for example per capita per year expenditure for solid waste management in Bombay is Tk. 304, Bangkok Tk.84 and Manila Tk. 192 (Appendix A-4).

According to DCC's 1993-94 budget, they spent Tk. 11,80,32,582/- for SWM which is 14.51% of its annual expenditure of Tk. 81,33,99,978. From 1993-94 DCC budget it is also observed that they have collected revenue amounting to Tk. 8,00,13,428/- against their demand of Tk. 9,52,15,850/- as conservancy tax which is 6.81% of the total revenue income of Tk. 117,4888,562. This indicates the difference between revenue earned and expenditure incurred against this sector. It also suggests the need for increase in revenue to make SWM operation of DCC sustainable and cost effective. Another study by Bhide (1990) has shown that DCC spends 14%-17% of its budget on solid waste management. Normally, municipalities in the developing countries spend substantial resources on solid waste management ranging from 20% to 30% of municipal operating revenues (Schertenleib, et.al.,1992a).

5.3 MANAGEMENT OF SOLID WASTE IN DHAKA CITY

5.3.1. SOLID WASTE GENERATION RATE OF DHAKA CITY

Solid wastes in Dhaka city are mainly generated from domestic, commercial and industrial sources. The Waste stream fraction of Dhaka City is given in Table (5.2)

Table 5.2 Waste Stream Fractions of Dhaka City

Type of Waste	Percentage
Domestic Waste	46.8%
Street Sweeping	22.6%
Commercial Waste	17.3%
Industrial Waste	12.9%
Clinical	0.5%

Source : UNDP et. al., 1992

Street sweepings in Dhaka City also contain domestic wastes as a large number of population dispose their waste on road sides. For Dhaka City there is no exact data available as to how much waste is generated. However, according to DCC, the solid waste generation per day in Dhaka is estimated at 3,000 tons, considering an urban population of 6 million. On this basis the waste generation rate per person per day is 0.5 kg. Solid waste generation rate of Dhaka city as reported in different reports is presented Table (5.3).

Table 5.3 Waste Generation Rate of Dhaka City

WASTE GENERATION RATE
0.47 *
0.50 **
0.52 **

Source : * UNDP et.al., 1992
** Islam, 1992, P.154

According to Cointreau (1986), waste generation rate for low-income countries varies between 0.4 to 0.6 kg/cap/day. Based on the aforesaid range, the total solid waste generated in DCC area is calculated by the author and shown in Table (5.4).

Table 5.4 Total Waste Generation For DCC Area

Waste generation rate (kg/cap/day)	Total population of DCC area (1991)	Total Waste generated (Ton/day)
0.40	35,83,000	1433
0.50	35,83,000	1792
0.60	35,83,000	2150

a city of Dhaka's size is normally expected to generate waste of about 0.5 kg/cap/day. On this basis the waste generated in Dhaka city (DCC area) is 1792 tons per day. In the absence of an accurate data, most solid waste planners have been using a refuse generation rate of 0.5 to 0.6 kg/cap/day in connection with different projects.

5.3.2. PHYSICAL COMPOSITION OF SOLID WASTES OF DHAKA CITY

The major components of municipal wastes include food wastes, leaves, grass, paper, boards, glass, plastic, metals, can, bricks, debris, dirt and ashes. An analysis for physical composition of solid wastes in Dhaka City is presented below.

Table 5.5 Physical Composition of Mixed Municipal Wastes of Dhaka

Fine dust	30.8%
Vegetable Matter	18.8%
Stone, bricks, & Earthward	10.5%
Rags	3.8%
Paper	1.5%
Leather	0.7%
Metals	0.4%
Fine organic	33.5%

Source : Bhide, 1990.

Table 5.6 Composition of Waste in Residential Area of Dhaka City

Plastics	1.74%
Paper	5.68%
Metal, Glass & Construction Wastes	6.38%
Cloths	1.83%
Food Wastes	84.37%

Source : Ahmed, 1993.

Table 5.7 Composition of Waste in Commercial Area of Dhaka City

Plastics	1.48%
Paper	7.22%
Metal, Glass & Construction Materials	10.22%
Cloths	1.59%
Food Wastes	79.49%

Source : Ahmed, 1993.

The results from analysis of wastes show that organic waste comprises the major component of the municipal waste in both residential and commercial areas.

5.3.3 CHEMICAL COMPOSITION OF WASTES GENERATED IN DHAKA CITY

Table 5.8 Chemical Composition of Wastes Generated in Dhaka City

Constituents	Refuse From Disposal site	Domestic Wastes	Market Wastes	Mixed Refuse
Moisture Content %	47-55	45.3	53.6	95.31
Fixed Residue %	52.2-59.7	57.2	55.6	83.37
Organic Carbon (C%)	Nil	22.6	25.7	21.84
Organic Nitrogen (N%)	0.4-0.6	.41	.36	.39
Phosphorus (P%)	0.0-.05	.05	Nil	.04
Potassium (K%)	Nil	Nil	Nil	Nil

Source : Ahmed, 1993.

The results of the analysis of the mixed waste show high moisture content, high ash and inorganic contents and comparatively low N.P.K values of mixed refuse of Dhaka City. The N.P.K. contents represents the fertilizer value of the waste and potential for conversion of the waste into good compost.

5.3.4 LEACHATE CHARACTERISTICS OF DHAKA SOLID WASTE

The leachate characteristics of Dhaka solid waste is given in Table (5.9).

Table 5.9 Characteristic Quality of Leachate of Dhaka

Parameter	Unit	Typical	Range
pH		4.75	4.5-6.00
Suspended Solid	mg/l	10000	3000-14000
Chloride	mg/l	1400	1300-5000
Nitrate	mg/l	50	0-200
Phosphate	mg/l	5	0-15
BOD	mg/l	9000	5000-15000
COD	mg/l	14000	5000-17000

Source : Islam, 1992.

It is clear from Table (5.9) that the leachate is acidic with very high BOD and COD load (9000 and 14000 mg/l respectively). It is also rich in nitrate and phosphate, whenever this highly polluted leachate got entrapped in ponds with the surface wash, it poses a high degree of pollution threat to ground water as well as surface water and subsequently health hazard. Construction of Greater Dhaka City Flood Protection Embankment would isolate the city from liquid movement point of view. A study Islam (1992), has found that after construction of Greater Dhaka City Flood Protection Embankment all the surface wash will accumulate in the low lying areas on the country side of the embankment, which would later be discharged by pump or sluice gates. Leachate from solid waste with high pollution potential from community bins, storage points, and landfills later mixed with surface wash would be stored in the lagoons. Before implementation of Greater Dhaka Flood Protection Embankemnt Project, there were no lagoons, and there was no stagnation of water. After execution of the project stagnant water pools would remain most period of the year. From the study of Islam (1992), it is evident that lagoon containg leachate mixed with surface wash would pollute the environment and also increased the risk of ground water contamination.

5.3.5 COLLECTION

Presently the community bin system of collection is being practiced in Dhaka. For collection of wastes from households or any other premises, DCC provides two types of dustbins, one made of corrugated iron (Cl) sheets, another of masonry construction. It may be mentioned here that all parts of the city are not furnished with these bins. The CI bins have a

normal size of 3 feet diameter and 3 feet high with a lid. The masonry bins are of variable sizes, but are normally of one meter wide one meter high and 2 meters in length (Fig. 5.4). Sometimes in larger masonry bin the sides are sloping, but in smaller ones these are horizontal. At present, there are 2,450 CI sheet and 1,595 masonry dustbins in DCC area (UNDP et. al. 1992) There is no specific rules in placement of these dustbins. In the prevailing system of collection house holds are supposed to deposit their solid wastes in the communal bin between 6pm to 10pm. When the communal bins are placed at far distance households usually throw their garbage at any convenient point like nearby road, ditches, ponds, lakes, or surface drains.

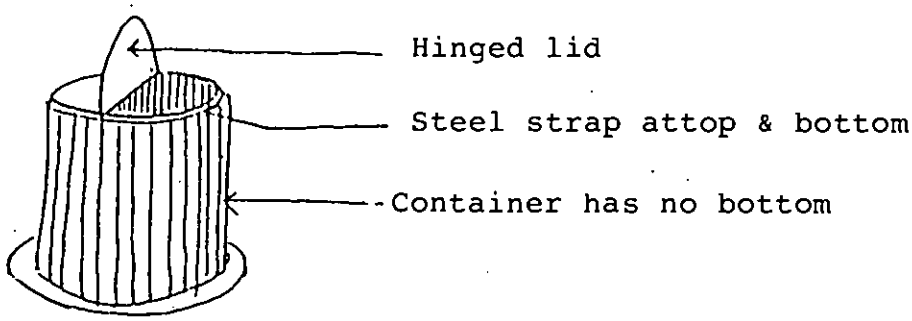
It is estimated by Dhaka City Corporation that, 50% of the population of DCC area is using dustbins for disposal of wastes, while 20% is using roads, 20% is using drains and 10% is using open grounds to dispose solid wastes (UNDP, et al, 1992 p.18). However, from the field survey at Dhanmondi and Kathalbagan area of Dhaka city it was found that 35.17% of the household are disposing waste on dustbin; 41.38% are disposing waste on road or drain side; 13.10% are disposing on vacant lots, while 6.90% are disposing in own premises Table (6.14).

A total of 4,221 cleaners distributed in ten zones of DCC are normally engaged for cleaning of the city. The staff of Conservancy Department of DCC works in two shifts - one in the night (8.30 pm to 5.00 am) and the other during the day (5 am to 2 pm). Special conservancy works along VIP roads is carried out during 1 pm to 8 pm. The night shift of waste collection is done in commercial and densely populated areas. According to DCC sources, at present 40%-50% of the city is being served by the night cleaning workers.

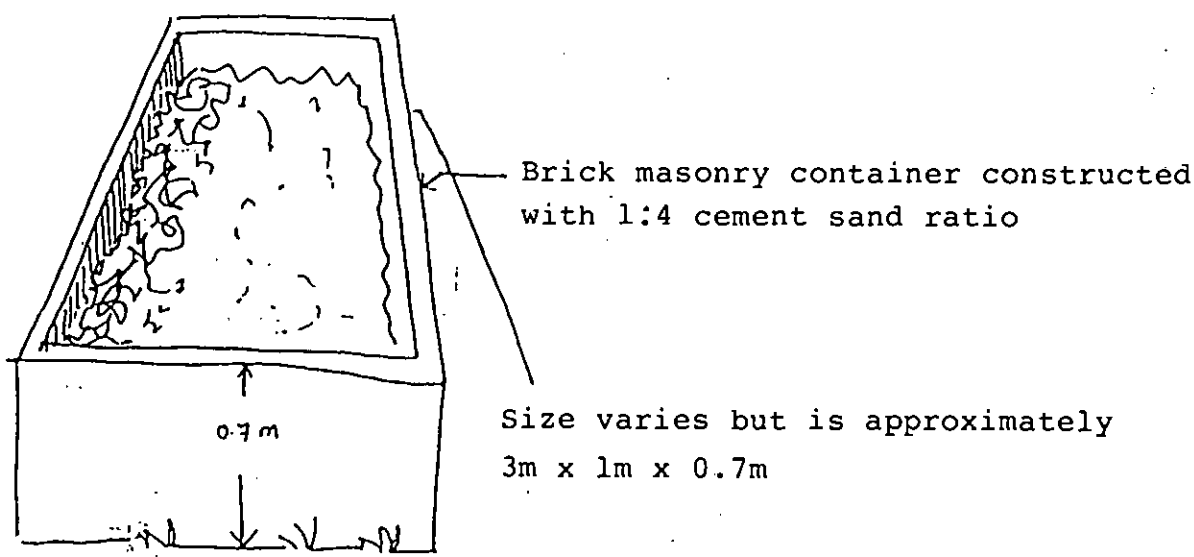
The collection of wastes and cleaning of streets are carried out manually by the cleaners, both male and female. Cleaners use short handled coconut leaf broom and collect the swept material in heaps which is taken to dustbins or, in its absence, to an open collection point. Cleaners normally use 5 cft capacity handcarts to collect refuse from narrow lanes and also silt from road side drains (Plate 5.1). It is estimated by DCC that in narrow lanes only 25% of the residents use dustbins or enclosures, while the rest 75% uses streets and drains for disposal of solid wastes (UNDP, et. al. 1992, p.19). However from field survey at Kathalbagan area of Dhaka city which is an unplanned area with narrow lanes it was found that only 5.1% of the household are using dustbin, while the rest 94.9% are using roads drains or vacant plots for disposal of wastes (Table 6.14).

The cleaners are provided with broom, basket, brush and spade (Plate 5.2) which is replaced every month. They take these materials with them and the handcarts are normally stored in the cleaning rooms in the wards. The cleaners directly report at their Ward Office and their attendance is taken by CI .

All the wastes that reaches the dustbin or designated collection point is collected and transported to disposal site. These include solid waste from residential, commercial, as well as industrial establishments. Waste from four major hospitals is collected separately but is disposed



1. C.I. Sheet Container(with lid)



2. Brick Masonry Refuse Container(Open to air)

Fig. 5.4 Existing Garbage Containers in Dhaka.

Plat ...en and covered tr... ...by DCC.

at the same site. Waste from other clinics get collected and disposed along with the municipal refuse (Bhide, 1990 p.8).

5.3.6 TRANSPORTATION

For removal of the wastes from bins and other collection points to final disposal site, DCC has a fleet of 159 trucks of 5 ton, 3 ton, 2 ton and 1.5 ton capacity (Appendix A-3). Out of 159 trucks, 63 i.e. 40% were out of order at the time of collection of data. Most of these trucks are open flat beded, some has closed body, having movable flap on the back side and 3-4 vertically sliding shutter on both sides (Plate 5.3). The trucks, both flat-beded and covered, typically stand still for 75% of their working time because the loading system is slow (UNCHS-HABITAT, et. al., 1991, p.B.5). The open trucks are much criticized because of the way they are loaded and left uncovered as, they transfer waste to landfills. The vehicles with roller shutter side covers are open during loading (75% of their working time) and are very difficult to load and unload because a man cannot stand up straight under the shutter.

Each truck is assigned a specific area for cleaning. The drivers work under Chief Executive Officer (CEO) but the cleaners are provided by Chief Conservancy Officer (CCO). The vehicles are loaded and unloaded manually by using cane baskets and forks having 3 to 4 teeth and 5'-6' long bamboo handle. Every truck on average makes 1-2 trips per day. All conservancy trucks are parked at a single site located at Saidabad, an extreme end of the city, resulting in large unproductive travel at the beginning and end of a shift while serving distant areas. DCC has proposed to modernize the transportation of solid waste by introducing dumper technology (demountable containers trucks) in the city, but the utility of these vehicles in narrow streets must be questioned. They will not have city-wide applicability. Recently DCC has also proposed to give contract for collection and transportation of wastes of Municipal zone 9 and 10 of the city.

5.3.7 DISPOSAL

At present final disposal of solid waste is being done by uncontrolled dumping of collected garbages in low-lying land, waterponds and derelict tanks. Crude dumping method is used to dispose the solid waste in Dhaka Though every crude dumping is an environmental disaster, causing health risk from different vectors along with air water and ground water pollution, still DCC has been using this method in order to minimize the cost of waste disposal. Land is quite scarce and expensive in DCC area. As such DCC is facing problem of land for disposal of solid waste. Due to lack of land, all solid wastes collected by DCC can not be disposed properly (DCC ,1993, p.2). Solid wastes are also used for infill of privately owned low lands in DCC area, if requested by the owner. Officially no charge is made to private landowners despite substantial enhancement in the value of land. Whenever low-lying land needs to be filled up, the beneficiary applies to the corporation and after approval, the Conservancy Department directs the vehicles to the site. Unofficially many landowners often pay the

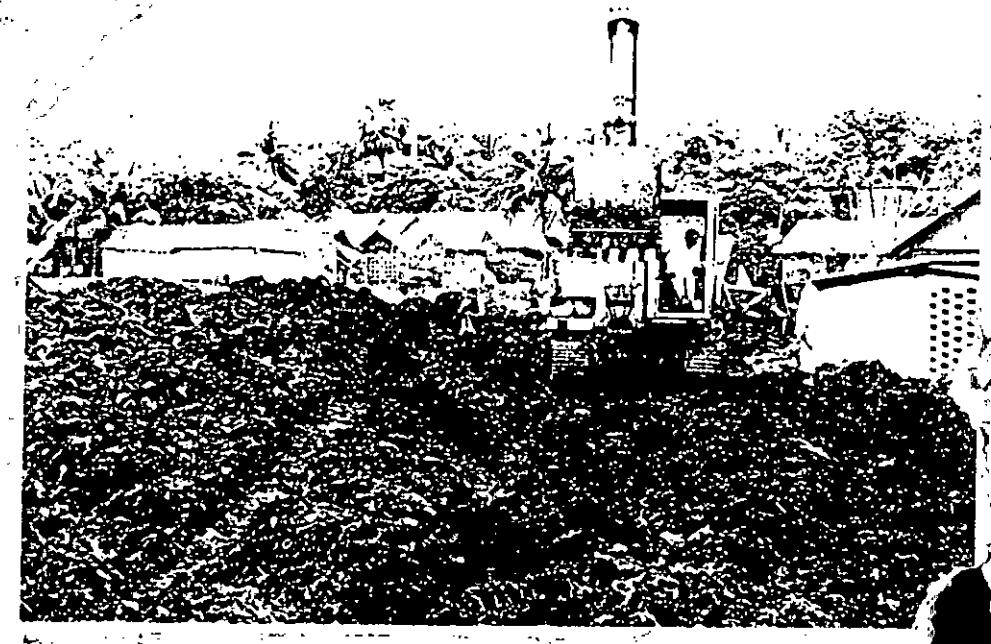


Plate : 5.4 Crude d[illegible] sal of solid wast[illegible]

Plate : 5.5 Landfill site near pond near Mirpur Mazar.

conservancy truck drivers to unload solid waste in his site for landfill. DCC is at present disposing .21 kg of waste per capita per day (Section 5.5.3).

Presently, the main dumping site is at Jatrabari. Another dumping site is at Mirpur behind the Mirpur Mazar. Other than these two sites there are some scattered small sites located in Mugdapara, Islambag, Hazaribag, Mukti Saroni, Dayagong etc.

Jatrabari

The site is located at the north of the main Dhaka-Chittagong highway. It covers an area of 25 acres with an average depth of 5 meters. This site is now almost 60% filled up. Coservancy vehicles on arrival at the site discharge their waste along the road with the help of cleaners and the waste is then pushed by bulldozers. This method of disposal is obviously crude dumping and no protective soil covering is given at the end of each day (Plate 5.4).

Mirpur

This site is located behind the Mirpur Mazar. The land is owned by the Mazar Board. The site is low-lying marshy land with an average depth of 3 meters(Plate 5.5). This site was temporarily closed at the time of my physical survey (December, 1993) due to pollution of pond water used for pisiculture by the Mazar committee caused by leachate from the dumpsite situated adjacent to the pond.

A new dump site at Matwail is acquired by DCC. This site is located along Dhaka-Demra road and 5 kilometers outside the corporation limits. The proposed site at Matwail covers an area of 25 hectares. It is intended that 5.3 hectores will be reserved for low-cost housing. While the remainder will be used for waste disposal. The site life of Matwail is estimated to be 3 years, neglecting expansion of collection area, population growth and increase in per capita generation of wastes (Appendix C-2).

5.3.8 RECYCLING

In Dhaka, Wastes of some market value are being reclaimed or salvaged in three stages (fig. 5.5). In first stage the house wives separate the refuse of higher value such as papers, bottles, fresh containers, old cloths, shoes etc and sell them to street hawkers(Table 6.11). The second stage of salvaging is carried out mostly by children of slum dwellers popularly known as 'Tokais'. They collect the refuse and domestic waste of low market value from bins and sweeping accumulation centers(Plate 5.6). The items include broken glass, can, card board, waste paper, rag, plastics, metals and miscellaneous wastes discarded by households. The third stage of salvaging is done by the refuse pickers when fresh refuse is unloaded by municipal trucks at the local disposal site (Plate 5.7).

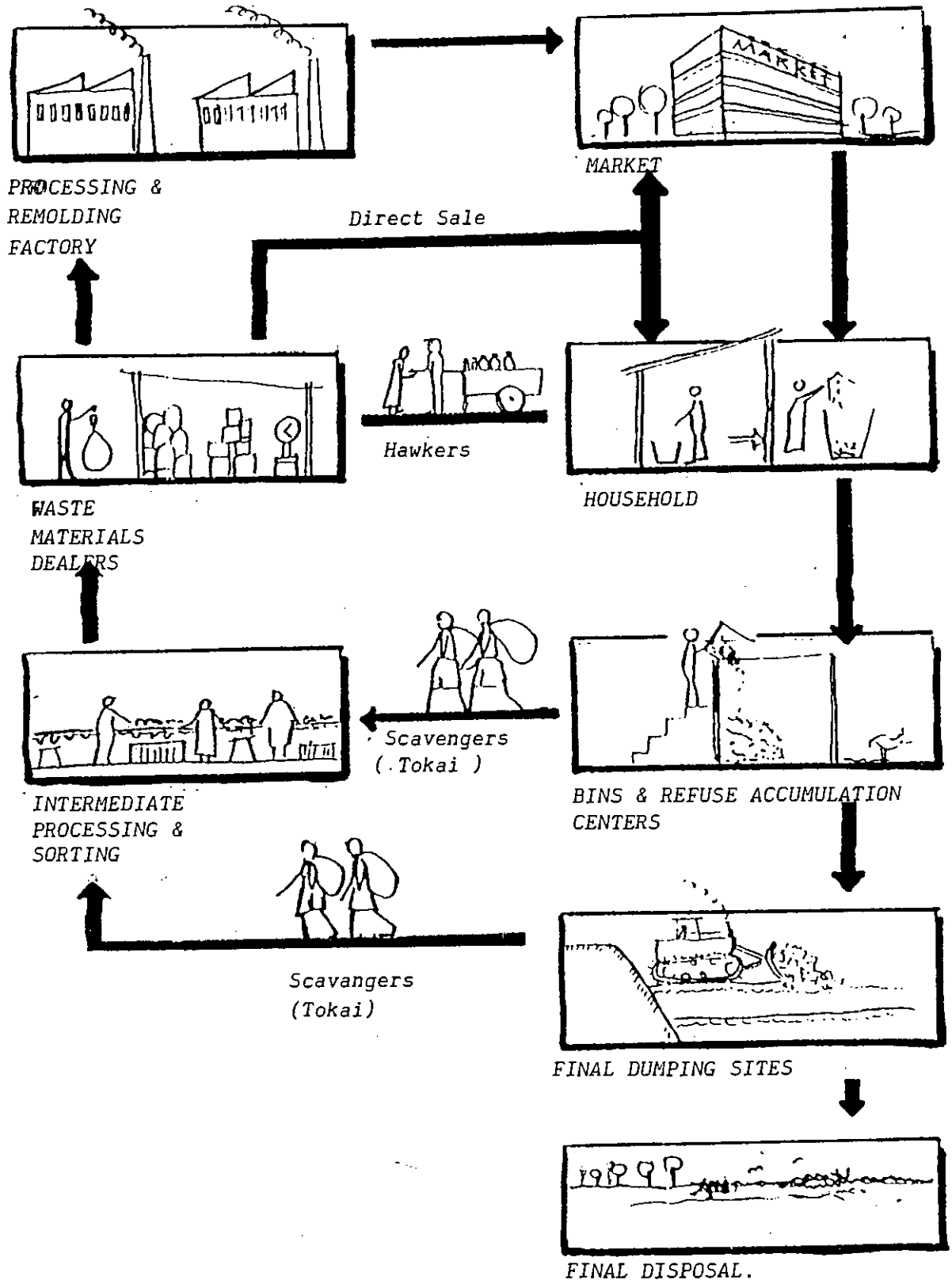


Fig. 5.5 : Recycling Pattern of Solid Waste in Dhaka.
Source : Ahmed, 1993.
(Addition of diagram done by the researcher).

The reclaimed material goes to the "Waste and old material shop" through the street hawkers who purchased the old material directly from the housewives and through refuse collectors who reclaim materials from bins and final disposal sites. The refuse dealers separate the materials in proper form and sell them to consumers as well as supply them to appropriate processing or remolding mills and factories. The processed material recycled through market finally goes to users again. The cycle goes on as long as the waste has no economic or market value.

It is estimated that about 87,000 people (including waste bin Tokais, dumpsite tokais, feriwallas, Vhangari Dokan, Broker, Wholesellers), working in the recycling trade of Dhaka are collecting and recyling materials like paper, plastic, glass, iron, alumunium, cloths, bones, tin, etc. (Sinha, 1993, pp. 108-110).

Although a large amount of money is saved by recycling of waste by waste pickers, who infact are helping DCC by saving disposal cost, no initative has so far been taken by the authority for improving their working and living condition as they work in unhygenic way nor providing them incentives for salvaging recycliable materials in hygenic manner with proper safeguards against health hazards.

Recognizing the benefits of waste reduction by recycling and their postive impact on total waste management, according to Furedy (1992, p.52) many countries like India, Indonesia, Phillipines, Columbia, are helping the scavangers to improve their working and living conditions. In Nepal, a special recycling platform is made at the compost and landfill sites in order to improve the recycling system. Moreover, in order to facilitate recycling and to protect waste pickers from infectious diseases, protective measures are taken, and they are given opportunity to see Doctors (Devkata, 1993). In Indonesia similar programmes are also taken. Inorganic wastes are recycled in Dhaka but the organic waste which constitutes the major portion (70-80%) is disposed by crude dumping and left unutilized. Recycling of organic waste is not popular in Dhaka. This is an unexplored sector in Bangladesh whereas in India and China the use of organic waste by recycling into organic manure is very popular. In Japan due to high percentage of unretrieved polethene, a number of composting projects were abondened. But it is interesting to note that in Dhaka more than 90% (Ahmed, 1993) plastics are recycled.

5.4 RECENT DEVELOPMENTS TO IMPROVE SOLID WASTE MANAGEMENT OF DHAKA CITY

Recently few isolated initiatives has been taken by both private and public organizations to improve the solid waste disposal system Dhaka City. These efforts describe the urgent need for the improvement of the existing solid waste management system. The recent developments to improve waste management of Dhaka is described in the following sections.

5.4.1 COMMUNITY PARTICIPATION IN THE MANAGEMENT OF SOLID WASTE IN KALABAGAN

Kalabagan is a densely populated area of Dhaka city with narrow lanes and bylanes. Wastebins could not be placed by the DCC according to the need of the community in Kalabagan due to lack of space and narrowness of lanes. Wastes used to be seen dumped on the lanes and bylanes, emitting bad smell from decomposing wastes and also from drains clogged with waste. As a result, the whole environment of the area had deteriorated. This prompted the local inhabitants to tackle the waste problem of their area by themselves.

In order to solve the waste disposal problem, the local residents initiated a house to house waste collection system privately and for this they purchased two rickshaws and modified it into a van (Plate 5.8). With the help of local people and community participation these vans started collection wastes from houses and disposing the wastes at community bin located at far distance at Mirpur road for collection by DCC (Plate 5.9). Each rickshaw van is maned by three persons. Initially this operation was limited to Bashiruddin Road and Lake Circus. Encouraged by successful collection of wastes and stopping of disposal of wastes on lanes, the service area of this operation was extended to Kalabagan 1st lane and 2nd Lane on the south, Lake Circus on the north, Mirpur Road on the West, and Green Road on the East. These areas now look much cleaner than other areas of the city.

At present this community based and participated waste collection system covers around 600-700 households and for the house to house waste collection system the community based organization "KALABAGAN SMAJ KALLYAN PARISHAD" is collecting Tk. 10/- per month from each household. Presently, there are three rickshaw vans in operations which collects the wastes between 12 noon to 5 pm each day. Each vans makes three trips during the summer period, starting from May to August and two trips during rest of the year.

5.4.2 AWARENESS GROWING PROGRAM OF ENVIRONMENTAL HAZARDS AT DHANMONDI

A group of language students of the German Cultural Center Goethe-Institute, Dhaka took the initiative and started a long term program to make "Dhaka, it is our city cleaner". They have formed a Task Force to make the people consious about environmental hazards. This Task Force had distributed letters (Appendix B-1) and held meetings with housewives of Dhanmondi Residential Area and requested them to dispose their garbage in the proper place, as most of the inhabitants of Dhanmondi Area do not use the dustbin and throw their garbage on the street, causing sufferings to the people (Khan, 1994). Some of Task Force members reported that the housewives misbehaved with members of environmental Task Force when they went to inform them about the proper disposal of waste. The initiative taken by the members of Task Force is laudable and deserves much attention as illegal disposal of solid waste on streets, drains and vacant plot is becoming a major problem due to lack of awareness, causing many environmental pollution like presence of disease vectors clogging of drains, aesthetic degradation and

Pla[illegible] house
[illegible]e waste collection in Kalabagan.

Plate : 5.9 Collected domestic waste from household at Kalabagan disposed at community bin at Mirpur road for removal by DCC.

production of leachate. Recently "Dhaka Little Theatre" with funding from German Cultural Centre, Dhaka has staged an open air drama regarding "Solid Waste Problems" in some schools of Dhaka city (Appendix B-2). The motive behind this drama is to grow awarness among the young students of Dhaka about growing solid waste problems. Dhaka Little Theatre group reported that many schools do not give them permission to stage the drama. This reflects lack of awareness of the school authorities about the environmental problems and also suggest the need for creating awareness regarding environmental problem and also to provide environmental education.

5.4.3 JOINT VENTURE BIO-GAS PROJECT OF DCC AND BCSIR

A pilot biogas plant was setup in a Saidabad area of Dhaka city at an estimated cost of Tk. 150,000/- (Plate 5.10). The project is a joint venture of DCC and Bangladesh Council for Scientific and Industrial Research (BCSIR). It was started in February, 1992 and was successfully finished in July 1993. It is expected that the pilot plant would produce 3000 cft of gas daily by using 350 tones of solid waste and this quantity of gas will meet the requirements of 30 families (DCC, 1993).

This biogas plant is an experimental one, but the technology is sound and there is little doubt that the gas can be economically produced (UNDP et. al., 1992 p.48). A commercial return on the manufacture of methane from solid waste is unlikely in view of the competition from natural gas. However, in places remote from the natural gas feed lines, it would be competitive.

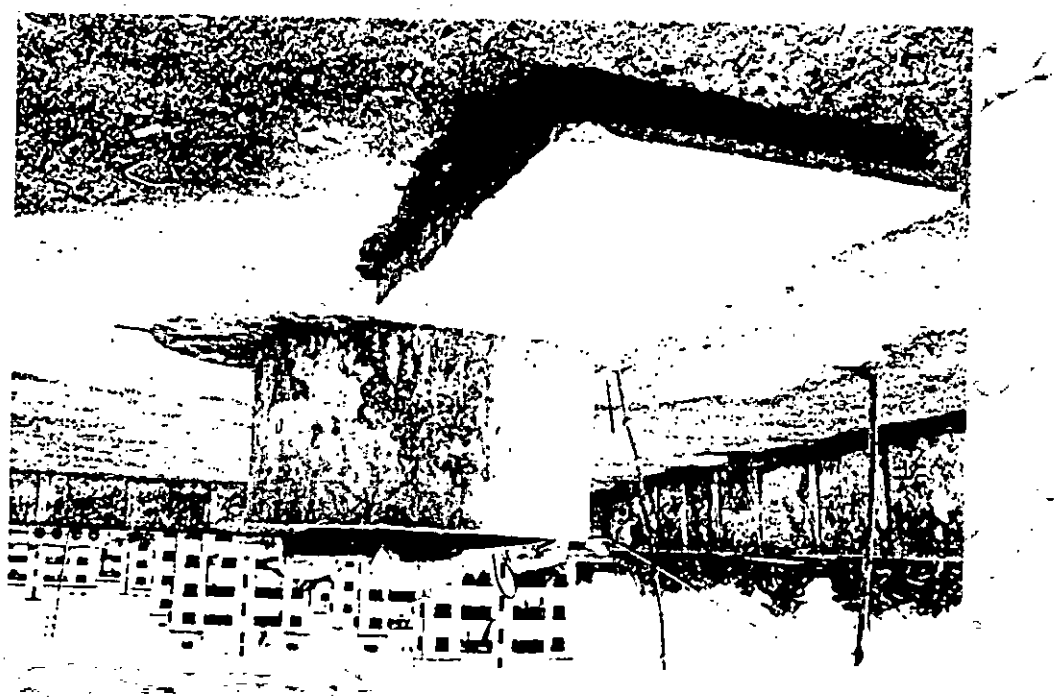
5.4.4 BIOGAS AND COMPOSTING PROJECT OF LGED

Recently, LGED has introduced a Co-composting pilot project in the Ganaktuli Sweeper Colony in Dhaka (Plate 5.11).

This project is designed to serve 40 families. The digester is directly connected to the toilets of the four storied sweepers colony and there is a provision for disposing organic waste inside the digester. The main purpose of the project is to help the sweepers to have a healthy environment and also have gas for cooking instead of wood. This pilot project might have a positive impact on the total solid waste management by reducing pressure on the heavily burdened infrastructure in DCC area.

5.5 PROBLEMS AND DRAWBACKS IN DCC's SWM

From the above discussions on the existing system of solid waste management, several problems and drawbacks can be identified. Some of the major drawbacks and problems which need urgent attention are mentioned below:



5.5.1 LACK OF FINANCE AND INEFFICIENT TAX COLLECTION

The financial allocation for SWM in Dhaka at present is approximately Tk.33 per person per year which is very low compared to other neighbouring countries. The present method of charging conservancy tax as a proportion of general property tax imposes limit to taxation. Recent performance in collection of local revenues namely those based on annual rental value of property has been disappointing, as tax payers can easily manipulate the rental value.

5.5.2 LACK OF MANPOWER AND INFRASTRUCTURE

The present number of sweepers, dustbins, trucks and handcarts are insufficient for the present need. The number of dustbin per 1000 population is 1.11 which is very low compared to population of 3583000 in DCC area. The number of cleaners per 1000 population is 1.17, whereas the number of cleaners for satisfactory manual cleaning is 2 to 5, person per 1000 population. Again, the number of conservancy vehicles per 15000 population in Dhaka is 0.66 against the satisfactory requirement of 1 vehicle per 15000 population.

5.5.3 INCOMPLETE AND INEFFICIENT COLLECTION PRACTICE

With the present number of conservancy trucks operating and considering two trips made by the each truck per day (according to DCC sources), and also taking into account maximum truck capacity and allowing 25% overloading the waste collected per day by DCC is around 750 tones per day (Appendix C-1) or .21 Kg. per capita per day. But the waste generation in DCC area is 1792 tons per day or .5 Kg. per capita per day. As such DCC is collecting only 42% of the total waste generated daily while 58% remains uncollected. According to another study UNCHS et.al (1991), it was found that DCC collects around 683 tons of solid waste per day. Obviously, accumulation of large amount of uncollected wastes produces strong offensive odour and pollutes the air. It also acts as a breeding ground for mosquitoes flies, and other insects. Moreover, it helps producing and spreading pathogenic micro-organisms. The leachates from these degrading wastes can pollute the ground and surface water. The present method of collection and disposal is very inefficient. Here trucks remain idle for most of the time and hence the total number of trips made are less. In most of the places waste has to be handled 3 to 4 times before disposal.

5.5.4 IMPROPER DESIGN OF COMMUNAL BINS

The present design of communal bin is not satisfactory, as it is open and allows entry of rainwater producing leachate; birds and other rodents spread the refuse, and scavengers can easily scatter the wastes. As a result, unhygienic and insanitary conditions prevail around the bins (Plate 5.12). To remove the waste from the bin, worker has to enter inside the bin, and it is difficult to completely clear the bin.

5.5.5 UNHYGIENIC PRACTICE

Conservancy workers do not have any protective covering for hands and feet while collecting and dumping the decomposed wastes from bins and trucks (Plate 5.13). According to a study (Sinha, 1993 p.129) the maximum exposure to health hazards occurs to the conservancy workers. Their poor health condition reduces labour productivity as well as poses threat to other employees and larger community.

5.5.6 LACK OF ACCESS TO MUNICIPAL SOLID WASTE DISPOSAL SYSTEM

A significant portion of Dhaka city's population reside in slums and squatter settlements. It is estimated that 25% of Dhaka population as about 1.2 million reside in slums and this population is increasing by at least 60,000 people or 10,000 household annually. Only 9% of the slum dwellers have any form of solid waste collection service, the remaining 91% (about 1.0 million people) generating about 100 tons of garbage per day dispose their wastes into low lying lands, road side drains or local drain or Khals (Louis Berger Inc. et.al, 1991 p.3-6).

5.5.7 IMPROPER SELECTION OF SITE AND INSANITARY SYSTEM OF FINAL DISPOSAL OF SOLID WASTE

At present DCC does not follow any criteria for selection of site and they are disposing the waste in low lying areas in insanitary manner, using crude dumping methods. It has been observed that no fencing is done at disposal sites. As a result, access to animals and tokais are found in dump sites (Plate 5.14). No soil covering is provided after each layer of disposed wastes. Present landfill sites are not designed to prevent contamination of surface and ground water. There is no prevention to check surface runoff to the sites. It has been also observed that there is no impermeable layer beneath the site to prevent infiltration of leachate into the ground water. Consequently, shallow tube wells adjacent to the waste disposal site may yield polluted water. The landfill sites do not have access road inside the disposal, area as a result the truck dispose wastes on the road which is then pushed into the site with the help of bulldozer, resulting in blockage of road (Plate 5.15). Present sites are observed to be the very near the residential blocks, resulting in bad odour and pollution of the neighbourhood (Plate 5.16). No fire fighting, arrangements are seen in the disposal site. Arrangement for pest and odour control is also absent in these sites. It is also observed that no monitoring of landfill site is done after its closure.

The leachate characteristics of Dhaka city landfill sites indicates high pollution load (Table 5.9). Leachate with such high pollution load can severely affect both surface and ground water resources. The present method of crude dumping without consideration of hydrological and hydro-geological conditions can not ensure protection of ground and surface water. The ground water pollution by infiltration of leachate causes an irreparable damage. The recovery of polluted ground water may take decade and involve huge cost.

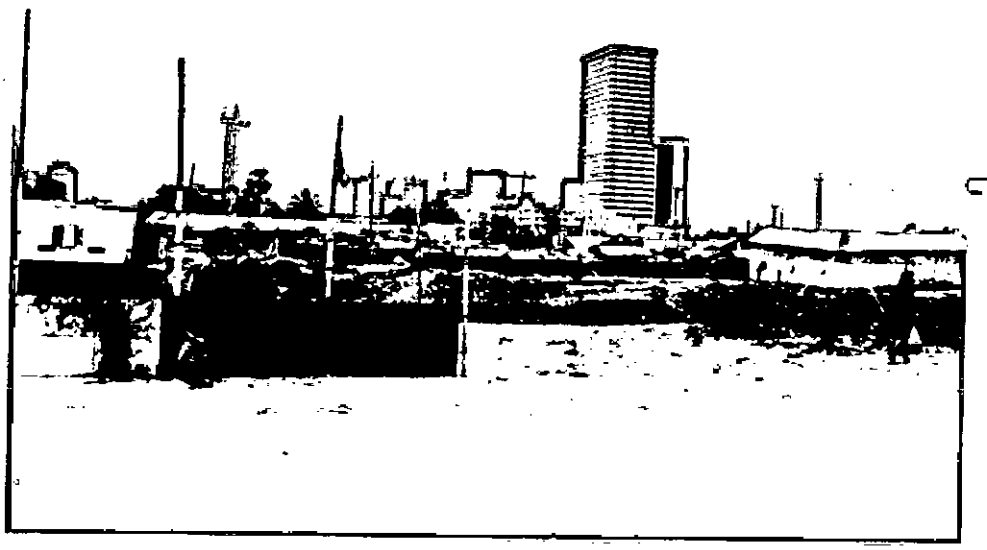


Plate : 5.16 Landfill sites near residential and commercial blocks.

5.5.8 LACK OF CO-ORDINATION

It has been observed that cleaners, collection and disposal trucks and the workshop are looked after by three different Divisions within DCC. As a result, there is fragmented responsibility and create problems in co-ordination of daily operations.

5.5.9 LACK OF LAW AND STANDARD

The present law does not provide any penalty for illegal disposal of wastes at any time, or littering in the street. The present law does neither provide any penal provision for showing negligence by the workers in collection and disposal. DCC also does not have such policy which defines the goals and established time table for their completion. It has been also observed that there is no standard for collection and disposal of wastes; as a result unhygienic and insanitary collection and disposal of solid waste is observed.

5.5.10 DISPOSAL OF MIXED TYPE OF WASTES

At present DCC is collecting solid wastes from households, industries and hospitals together and disposing them combinedly. Clinical wastes carries pathogens, industrial wastes carries toxic substance.

5.5.11 LACK OF LAND FOR FINAL DISPOSAL

The present main disposal site at JATRABARI is almost 60% filled up. The proposed site at Matwail with the present rate of waste generation would be filled in only 3 years times. Therefore, it is necessary for DCC to introduce waste reduction and minimization techniques, as it would face land crises for disposal of wastes in coming years.

5.6 CONCLUSIONS

It can be concluded from the discussions of this chapter that present system of solid waste management of DCC is neither satisfactory nor adequate. As such there is an urgent need for improvement in the financial, institutional and technical management by DCC for upgradation of city's environment. Another issue that must be considered in connection with improvement of solid waste management is the involvement and participation of community and creation of public awareness about adverse environmental and health impacts due to improper disposal of waste. It is seen in Kalabagan area of Dhaka city that community participation has been quite helpful in solving the solid waste disposal problem of the locality. This demonstrates the need for Municipal and, CBO partnership for solid waste management and overall environmental improvement of Dhaka City.

CHAPTER 6

DOMESTIC WASTE DISPOSAL PRACTICE OF DHAKA CITY

Households are the major source of solid waste generation. They have, therefore, direct link with its generation and disposal. Solid waste management system would rather be incomplete if households practices are not studied and their problems not identified. As stated earlier, household survey was conducted in Dhanmondi and Kathalbagan residential area of Dhaka City. In this chapter an analysis of current practices of waste disposal of household, problems faced by the households during waste disposal and their views for improvement of the waste management system have been conducted and summarized in the following sections.

6.1 SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

Respondents occupations varied as shown in Table 6.1. Majority of respondents are engaged in Business (34.48%) followed by Govt. Service (17.24%). Educational attainment is quite good in both the areas with about 57.24% having Bachelors Degree (Table 6.2). From the field survey, it is also found that in both the areas people of mixed income reside, but in Kathalbagan the majority is of middle income (46.16%) group followed by upper income (26.92%). In Dhanmondi majority belongs to upperincome group (46.27%) followed by high - income (34.33%). as shown in Table 6.3. With regard to the family members of which the respondents comprised, majority family size is of 4-6 members while the second largest group consisted of 7-10 members (Table 6.4). A six member family may generally be considered as medium sized in the context of Bangladesh. The mean family size of Kathalbagan and Dhanmondi areas, as found from the survey, stands at 5.56.

Table 6.1 Occupation Of The Respondents

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Occupation	No	%	No	%	No	%
Govt. Service	13	16.61	12	17.91	25	17.24
Non Govt. Service	8	10.26	5	7.46	13	8.97
Business	27	34.61	23	34.33	50	34.48
Student	2	2.56	4	5.97	6	4.14
Housewife	14	17.95	11	16.41	25	17.24
Retired	11	14.10	10	14.92	21	14.48
Others	3	3.85	2	3	5	3.45

Source : Field Survey, 1994.

Table 6.2 · Education level Of The Respondents

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Edu. Level	No	%	No	%	No	%
Illiterate	Nil	Nil	Nil	Nil	Nil	Nil
Primary	6	7.69	5	7.46	11	7.59
High School	4	5.12	4	5.97	8	5.52
S.S.C	11	14.11	10	14.93	21	14.48
H.S.C	12	15.38	10	14.93	22	15.17
B.Sc & Above	45	57.70	38	56.71	83	57.24

Source : Field Survey, 1994.

Table 6.3 Income Level Of The Respondents

Name of the Area	Kathalbagan		Dhanmondi	
Total household	78		67	
Income Level (Monthly)	No	%	No	%
Low Income (upto 3000)	Nil	Nil	Nil	Nil
Lower Middle (3001-5000)	7	8.97	Nil	Nil
Middle Income (5001-10000)	36	46.16	13	19.40
Upper Middle (10001-20000)	21	26.92	31	46.27
High Income (20000 & above)	14	17.95	23	34.33

Source : Field Survey, 1994

Table 6.4 Family Size Of The Respondents

Name of the Area	Kathalbagan		Dhanmondi	
Total household	78		67	
House hold members	No	%	No	%
Upto 3	6	7.69	15	22.39
4 to 6	49	62.82	44	65.67
7 to 10	16	20.51	6	8.96
10 and above	7	8.98	2	2.98

Source : Field Survey, 1994

6.2 OPINION OF RESPONDENTS ABOUT PRESENT SWM SYSTEM

When asked about their views on present solid waste management system more than 90% of respondents stated that it is polluting their environment (Table 6.5), and the majority rated the present DCC waste disposal services as unsatisfactory. The main reasons for the present SWM polluting environment are offensive odour from the wastes disposed on the road, wastes being not properly removed (Table-6.6). It is clear from the findings that the residents of both the areas are not satisfied with the present SWM system.

Table 6.5 Response Regarding Pollution Due To Present SWM System

Name of the Area	Kathalbagan		Dhanmondi	
Response	No	%	No	%
Yes	72	92.3	65	97
No	6	7.7	2	3

Source : Field Survey , 1994

Table 6.6 Response Regarding Reasons For Pollution Due To Present SWM

Name of the Area	Kathalbagan		Dhanmondi	
Total household	78		67	
Reasons	No	%	No	%
Offensive odour from scattered solid wastes all over the area due to lack of dustbin	72	92.3	26	38.81
Waste is not properly removed from the area	58	74.35	47	70.15
Waste is disposed on drains	17	21.8	38	56.72
Waste is scattered outside the bin	1	1.28	37	55.23
Waste is disposed on the road	68	87.18	43	64.18

Source : Field Survey, 1994

Table 6.7 Rating Of SWM System Of DCC By The Respondents

Name of the Area	Kathalbagan		Dhanmondi	
Total household	78		67	
Rating	No	%	No	%
Good	Nil	Nil	Nil	Nil
Fair	Nil	Nil	1	1.5
Poor	28	35.9	19	28.4
Unsatisfactory	50	64.1	47	70.1

Source : Field Survey, 1994

Table 6.8 Reasons For Unsatisfactory Performance

Name of the Area	Kathalbagan		Dhanmondi	
Total household	78		67	
Reasons	No	%	No	%
Waste of the Area is not properly removed.	23	29.49	17	25.37
Road and drain not properly cleared.	14	17.95	13	19.41
Waste transported to disposal site by open truck	4	5.12	5	1.47
No Dustbin in the area	16	20.51	Nil	Nil

Source : Field Survey, 1994

6.3 RESPONDENTS PRIORITY TO DIFFERENT SERVICES

When the households were asked about priority wise problems of different services, more than 90% of them attached higher priority to solid waste management to their community (Table 6.9). It is really important to know what exactly the community prefers before executing any project or policy change. For example, if a community wants water supply before SWM, a project on the latter will have less chance to succeed for lack of participation and interest by the target group.(Table 6.9) suggests that there is an urgent need for improvement of SWM system and there is a greater chance of community involvement and participation.

Table 6.9 House Holds Priority To Different Services

Name of the Area	Kathalbagan		Dhanmondi	
Total household	78		67	
PRIORITY	No	%	No	%
Water	57	73.1	44	65.67
Electricity	51	65.38	41	61.19
Solid Waste Management	76	97.43	63	94.02
Recreation	27	34.62	15	22.38
Gas	3	3.84	2	2.98

Source : Field Survey, 1994.

6.4 CURRENT WASTE DISPOSAL PRACTICES AND PLACES

6.4.1 GENERAL CHARACTERISTICS OF WASTE DISPOSED

Table 6.10 represents the characteristics of wastes being disposed by households. The table indicates that kitchen and vegetable wastes constitute the major portion of waste being disposed by households. In Kathalbagan waste also contain paper, plastics and broken glass, while the wastes in Dhanmondi also contain paper, plastics glass and tin items. It can be concluded from the Table 6.10 that kitchen and vegetable wastes predominate as the major portion of household waste. The amount of paper, tin, plastic items are comparativly greater in upper income areas.

Table 6.10 General Characteristics Of Household Wastes

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Type ofItems	No	%	No	%	No	%
Kitchen and Vegetable Wastes	78	100	67	100	145	100
Paper Wastes	12	15.38	12	17.91	24	16.55
Plastics	3	3.85	4	4.48	7	4.82
Glass (Broken)	2	2.56	2	2.98	4	2.75
Metal/Tin	Nil	Nil	6	8.96	6	4.13

Source : Field Survey, 1994.

6.4.2 ITEMS SEPARATED BEFORE DISPOSAL

When the households were asked about any kind of separation of items before disposal, more than 90% of respondents in both the areas answered that they separate certain items before disposal and sell them to hawkers. Table 6.11 shows items separated for selling. More than 90% of the household sold the items to hawker who collect them from door to door. From table 6.11 we can observe that major items which are sold consist of newspapers, old books, magazine, plastic materials like cans, jugs, and glass items. The percentage of rubber and metal or tin items sold in kathalbagan is less than Dhanmondi, it is due to difference in income level as the percen-tage of tin food, or beverage items are mostly used in upper income areas than low income ones.

Table 6.11 : Types Of Items Separated By House Hold

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Type of Items	No	%	No	%	No	%
News paper old books, magazine, khata	72	92.31	64	95.52	136	93.79
Plastic Material	67	85.89	58	86.56	125	86.21
Glass Bottles	37	47.43	22	32.83	59	40.69
Rubber Items	6	7.69	8	11.94	14	9.65
Metal/tin	1	1.28	5	7.46	6	4.14

Source : Field Survey, 1994.

Table 6.12 : Frequency Of Selling Of Separated Items

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Frequency	No	%	No	%	No	%
Every month	3	3.8	4	6	7	4.83
Every two month	12	15.4	14	20.9	26	17.93
More than two month	57	73.1	46	68.7	103	71.03
Not Applicable	6	7.7	3	4.5	9	6.21

Source : Field Survey, 1994.

Table 6.13 Buyers Of Seperated Items

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Buyers	No	%	No	%	No	%
Hawkers	71	91	64	95.5	135	93.10
Shops	Nil	Nil	Nil	Nil	Nil	Nil
Others	1	1.3	Nil	Nil	1	0.69
Not Applicable	6	7.7	3	4.5	9	6.21

Source : Field Survey, 1994.

6.4.3 PLACE OF DISPOSAL

Table 6.14 shows the place used by households for disposal of the wastes. It is evident from the table that about 67% of respon-dents in Kathalbagan are disposing their waste on road side or drain side rather than community bin, while 70% of respondents in Dhanmondi area are disposing their waste in community bins. The second highest place used by respondents for disposal of waste in kathalbagan is vacant plots (20.5%), while in Dhanmondi area it is road or drain side (11.9%). About 6.4% of the respondents in kathalbagan and 7.5% of respondents in Dhanmondi are disposing their waste in vacant space of their own house. It indicates that in unplanned area only 5.1% are using community bin for disposal of wastes.

Table 6.14 Types Of Disposal Place Used By Respondents

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Disposal place	No	%	No	%	No	%
Community bin	4	5.1	47	70.1	51	35.17
Road side	52	66.7	8	11.9	60	41.38
In a vacant lot	16	20.5	3	4.5	19	13.10
In own house	5	6.4	5	7.5	10	6.90
Do Not know where waste is disposed	1	1.3	4	6.0	5	3.45

Source : Field Survey, 1994.

6.4.4 PERSONS DISPOSING WASTES AND FREQUENCY OF DISPOSAL

Table 6.15 shows that in majority of cases servant are used for disposal of wastes. Table 6.16 indicates that the frequency of such disposal of waste is daily.

Table 6.15 Disposers Of Solid Waste

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Disposer	No	%	No	%	No	%
Servants	64	82.1	60	89.55	124	85.5
Family members	12	15.3	1	1.49	13	9
Collected by DCC Employees	2	2.6	3	4.48	5	3.4
Collected by private persons	Nil	Nil	3	4.48	3	2.1

Source : Field Survey, 1994.

Table 6.16 Frequency Of Waste Disposal Of The Respondents

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Frequency	No	%	No	%	No	%
Daily	72	92.3	63	94	135	93.1
Alt day	5	6.4	2	3	7	4.8
Twice a week	1	1.3	2	3	3	2.1

Source : Field Survey, 1994.

6.4.5 MATERIAL USED FOR DISPOSAL OF WASTES

Table 6.17 indicates that about 59% respondents in kathalbagan and 61.2% uses polythene bags for disposal of wastes, while 37.2% in katalbagan and 32.8% in Dhanmondi uses small bucket for disposal of wastes. This indicates that it would not be a problem if waste is collected from house to house.

Table 6.17 Material Used For Disposal Of Wastes By Respondents

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Material Used	No	%	No	%	No	%
Polythene packet	46	59	41	61.2	87	60
Small Bucket	29	37.2	22	32.8	51	35.2
Others	3	3.8	4	6	7	4.8

Source : Field Survey, 1994.

6.4.6 MONEY SPENT FOR DISPOSAL OF WASTES

When respondents were asked specifically about their expenditure exclusively for disposal of wastes about 86% in Kathalbagan and 79% in Dhanmondi responded that they do not spend any money for disposal of waste. About 14% respondents in Kathalbagan and 21% in Dhanmondi are expending some money upto Tk. 30 per month for this purpose.

Table 6.18 Money Spent For Waste Disposal By Respondents

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Amount of money	No	%	No	%	No	%
No money	67	85.9	53	79	120	82.76
TK. 1-10	2	2.6	4	6	6	4.14
Tk 11-20	4	5	4	6	8	5.51
Tk. 21-30	5	6.5	6	9	11	7.59

Source : Field Survey, 1994.

6.5 PROBLEMS FACED BY RESPONDENTS DURING WASTE DISPOSAL

Households were asked to identify two main problems they face during waste disposal. Table 6.19 indicates that the main problem faced by respondents in Kathalbagan is absence of dustbin in the area, while the dustbin provided by DCC is at distant location, one is located at Green Road and another at Sonargoan Road. Perhaps due to these reasons people throw their wastes on roads at Kathalbagan. The main problems identified by respondents in Dhanmondi area is not easy access to dustbin, offensive odour from dustbin and inappropriate location of dustbin. These are the reasons why waste is seen illegally disposed on road at Dhanmondi area.

Table 6.19 Problem Faced By Respondents Regarding Waste Disposal

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Problems	No	%	No	%	No	%
No Dustbin in the area	68	87.18	9	13.43	77	53.10
Dustbin is not easily accessible	72	92.30	47	70.43	119	82.06
Dustbin is not in appropriate location	12	15.39	32	47.76	44	30.34
Dustbin is not in way of walking	2	2.56	11	16.42	13	8.96
Offensive odour near the bin	Nil	Nil	35	52.24	35	24.13
Lack of manpower for waste disposal	2	2.56	Nil	Nil	2	1.38

Source : Field Survey, 1994.

6.6 PROBLEMS DUE TO IMPROPER DISPOSAL OF WASTES

Several problems were unfolded due to improper disposal of wastes by the respondents in their areas. Table 6.20 shows that most of respondents identified encroachment of road way by waste, presence of flies and mosquitoes, offensive odour and overall degradation of environment as the major problems due to improper disposal of waste in their respective areas.

Table 6.20 Problem Due To Improper Disposal Of Wastes In The Respondents Area

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Problems	No	%	No	%	No	%
Blockage of open drains with wastes	32	41.03	35	52.33	67	46.21
Clogging of swereline with wastes.	35	44.87	16	13.88	51	35.17
Encroachment of road ways by disposal of wastes on roads.	73	93.59	54	80.59	127	87.59
Offensive odour from wastes.	26	33.34	49	73.13	75	51.72
Presence of Flies/ Mosquitoes due to indiscriminate disposal of wastes in the area.	71	91.03	60	89.56	131	90.34
Degradation of environment due to indiscriminate disposal of wastes in the area.	75	96.15	53	79.11	128	88.29

Source : Field Survey, 1994.

6.7 KNOWLEDGE OF RESPONDENTS ABOUT DISEASE AND DISEASE VECTORS

Table 6.22 indicates that majority of the respondents have poor knowledge about disease that spread through or linked with solid waste pollution. It was also found from the survey that they have some idea about disease vectors.

Table 6.21 Knowledge Of Respondents About Disease Vectors

Name of the Area	Quality of Knowledge				Total	Percentage			
	Very Good	Good	Fair	Poor		Very Good	Good	Fair	Poor
Kathal bagan	8	16	47	7	78	10.26	20.51	60.25	8.97
Dhanmondi	10	8	43	6	67	14.92	11.95	64.17	8.96
Total	18	24	90	13	145	12.41	16.56	62.07	8.96

Source : Field Survey, 1994.

Note : Quality of knowledge

Very Good : who can identify the four major names of disease vectors.

Good : Who can identify the three major names of disease vectors.

Fair : Who can identify two major names of disease vectors.

Poor : Who can identify one major name of disease vectors.

Table 6.22 Knowledge Of Respondents About Diseases Spreading Through Solid Wastes

Name of the area	Quality of Knowledge					Total	Percentage				
	Very Good	Good	Fair	Poor	No Know-ledge		Very Good	Good	Fair	Poor	No Know-ledge
Kathal-bagan	1	2	14	47	14	78	1.28	2.56	17.95	60.26	17.95
Dhan-mondi	Nil	2	14	39	12	67	Nil	2.99	20.89	58.21	17.91
Total	1	4	28	86	26	145	0.69	2.76	19.31	59.51	17.93

Source : Field Survey, 1994.

Note : Quality of knowledge:

Very Good : Who can identify the five major names of diseases.

Good : Who can identify the four major names of diseases

Fair : Who can identify three major names of diseases.

poor : Who can identify one or two major name of diseases.

No knowledge : Who can not identify the name of any disease.

6.8 SUGGESTIONS FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT SYSTEM

6.8.1 TYPE OF COLLECTION SYSTEM PREFERRED

When the respondents were asked about the type of system they preferred for waste disposal, majority of them liked that waste be collected from their houses. It is interesting to note that only 5.52% of the total respondents preferred to dispose their waste in community dustbins (Table 6.23).

Table 6.23 House Hold's Preference Of Waste Disposal System

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Type of Systems preferred	No	%	No	%	No	%
House to House Collection	37	47.4	44	65.7	81	55.86
Block Collection	39	50	12	17.9	51	35.17
Communal Collection	1	1.3	7	10.4	8	5.52
Curb Collection	1	1.3	4	6	5	3.45

Source : Field Survey, 1994.

6.8.2 PREFERENCE REGARDING FREQUENCY AND TIME OF COLLECTION

Majority of the respondents 89.7% in Kathalbagan and 94.07% in Dhanmondi wanted that the waste from their premises be collected daily (Table 6.24). It was also found from the survey that majority of them desired that waste be collected between afternoon and evening hours (Table 6.25)

Table 6.24 Frequency Of Collection Desired

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Frequency	No	%	No	%	No	%
Daily	70	89.7	63	94	133	91.7
Alt. day	8	10.3	3	4.5	11	7.6
Every two days	Nil	Nil	1	1.5	1	.69

Source : Field Survey, 1994.

Table 6.25 Time Of Collection Preferred

Name of the Area	Kathalbagan		Dhanmondi		Total	
Total Household	78		67		145	
Time	No	%	No	%	No	%
Morning	3	3.9	4	5.97	7	4.83
Noon	1	1.3	2	2.98	3	2.07
After Noon	32	41	30	44.78	62	42.76
Evening	42	53.8	31	46.27	73	50.34

Source : Field Survey, 1994.

6.8.3 FINANCIAL CONTRIBUTION FOR IMPROVEMENT OF THE WASTE DISPOSAL SYSTEM OF THE AREA

Table 6.26 indicates the respondents willingness to contribute for improvement of present waste disposal system. It was found from the survey that more than 90% of respondent are willing to pay for improvement of the garbage disposal situation. It can be seen from the table 6.26 that in Kathalbagan majority (39.7%) are willing to pay Tk. 10/-per month for it if the

waste is directly collected from their houses followed by Tk. 20 per month (23.1%).The amount of contribution is larger in Dhanmondi area; as majority of householders (23.9%) are willing to pay Tk. 20/ per month followed by Tk. 50 per month (20.9%). Even 7.5% of the respondent are willing to pay Tk. 100 per month for direct removal of waste from their premises. The amount is greater in Dhanmondi area for the obvious reason that it happens to be an upper income residential area.

Table 6.26 Respondents Ability To Contribute Financially

Name of the area	Kathalbagan		Dhanmondi	
Total household	78		67	
Amount of Contribution	No	%	No	%
Tk. 10/-	31	39.7	13	19.4
Tk. 20/-	18	23.1	16	23.9
Tk. 25/-	3	3.8	1	1.5
Tk. 30/-	9	11.5	12	17.9
Tk. 40/-	2	2.6	3	4.5
Tk. 50/-	7	9	14	20.9
Tk. 100/-	2	2.6	5	7.4
No contribution	6	7.7	3	4.5

Source : Field Survey, 1994

6.8.4 RESPONSE REGARDING USE OF ORGANIC FERTILIZER IN GARDEN AND FLOWER POTS

The respondents were also asked about their knowledge of organic fertilizer which could be made from kitchen and vegetable wastes. More than 75% respondents answered that they knew about the organic fertilizer and its environmental benefits. When the respon-dents were asked about their willingness to use the same in the garden and flower pots, more than 80% responded favorably.

6.8.5 RESPONSE REGARDING SEPARATION OF WASTE AT HOUSEHOLD LEVEL

When the respondents were asked whether they liked to separate their kitchen and vegetable waste from other household wastes, majority of them (53.8%) responded in the

negative. When the negative respondents were asked that in case they were supplied with container or plastic packet whether they would segregate they waste, majority (79.48%) responded positively.

6.8.6 RESPONSE REGARDING COMMUNITY PARTICIPATION

About 99% of the respondents in the study area felt that community participation was essential for improvement of waste management and overall environment of the neighbourhood. When the respondents were asked whether they had any knowledge about community based organizations (CBOs), majority (78%) answered in the negative. When asked about presence of any such organization in their respective areas, majority of them again responded negatively.

6.8.7 RESPONSE REGARDING PARTICIPATION IN COMMUNITY BASED ORGANIZATIONS (CBOs)

About 85% of the respondents expressed their willingness to participate in community based organizations and programs in order to improve the waste management as well as for environmental improvement their areas.

6.8.8 RESPONSE REGARDING AWARENESS OF PROPER WASTE DISPOSAL PRACTICE

When the respondents were asked as to how disposal of waste by the household at proper places can be attained, 42% suggested people's participation followed by creating awareness among people about disposal at proper places by the relevant authority (37.9%); while 20.1% replied that it can be attained by enforcement of law.

6.8.9 RESPONSE REGARDING PRESENT DESIGN OF COMMUNITY BIN

When the respondents were asked about their opinion about present design of community bin provided by DCC, 71% of them answered that the design is not perfect. They suggested that it should have cover or lid.

6.8.10 PREFERENCE OF RESPONDENTS REGARDING USE OF MEDIA FOR ENVIRONMENTAL AWARENESS

Table 6.27 indicates the preference for use of media suggested by respondents in order to educate the people about proper waste disposal and for building environmental awareness among them.

Table 6.27 Preference Regarding Use Of Media By Respondents For Environmental Awareness

Name of the Area	Kathalbagan		Dhanmondi	
Total Household	78		67	
Preference	No	%	No	%
News Paper	66	84.61	56	83.58
Radio	69	88.46	49	73.13
Televison	69	88.46	53	79.01
Leaflet	22	28.20	18	26.86
Poster	31	39.74	35	52.23
Teaching in School and College	54	69.23	45	67.16

Source : Field Survey, 1994

It is evident that majority of the respondent preferred electronic and print media to be used for educating the people for proper waste disposal and for building environmental awareness. A good number of respondents suggested that teaching in school can help to educate good environmental habits in the long run.

CHAPTER 7

FINAL DISPOSAL OF SOLID WASTE & ALTERNATIVE OPTIONS FOR DHAKA CITY

This chapter evaluates the waste disposal options for Dhaka city. Final disposal of solid waste is one of the major problems of SWM of the metropolis. The following sections deals with different options for final disposal of solid waste of the capital city.

7.1 SOLID WASTE DISPOSAL OPTIONS FOR DHAKA CITY

Different methods which may be considered for disposal of solid waste are :

a) Sanitary landfilling. b) Incineration, c) Composting and d) Anaerobic Digestion. Advantages and disadvantages of these methods have already been discussed in chapter 3. Feasibility of different techniques of solid waste disposal for Dhaka City is being examined in the following sections.

7.1.1 SANITARY LANDFILLING

Sanitary landfilling is the method of disposing of solid waste on land without creating nuisance or hazard to public health or safety.

Feasibiity Of Sanitary Landfilling In Dhaka City

Sanitary landfilling is a low-cost method compared to other methods (incineration, & mechanized compositng), which involves simple technology and possesses good grounds for adpotion in preferance to the existing method of crude dumping. Recently, DCC has decided to introduce sanitary landfilling method in its newly acquired site at Matwail. However, the main problem associated with this method is that it requires large areas of land to hold waste for a minimum period of one year, preferably five to ten years.

With the present rate of waste collection in Dhaka city (.21 kg/cap/day), DCC requires an estimated space of 2,48,860.65 cubic metres (approximately 202 acre-ft) for disposal of solid waste, per year (Appendix C-2). The new site at Matwail covers an area of 37 acres with a depth of 5 metres. As such, this site will be filled up in three years time (Appendix C-2), neglecting any increase in collection of solid waste. However, with the present population growth rate of 4.75% of DCC area, it is increasing by 1,70,193 persons annually. With the present rate of waste collection, DCC would require an additional space of 11859.35 cubic metes (9.62 acre-ft) per year.

With improvement in collection of solid wastes, more space would be required for its disposal, making the disposal problem of Dhaka city more acute. Land is quite scarce and costly in Dhaka; for instance, low land in the fringe areas of Dhaka costs around Tk. 210 per sq. metre (UNDP, 1993, p. 25). Moreover, with the increase of population and urban areas of Dhaka city, it would become very difficult to find suitable disposal site within easy access for solid waste disposal, necessitating long haulage and resulting in increase of transportation cost. The new site at Matwail, situated on south eastern outskirt 5km outside DCC area, will involve an average haulage of approximately 15 Km from central collection areas of the city. Obivously, increase in collection coverage will aggravate the disposal problem, if the volume of waste is not reduced. As such, waste reduction methods deserve serious consideration in conjuction with sanitary landfill method, in order to prolong the life of landfill sites and also to reduce SWM cost.

7.1.2 INCINERATION

Incineration is the process of reducing combustible waste to an inert residue by high temperature burning.

Feasibility Of Incineration For Dhaka City

From Tables 5.6, 5.7 and 6.10 it can be seen that the major portion of solid waste comprises of organic matter. From Table 5.8 it may also be observed that the wastes contain high moisture and low phosphorus content. Incineration of solid waste of Dhaka city would not be a viable option because :

1) a large amount of heat will be required to evaporte the moisture content;

2) Plastic and papers which mainly add to the calorific value are in low percentage as most of these items are recycled in Dhaka (Table 6.11 and 6. 13); &

3) The waste of Dhaka city has lower calorific value (Appendix A-4). A self sustained combustion reaction cannot be obtained from waste characteristics. Moreover, incinerator plants are costly to install and requires heavy maintenance cost and skilled manpower to operate. DCC has financial problem in this regard. Hence this method of disposal is not appropriate and not recommended for solid waste disposal of the capital city at this stage.

7.1.3 COMPOSTING

Composting can be defined as biological decomposition of organic constitutents of wastes under controlled conditions.

Feasibility Of Composting In Dhaka City

The high percentage of organic matter in the solid waste shows a good possibility of compositng for Dhaka city garbage. Moisture content between 50 and 60 percent and carbon-nitrogen ratios between 35 & 50 are optium for aerobic composting (Peavy, et. al,. p 661).The typical moisture content of solid waste of Dhaka is around 45% which is within the acceptable range (Table 5.8). The carbon-nitrogen ratio of Dhaka solid waste is slightly higher (carbon 22.6% & nitrogen.41%). At higher carbon-nitrogen ratios, nitrogen may be a limiting nutrient. However, nitrogen deficiency can be overcome with the addition of nitrogenous wastes like night soil from septic tanks or digested sludge. Soil fertility in many areas of Bangladesh has decreased due to excessive use of chemical fertilizer and lack of use and availability of organic manure (DOE, 1990, p. 68, and Bangladesh Observer 1994 c,d). Lack of availability and use of organic manure is mainly due to the large use of agricultural residues and animal dung as fuel in rural areas. It has been found that in rural areas of Bangladesh 98.69% of the households use cowdung, husk and wood as fuel (BBS, 1993b, p.95). Instead of recycling back to land, burning of residues is contributing to the deterioration of soil quality. Recently, in Mymensingh a local enterprising scientist collects about 1 ton of decomposed garbage (compost) from dumpsites and mixes with it urea and mustard oil seed cake in equal proportions and markets the product as soil enticher or special manure. This special manure is very popular among local farmers and sold at an average cost of Tk 10/- per kg; and due to the increasing demand of the manure the scientiest is increasing his production by processing fresh garbage into compost (ADB, 1992). Recently adopted environmental policy of Government of Bangladesh urges to restrict the use of chemical fertilizer as far as possible and encourages use of organic manure (GOB, 1992). As such, the scope, need and importance of recycling of organic waste into organic manure, viewed from agricultural, environmental and sustainable development aspects, highlight the necessity of undertaking composting projects in Dhaka city.

Potential Sources Of Demand For Compost

Compost can be used in rice based farming system, in production of high value crops, flowers, fruit trees, ornamental plants for households, offices, hotels, in nurseries for seedbeds and potted plants, for use in urban agricultural and forest setting, in turf grass production, sportsfields and landfills. The use of compost can range from domestic applicantion to large scale commercial farming. Dhaka has agricultural land in its fringe areas and approximately 44.9% of its land is agricultural (Appendix A-5). From the field survey it was found that most of the households are willing to use compost in their gardens and potted plants (section 6.8.4).

Composting Strategy For Dhaka City

The cost of producing compost varies with the usage of type of plants i.e., mechanized or manual. Highly mechanized capital intensive compost plants have failed in many developing countries for a number of reasons, such as high operational cost, maintenance and production cost and lack of skilled manpower. For example, between 1975-1988 eleven mechanical compost plants were installed in different parts of India of different capacities varying from 150-300 tons/day and at present only three are working while the rest are closed down due to high production cost (UNDP, 1991).

However, small scale labour intensive composting plants have been initiated in many cities to improve the present sitution of composting and to solve solid waste disposal problem. Indonesian and Chinnes manual composting methods (Appendix B-3 & Appendix B-4) are found very successful in those countries. According to DCC and amount of Tk. 2 crore (Islam 1994) is required to instal a 10 ton/day capacity mechanized compost plant from Sweden, and at present DCC is facing financial problem to instal such plant. It is estimated by the author that initial cost of Tk. 4,96,400 will be required to start manual compost plant of Indonesian type of 5 ton day capacity and the production cost per ton of compost will be around Tk. 175 only (Appendix C-3). Generally in Asian cities the productiion cost of per ton of compost using manual method varies between US $ 1 to 5 (Lardinois, et. al, 1991 p. 38). In India it is estimated that production cost per ton of compost using manual method would be Rs 325 to 400(Tk 390 to 480) (UNDP, 1991). Therefore, small scale decentralized composting method would be most suitable and cost effective method for Dhaka city.

7.1.4 ANEAEROBIC DIGESTION

Anearobic decomposition is the process of digesting organic waste in the absence of oxygen and light. Biogas is the by - product of anaerobic decomposition of organic matter.

Feasibility Of Anaerobic Digestion In Dhaka City

Presence of high percentage of organic matter in the solid waste of Dhaka city makes it favourable for biogas genreation. The solid waste of residential and commercial areas of Dhaka city contains 70%-80% organic matter. Generally, 8 to 12 cubic feet gas is produced by decomposition of 1 pound of organic solid waste of which 60% is methane (Pandey, et. al., 1992, p. 247). As stated in chapter 5 (sections 5.4.3& 5.4.4), bio gas has been success-fully generated from the city garbage in two pilot projects. Natural gas is available in Dhaka city, as such, large scale commercial use of biogas would be highly competitive. Natural gas reserve in Bangladesh is estimated at 303.62X 10^9 cubic meter (BBS, 1993). With the present rate of consumption, this reserve is expected to be exhausted in 20-22 years time i.e. by 2013-2015 AD. Therefore, Biogas from organic solid waste has good prospect in future to meet the energy requirements of the metropolis. However, at present biogas may be used in areas where natural gas is not available. Majority of slums in DCC area has no gas supply and access to solid waste disposal facility . As such, biogas could be produced from the organic solid waste generated in these areas and used by its dwellers. Undertaking of such projects in potential areas would obviously help environmental improvement of Dhaka city.

7.2 CONCLUSIONS

From the discussions of this chapter it is clear that inoffensive and simplest method of solid waste disposal is sanitary landfilling. As the population of Dhaka city is growing so is its generation of wastes. Consequently, less area is available for disposal of solid waste on land.

As such, waste minimisation is highly essential. There is a good prospect of recycling the organic portion of wastes into compost which is important both from environmental and sustainable development aspects. A combination of sanitary landfilling and composting methods should therefore be followed in Dhaka.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

This chapter consists of two major parts. First part provides a brief summary of overall findings, while the second contains recommendations for improvement of solid waste management of Dhaka city, which if implemented would eventually lead to substantial improvement in the environment of the metropolis.

8.1 REVIEW OF FINDINGS

Summary of the findings presented in the following section is based on observations, questionnaire survey and literature review.

1. Waste generation of Dhaka city is increasing with the growth of its population. Population of DCC area increased during 1985-1991 period from 2.62 million to 3.583 million; while the waste generation during the same period rose from 1040 to 1792 tons per day, representing per capita increase at an average annual rate of 4.33%.

2. The present financial outlay of DCC with regard to solid waste management is quite inadequate and there is an urgent need to improve this situation. The present per capita expenditure for SWM in Dhaka is only Tk. 33/- which is one of the lowest amoung neighbouring countries.

3. The present revenue collection system of DCC for conservancy (SWM) is not satisfactory. There was a shortfall of Tk.3,80,19,154/- during 1993-94 financial year between revenue earned and expenditure incurred on SWM sector by DCC, representing a mismatch of 47.51% . It appears that per capita revenue earned by DCC for solid waste management is only Tk.22/- representing a shortfall of Tk. 11/- between per capita revenue earned and per capita expenditure made during 1993-94.

4. There is neither any specific legislation nor any standard regarding solid waste disposal. As a result of this deficiency, solid waste disposal system being practiced in Dhaka is unsatisfactory in many respect.

5. The present waste disposal infrastructure of DCC such as cleaners/sweepers, vehicles and equipments are inadequate to meet the increasing demand.

6. Present waste collection system of DCC is inadequate and inefficient. Only 42% of the total generated waste is disposed per day by DCC.

7. Unhygenic practices are being followed by DCC staffs for collection, transportation and disposal of solid wastes.

8. Co-ordination problem is observed within the DCC regarding SWM.

9. Scarcity of land for final disposal of waste needs special attention of DCC for early

10. Many insanitary practices are being followed by DCC regarding waste disposal. No measures are taken to monitor or check the leachate from land fill sites.

11. It was revealed that community involvement in solid waste management is an important factor and it can improve the waste disposal system of residential areas significantly. Partnership between community and DCC is essential to improve waste disposal system & overall environment.

12. It was revealed from the study that most of households attached highest priority to solid waste management as compared to other civic servies in their areas. It was also found that most of the household surveyed are not satisfied with the present waste management system.

13. It was found that majority of the respondent households (above 90%) in Kathalbagan which is an unplanned area have no access to community bin for waste disposal. As such, most house hold are disposing their waste on road or drain side, while in Dhanmondi which is a planned area majority of the households are disposing their waste in community bins. As such waste disposal problem is more acute in unplanned areas.

14. From analysis it was found that in unplanned area like kathalbagan absence of dustbin and lack of accessibility to the dustbin are the major problems faced by households regarding disposal of waste while in Dhanmondi ofensive odour and improper location of dustbin are the major problems faced by the households regarding waste disposal. These are the reasons why waste is being disposed at unauthorised places.

15. Most of the respondent households indentified encroachment of roadway by wastes, offensive odour from uncollected wastes, presence of disease vectors and clogged drainage system with domestic waste in their area as main factors responsibile for environmental degradetion.

16. Recycling of solid waste is popular among households in Dhaka because of its economic value in the market. News papers, bottles and tincans are found to be the most popular recyclable items at the household level and are mainly sold to hawkers by the households.

17. It was further revealed from the study that majority of the respondents in the study area have poor knowledge about diseases caused by solid waste pollution. It is one of the main reasons why people dispose their waste indiscriminately. This suggests the need for education on health and hygiene.

18. Recently DCC has decided to introduce sanitary landfilling method instead of crude dumping method in its newly acquired disposal site at Matwail. At the current rate of waste disposal, it would be filled up in three years. Moreover DCC is also facing problems of land for disposal of waste. As such waste volume reduction method should be considered to prolong the life of land fill site.

19. It was found from the study that organic material such as kitchen and vegetable wastes constitute the major portion of waste. This type of waste offer nothing to the

scavengers to collect. This is why organic waste are used for landfilling. Recycling of organic wastes which constitute the major portion is not popular in Dhaka and is an unexplored sector. Very recently an example of successful natural composting from solid waste has been found in Mymensingh by private initiative.

20. It was found that there is a scope & need of recycling the organic wastes into compost of Dhaka from environmental, agricultural and sustainable development aspects. It was also revealed from the study that manual composting plant would be a cost effective and suitable method for Dhaka city, and compost could be produced at a much lower cost than chemical fertilizer.

21. It was found that biogas could be generated from the solid wastes of Dhaka. Natural gas is available in Dhaka, so commercial use of biogas would be a highly competitive, but it could be an option for disposal of wastes for slum and squatter settlement areas where waste disposal and sanitation situation are poor. Recently, biogas plant was found successful in Ganktuli sweeper's colony of Dhaka city.

22. It was revealed that gas reserve in Bangladesh, with current consumption rate, would be exhausted within 20-22 years. As such, recycling of organic waste by converting into biogas also deserves attention fromimportance in sustainable development. Moreover, biogas is a renewable source of energy and has environmental benefits.

23. It was also revealed from the study that Dhaka city solid waste contains high moisture content (about 45%) and low phosphorus (.05%). This suggests that incineration of solid waste would not be suitable, as a large amount of heat would be required to evaporate the moisture content. Paper and plastic which mainly add to the calorific value are in low proportion; as such incineration would not be self sustaining and it would be too costly for the DCC to maintain the system.

24. Majority of the respondents in the study area preferred that waste should be diretly collected from their houses. It is interesting to note that only 5.5% of the total respondents in the study area preferred to dispose their waste in tho community bins. This reflects that the present system of DCC does not conform with the residents preference.

25. The study also unfolded that majority of respondents (more than 90%) in the study area are willing to pay for improvement of waste management system. Majority of the households are willing to pay for house to house waste collection a sum of Tk. 10-20 per month. Some households are willing to pay even Tk. 50 to Tk. 100 per month for waste collection. This number is more in upper income area like Dhanmondi. It suggests that house to house collection could be initited where people are willing to pay for the service.

26. Recently it has been found that in Kalabagan area of Dhaka city house to house waste collection system introduced by CBO has solved the waste disposal problem of the area.

27. It was found from the study that separation of waste at household level could be attained by providing container or plastic or polythene packets to the households.

28. Majority of the households suggested that community participation should be promoted to improve the waste management system and environmental situation.

29. It was also revealed that majority of the households of the study area would participate in CBOs in order to improve the waste management system as well as for environmental improvement.

30. Most of the respondents suggested that electronic and print media should be used for educating the people about proper waste disposal practices and for building environmental awareness. A good number of respondents also suggested environmental education should be included in school curricula.

8.2 RECOMMENDATIONS

Following section describes the recommendations for solving the solid waste management problem of Dhaka city. It is divided into two parts - first part discusses the role of national government and DCC as well as NGO's and CBO's for improvement of the SWM system; while the second part describes some specific guidelines for improvement of SWM system.

In order to address the solid waste problem and to improve the environmental conditions of Dhaka city the following macro and micro level policy measures are recommended.

8.2.1 ROLE OF NATIONAL GOVERNMENT AT MACRO LEVEL

Policies related to solid waste management improvement for implementation by the national government at macro level are as under

1) Assisting in the formation of single division responsible for solid waste management.

2) Formulation of legislation regarding solid waste management.

3) Formulation of standards for collection and disposal of wastes.

4) Incentive for introduction of environmentally clean and efficient technology for waste disposal which would help to reduce the volume of waste and facilitate more recycling.

5) Consideration of waste as an unutilized resource and assisting in recycling of waste for conservation of resources and protection of environment.

6) Introduction of environmental education specially sanitary habits in school curriculum.

7) Introduction of new taxation system for conservancy operation.

8.2.2 ROLE OF DCC AT MICRO LEVEL

Micro level policy should be implemented by DCC because it is directly involved in the management of solid wastes. The aspects which should be improved at micro level are:

1. Increase in collection of taxes.
2. Taking measures to increase locally generated revenues to recover the cost of urban infrastructure.
3. Penalties for violation by public and operators.
4. Development of awareness and motivation through dissementation of information and education.
5. Research and Development for low cost option for waste management.
6. Co-ordination with other agencies regarding waste management.
7. Improvement in the collection and final disposal system of solid waste.
8. Optimum utilization of manpower and infrastructure.
9. Improvement in technical skill and efficiency of conservancy workers and staffs.
10. Support to self help group i.e (CBOs) in the neighbourhood.
11. Development of separate collection and disposal system of different types of wastes such as domestic, industrial and clinical.
12. Maintenance of adequate data regarding waste generation, composition and characteristic.
13. Regular monitoring of land fill sites and maintenance of record of such sites.
14. Promotion of separation and minimization of wastes at house hold level.
15. Regular maintenance of solid waste infrastructure.
16. Restriction of building or close structures on or near land fill sites.

8.2.3. ROLE OF NGOs AND CBOs AT MICRO LEVEL

The role of private organizations (such as NGOs and CBOs) in providing urban service is a new issue today. NGOs and CBOs can play a vital role in solid waste management and overall improvement of environment. Most societies are faced with multitude of collective needs and aspiration which household are often unable to meet on

their own. The reason is that these services are not affordable to individual household or are not available individually.

Community involvement is essential for improving living environment in urban settlements. Community participation is a fundamental democratic process which accords the community and its organizations an effective form of participation in decision making, planning, implementation and maintenance of urban services such as solid waste disposal. Its benefit are self-reliance, technical and organizational efficiency, environmental enhancement, generation of employment and user's satisfaction.

For example, in chapter 5 we have seen that how community participation in Kalabagan residential area has solved their waste disposal problem by introducing house to house waste collection process through community based organization. This waste collection process had led to the environmental improvement, while Kalabagan area now gives a cleaner look and the residents are satisfied with this service. In Bangalore and Madras we have seen similar community participation in solving the waste disposal problem and over-all environmental improvement.

In Dhaka, there is a tremendous possibility of involving NGOs and CBOs in solving solid waste problem, NGOs can act as intermediaries between government, municipal authority and CBOs. It can serve as linkages between government, local level and community. NGOs staffed with professional planners, engineers and social workers can provide technical advice and help in co-ordinating and implementing small scale waste management programs in different residential areas of Dhaka city. NGOs can also help in community based organization in negotiation with government agencies to obtain access to the basic problem of waste disposal.

There is a very good opportunity in mobilizing CBOs and NGOs to address the waste disposal problem at local level. In practice "upstream" management of waste at the point of generation and before transportation to the final disposal site, is in principle in the hands of the producers or generators themselves. As such, community involvement is very essential in waste management. Partnership between community based organization and municipal authorities is very important. For this it is required that primary and secondary infrastructure would be supplied by local authorities and tertiary infrastructure would be provided, operated and maintained by CBOs.

8.3 GUIDELINES FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT OF DHAKA CITY

1. It is recommended that there should be suitable legislation in which guide-lines are provided to cope with solid waste disposal which should also provide as a basis for legal action to be taken against polluters

2. The new solid waste management law should include the following provisions :

   a) Standards for collection and disposal of wastes;

   b) Types of wastes that should be land-filled and collected by municipal workers;

c) Time frame work for the conservancy work;

d) Penal action for illegal disposal of garbage on roads, drains and unauthorized places; and

e) Penal action for negligence and unsatisfactory performance by the staff.

3. For a clean environment and prevention of transfer of infectious disease it is required that there should be adequate finance or allocation for SWM. Adequate finance could be attained by :

a) Delinking conservancy tax from general property tax based on rental value. It is recommended that market value of property should be use.

b) Separate charge rate should be developed for commercial and industrial solid waste.

c) Charges should be made for removal of construction or demolition waste. This tax could be levied while granting building permission.

4. For efficient management of solid waste activities vehicles maintenance and cleaners (sweepers) should be under one Division for better co-ordination and control.

5. In order to reduce the health hazard among the garbage crew it is recommended that they should be provided with proper protective clothing, gloves, boots etc. when loading and unloading wastes which are generally partially decomposed.

6. The present design of community bins is not satisfactory as it open and without cover or lid. It is recommended that all bins should have covered lid and have concrete bottom to prevent leachate leakage. Another type of portable community bin or container which can be lifted directly on the vehicle could be used.

7. It has been found that most of the staff in the conservancy. Division of DCC do not have proper training regarding waste management. It is recommended that adequate "in house" training should be made for conservancy staffs. Senior level conservancy staffs should be trained in neighboring countries where waste management is satisfactory.

8. It has been found that at present low level of awareness among public about health and environmental problems due to improper disposal of wastes prevail. It is recommended that public education campaign should be launched carefully co-ordinated with improvements in solid waste management system. The campaign should educate the public about relation between health clean environment and proper waste disposal. The campaign should also help to develop good public habits of garbage disposal. To educate the people electronic and print media should be used. For long term benefit course should be introduced in school level about environmental education specially sanitary habits. Clean ward competition can also be introduced by DCC to involve the people by motivation.

8. Active participation of community is essential for proper waste management. Active participation can be ensured with the involvement of community based organizations (CBOS) in waste management.

9. It has been observed that majority of the problems of littering illegal disposal of wastes on roads, drain or vacant plots is associated with the present community bin system of waste disposal. The problems of this system can be avoided by using house to house waste collection system .

10. With the present level of conservancy staff and cleaners, infrastructure and finance it is very difficult for DCC to introduce such system. It is therefore recommended that house to house collection can be introduced in different neighbourhoods by community participation involving community based organization. In such cases CBOs can organize house to house waste collection system within the prescribed time agreed by the households of the respective area. For this system based on community participation every household has to contribute for the service. In this system the waste from the respective area would be removed from individual household and disposed to fixed or portable community bin supplied by local government. The local government would remove the waste to disposal or treatment facility from communal bin or transfer stations. For this system involvement of NGO's for motivation and technical support would be required and DCC, NGO's and CBOs partnership is required. The benefit of this system is that it would reduce the litter and illegal disposal of wastes and thereby improve the environment of the area.

11. In order to improve the waste transportation system, it is recommended that for shorter distance and narrow lanes non motorized vehicles such as tricycle van or modified handcart should be used and for longer distance motorized vehicles should be used. For motorized vehicles of longer haul distance roll on roll off system could give much better service. It is also suggested to use transfer stations for longer haul distance to increase transportation efficiency.

12. To improve the waste disposal system it is recommended to use sanitary land fill method

13. The waste characteristics of Dhaka shows that incineration would be expensive and not viable due to high moisture content and lack of calorific value and fixed residue, hence this system can not be recommended.

14. Large percentage of organic material present in Dhaka's waste could be easily recycled by composting. It is recommended that small manually operated compost plant should be used in Dhaka strategically around the city peripheries rather than one single large mechanical compost plant. This decentralized approach will have following advantages;

    a) As Dhaka is large city the potential consumers of compost - as the farmer and agricultural lands are located outside the city boundary near the peripheries.

b) Low transportation cost both for carrying of waste from collection centers to the compost plant and transportation of compost from the plant to agricultural lands.

c) Low production cost due to manual composting method; because of the smaller size it is feasible to use manual composting process.

Most of the agricultural lands of Dhaka are located in Gulshan, Mirpur, Mohammadpur and Demra (Appendix A-6). As such, it is suggested to start small manual compost plant at any of these areas. DCC could instal a pilot compost plant at its newly acquired landfill site at Matwail under Demra Thana and after its successful operation could set up plants at the above mentioned areas.

15. It is also recommended that DCC should take the help of Agriculture Extension Department for marketing of the compost. It has been found that due to high use of chemical fertilizer and shortage of organic mannure, soil fertility has decreased in many parts of Bangladesh. As such, Agriculture Extension Department with its wide network can educate the farmers about the benefits of organic mannure, like increase in soil fertility as well as greater crop yield and environmental benefits.

16. In order to improve the waste disposal system of slum areas, it is recommended to use biogas plant which would solve the disposal problem of both solid waste and human excreta. The benefit of this would not only be a solution of waste disposal problem by recycling but at the same time bio-gas could be use as fuel by the slum dwellers, which would help improve environment. It is suggested that DCC could take the help of NGOs and BCSIR inconnection with instalation of biogas plants.

17. Adequate data regarding generation disposal and characteristic of solid waste should be maintained. It is recommended that DCC should have weighbridge. DCC should have also data and characteristic of solid wastes in all three seasons of the year, which is necessary for better planning in future.

18. Construction of closed structure on filled up low-lying land by solid waste should not permitted by RAJUK and hand pumps should not be allowed to be installed at such site. For this, RAJUK should have full information about private and municipal landfill site which at present is lacking.

19. In selection of future suitable sites for waste disposal, the help of RAJUK should be taken. It is recommended that additional disposal sites be identified before hand and notified for acquisition, because it needs a lot of time to acquire land and land acquisition proceedings involve a lengthy process. Selection of future land fill site should be based on the criteria which will minimize their adverse impact upon environment. The location, underling soil condition, and groundwater hydrology must be reviewed before final selection of landfill sites. Moreover, in selection of location proximity of houses or other sensitive buildings, site access roads, river or ponds, acquifers, water and gas piplines should also be considered.

REFERENCES

Ahmed, M.F.(1994), "Environment and Sustainable Development", paper presented at National Seminar on Sustainable Development in Bangladesh : Issues and Options, held during the 38th Annual Convention of the Institution Engineers Bangladesh (IEB), Dhaka, January, 18-21.

Ahmed, M.F.(1993), "Municipal Waste Management in Bangladesh with Emphasis on Recycling", paper presented in the Regional Workshop on Urban Waste Management in Asian Cities, Dhaka, April, 10-12.

Asian Development Bank (1992), "A Pilot Project Proposal To Improve Collection, Transport and Disposal of Solid Waste at Mymensingh", an unpublished draft for discussion.

Asian Development Bank (1987), "Urban Policy Issues", Manila, Phillippines, pp 79-84.

Asian Development Bank (1986) "Environmental Planning and Management", Manila, Phillippines, pp. 139-160.

Bangladesh Gazettee(1983),"The Dhaka Municipal Corporation Ordinance, 1983" Government of Bangladesh, Ministry of Law & Land Reforms, Law and Parlimentary Affairs Division, Dhaka.

Bangladesh Observer (1994a), "Urban Problems : Unemployment and inadequate Housing Top Concern", September 10.

Bangladesh Observer (1994b), "A City In Decay", July, 14.

Bangladesh Observer (1994c), "Natural Versus Artificial Fertilizer", February, 14.

Bangladesh Observer (1994d), "Excessive Use of Soil Decreases Fertility", February, 2.

Bangladesh Observer (1993a), "Fertilizer Use Reduces Soil Fertility", August, 15.

Bangladesh Observer (1993b), "Waste Disposal - Burn, Recycle or Digest?", December 18.

Bangladesh Times (1993), "Immense Loss in Soil Fertility Organic Fertilizer Rarely Used in Our Farmlands," June, 21.

Bartone, C.(1990), "Towards A Healthier Urban Environment," published in Special Report: The Urban Challenge, UNDP, New York, USA.

BBS (1993a), "Bangladesh Population Cencus 1991, Community Series, Zilla, Dhaka", Statistics Division, Ministry of Planning, Dhaka.

BBS (1993b), "Statistical Pocket Book of Bangladesh 1993", Statistics Division, Ministry of Planning, Dhaka.

Bhide, A.D.(1990), "Solid Waste Management at Dhaka, Khulna and Natore", WHO Project Assignment Report : BAN CWS 001, July-August.

Bhide, A.D & Sundaresan B.B.(1983), "SWM in Developing Countries", Indian Naional Scientific Documentation Centre.

Centre for Policy and Implementation Studies (CPIS) (1993), "Enterprise for Recycling & Composting of Municipal Solid Wastes, Vol I", Jakarta, Indonesia.

Cointreau, S.J.(1985), "Recycling from Municipal Refuse: A state of Art Review and Annotated Bibliography", World Bank Technical Paper, The World Bank, Washington D.C., USA.

Cointreau, S.J.(1986), "Environmental Management of Urban Solid Wastes in Developing Countries : A Project Guide,", The World Bank, Washington DC, USA.

CUS (1988), "Slums and Squatters in Dhaka City " A survey conducted for Dhaka Municipal Corporation".

DCC (1993),"Dhaka City Corporation Annual Budget, 1993-94".

Department of Environment (DOE) (1990), "Environment of Bangladesh and Department of Environment", a report published by DOE.

Devkota, R (1993), "Towards Special Reference to SWM Project In Katmandu," paper presented in the Regional Workshop on Urban Waste Management in Asian Cities, Dhaka, Bangladesh April 10-12.

Furedy, C.(1989), "Social Considerations in Solid Waste Management in Asian Cities", a paper published in Regional Development Dialogue, Vol.10, No.3, UNCRD, Nagoya, Japan.

Furedy, C (1990), "Social Aspects of Solid Waste Recovery in Asian Cities", Environment Sanitation Review, No.30.

Furedy, C.(1992), "Garbage: Exploring Non-conventional Options in Asian Cities", paper published in Environment & Urbanization, Vol.4, No.2, October, 1992.

GOB (1992), "Poribash Niti O Bastobayon Karjokrom", Ministry of Environment and Forestry, Dhaka.

GOB, ADB, UNDP (1981), "Dhaka Metropolitan Area Integrated Urban Development Project", Final Report.

Gotoh, S.(1989)" Issues and Factors To Be Considered For Improvement of Solid Waste Management in Asian Metropolises", a paper published in Regional Development Dialogue, Vol.10, No.3, UNCRD, Nagoya, Japan.

Haque, N.(1993), "Community Participation and Waste Management: Dhaka City" paper presented in the Regional Workshop on Urban Waste Management in Asian Cities, Dhaka Bangladesh, April, 10-12.

IFRD (1994), "Fixed Dome Biogas Plant", A booklet published by IFRD, BCSIR, Dhaka.

Islam, M.N.(1992a), "Dumping of Solid Waste, It is Dangerous for Dhaka City's Water Quality", The Telegraph, June, 27.

Islam, M.N.(1992b), "Regulatory Frame Work For Waste Disposal", The Telegraph, June,3.

Islam, M.N. (1992), "Environmental Impact of Greater Dhaka Flood Protection Embankment with Special Reference to Domestic Waste Disposal", unpublished M.Sc. Engg. thesis, Dept of Civil Engineering, BUET, Dhaka.

Islam, M.N. (1993), "Criteria For Land Filling Site" a paper presented in the Regional Workshop on Urban Waste Management in Asian Cities, Dhaka, Bangladesh, April, 10-12.

Islam, M.S.(1993), "Environment For Densely populated Areas of Bangladesh with Special Referece To Dhaka and Mymensingh", paper presented at Second International Congress of Asian Planning Schools, Centre of Urban Planning & Environmental Management, The University of Hongkong, August, 25-27.

Islam, M.S. and Nabi, A.S.M.M.,(1990), "Population of Dhaka City: Past, Present, and Future", Journal of Institute of Planners, Vol.1, Nos 1 and 2, pp. 27-35.

Islam, S (1994), "Solid Waste Management" Paper Presented In Workshop on Resource Waste: Source of Income, German Cultural Centre, Dhaka December 11-13.

Japan International Cooperation Agency (JICA) (1991), "Greater Dhaka Protection Project, FAP-8A", Draft Final Report.

Joseph, A.(1994), "Urban Garbage : Recognising the Removers", The Hindu Survey of Environment 1994, pp. 183-188.

Khan, A.R.(1994), "Goethe-Institut: A World Of Its Own", Dhaka Courier, January, Vol 10, Issue, 24, pp. 32-33.

Lardinois I, and Kivndert, A. (ed.), (1992), " Organic Waste, Options for Small Scale Resource Recovery, Urban Waste Series-I", Prepared by Waste Consultant, Amsterdam.

Lohani, B.N. (1986), "Environmental Assesment And Management Trends, Resource Requirements, And Strategies in Developing Countries", a paper presented in Regional Symposium on Environment and Natural Resource Planning, Manila, Phillippines, Feb, 19-21.

Louis Berger International, Accociated Consulting Engineers Ltd, Desh Upodesh Ltd, and Technoconsult International Ltd.(1991),"Dhaka Integrated Flood Protection FAP-8B", ADB Project Draft Final Report, ADB T.A. No. 1318-BAN, August.

Mehta, D., Raghupathi, U., and Sharma, R. (1994), "Urban Ecology: Squalor That Need Not Be", The Hindu Survey of Environment 1994, pp. 11-18.

Mobarak, R.(1993), "Health Problems Due to Urban Wastes in Dhaka City", paper presented in the Regional Workshop on Urban Waste Managemental in Asian Cities, Dhaka, Bangladesh, April, 10-12.

Obeng, L.A., and Wright, F.W., (1987), "The Co-composting of Domestic Solid and Human Wastes", World Bank Technical Paper No.57, The World Bank, Washington D.C., USA.

Ogwa, H.(1989), "Selection of Appropriate Technology for Solid Waste Management In Asian Metropolises," a paper published in Regional Development Dialouge, Vol.10, No.3, UNCRD, Nagoya, Japan.

Pandey, G.N. and Carney, G.C. (1992) " Environmental Engineering", New Delhi: Tata Mc Graw Hill Publishing Company Limited.

Panday, V.(1992), "Where it brooks no stigma to do a clean-up job", The Times of India, New Delhi, October, 3.

Paul, K.(1991), "Solid Waste Management in Bangladesh with Special Reference to The Situation in Dhaka, The capital of Bangladesh", country paper presented on informal consultative meeting on Solid Waste Management, New Delhi, India, October, 8-11.

Public Works Department (1993), " Schedule of Rates" Eighth Edition, Second Revision.

Peavy, H.S. and Rowe, D.R.(1985), "Environmental Engineering", Singapore: McGraw Hill. Publishing Company Limited.

Schertenleib, R.and Meyer, W.(1992a), "Municipal Solid Waste Management in Developing Countries: Problems and Issues; Need For Future Research", a paper published in International Reference Centre for Waste Disposal (IRCWD) News, No.26, March 1992, Duebendrof, Swizerland.

Schertenleib, R. and Meyer, W. (1992b), "Synergetic Effects of Municipal Solid Waste Collection, Recycling and Disposal", a paper published in International Reference Centre for Waste Disposal (IRCWD) News, No.26, March 1992, Duebendrof Swizerland.

Shamsuzzoha, M.(1993a), "Solid Waste Management in Dhaka City", Bangladesh Observer, September 8.

Shamsuzzoha, M.(1993b), "Solid Waste Management in Dhaka City-II", Bangladesh Observer, September 14.

Shukur, M.A. and Paul, K. (1993), "Final Disposal of Solid Wastes in Dhaka City" paper presented in the Regional Workshop on Urban Waste Management in Asian Cities, Dhaka April 10-12.

Siddiqui, K., Qadir, S.R., Alamgir, S. and Haq, S.(1993), "Social Formation in Dhaka City", Dhaka : University Press, pp. 34-39.

Sinha, A.H.M.M.(1993), "The Formal And Informal Sector Linkages in Waste Recycling: A Case Study of Solid Waste Management in Dhaka", unpublished M.Sc. Thesis, Human Settlement Division, Asian Institute of Technology (AIT), Bangkok, Thiland.

Suess, M.J.(ed.)(1985), "Solid Waste Management Selected Topics", World Health Organization (WHO), Copenhagen, Denmark.

The Telegraph (1993), "Biogas", December 18.

Trivedi, P.R. and Raj, G.(1992), "Solid Waste Pollution", New Delhi : Akashdeep Publishing House.

UDD, UNDP, UNCHS-Habitat (1985), "Dhaka Municipal Corporation, Finance Management Study", a report prepared by Cipfa Service Limited, London.

UNCHS (Habitat), GOB (1991), "Solid Waste Management Draft Technical Manual", prepared by Mott Mac Donald Ltd, Culpin Planning Ltd, Engineering & Planning Consultants Ltd.

UNCHS (Habitat) (1988), "Refuse Collection Vechicles For Developing Countries", Nairobi, Kenya.

UNCRD (1989), "Regional Development Dialogue", Vol.10, No.3, Nagoya, Japan.

UNDP (1993), "Bangladesh Urban And Shelter Sector Review", Final Report, May, 1993.

UNDP, UNCHS, GOB, RAJUK (1992), "Dhaka Metropolitan Development Planning (DMDP) : Waste Management Report", Prepared by Mott MacDonald Ltd. Culpin Planning Ltd., Engineering & Planning Consultants Ltd., Development Adminstration Group.

UNDP, World Bank (1991), "Indian Experience on Composting as means of Resource Recovery," report presented in Regional workshop on Waste Management Polices, Singapore, July 1-5.

UNDP (1991), "Alternative Approaches To Pollution Control and Waste Management: Regulatory and Economic Instruments", Urban Development Division, The World Bank, Washington DC, USA.

UNDP, UNCHS, GOB, (1985), "Housing Development Project, Subcontract 'A' Annex-V, Solid Waste Management", prepared by Consulting Engineers, Bongaerts, Kuyper and Huiswaard (BKH), Institute for Housing Studies, Culpin Planning and Aqua Consultant and Associates Ltd.

Wadood, A.(1993), "Effect of Urban Waste on Environment and Its Control", paper presented in the Regional Workshop on Urban Waste Management in Asian Cities, Dhaka, Bangladesh, April, 10-12.

WHO (1971), "Techn. Rep. Ser. No. 484".

WHO (1967), "Tech. Rep. Ser. No. 367.

World Bank (1991), "Environmental Assesment Source Book", Technical Paper Number 140, Vol.II, Sectoral Guidelines, Environment Department, Washington D.C., USA.

APPENDICES

Table A-1 Fly Borne, Mosquito Borne & Rodent Borne Diseases.

Fly Borne Diseases	Mosquito Borne Diseases	Rodent Borne Diseases
Typhoid	Dengue	Echinostomiasis
Bcillary dysentery	Filariasis	Plauge
Amoebic dysentry	Malaria	Rat bite fever
Diarrheas	Yellow Fever	Rat bite dermatitis
Asiatic cholera	Tularemia	Rat-tapeworm
Helminth infections	Melioidosis	infestion
Myiasis	Rift Vally Fever	Salivary-gland virus
Loiasis	Lymphocytic	intection
Onchocerciasis	choriomengitis	Sporotrichosis
Ozzard's filariasis		Relapsing fever
Yaws		Tularemoa
Tularemia		Rickettsial Pox
Bartonellosis		Murine ryphus
Cararrhal		Bilharziasis
Conjuctivities		Leptospirosis
Sandfly fever		Salmanellosis

Source: Trivedi, et.al. pp. 68-70.

Table A-2 Zone Wise Distribution of Man Power in DCC Area.

Zone	Conservancy Officer	CSI	CI	Cleaners
1. Jatrabari	1	2	11	450
2. Laxmi Bazar	1	2	11	745
3. Azimpur	1	2	10	476
4. Khilgaon	1	2	12	583
5. New Market	1	2	8	551
6. Kawranbazar	1	2	7	486
7. Mirpur	1	2	6	182
8. Mirpur	1	2	7	240
9. Gulshan	1	2	8	442
I0. Uttara	1	2	8	66
Total	10	20	88	4221

Source : Bhide, 1990.

Table A-3 Total Conservancy Vehicles of DCC.

Capacity ton	Covered Body	Open Body
5	23	25
3	13	34
2	-	25
1.5	-	39
Total	36	123

Source : UNDP, et.al., 1992.

Table A-4 Comparison Of Solid Waste Characteristics In Asian Cities.

City	Dhaka		Bombay	Colombo	Bangkok	Manila	Singapore	Kualalampur
Area(Km²)	344 #		466.35	37.3	1568.74	636	618.1	243
Population (m)	3.583(91) ##		8.243(81)	.615(87)	5.61(87)	7.56(88)	2.67(87)	1.04(80)
Refuse Comp. %								
Moisture	45.3 #		40	40	59.1	42.6	53.4	50.2
Combustible	20 #		22	33	35.7	33.8	32.8	41.4
Incombustable	34.7 #		38	27	5.2	23.6	13.8	8.4
Physical Comp % *	R/A	C/A						
Paper	5.68	7.22	10	11.1	13.9	14.5	28.3	11.7
Plastic	1.74	1.48	2	2.5	11	7.5	11.8	7
Metal			0.2	2.5	1.8	4.9	4.8	6.4
Glass	6.38	10.22	0.2	0.8	2	2.7	5.7	2.5
Cons. Material			-					
Textile	1.83	1.59	3.6	0.5	6.9	1.3	3	1.3
Food wastes	84.67	79.49	20	55.5	36.5	31.8	44.4	63.7
Wood/Grass			20	0.2	14.9	7.7		6.5
Ash/soil			38	24.1	12.6	6	2	0.09
Others			6	2.5	0.04	23.6		
Refuse Density kg/m³	Night time - 611 Day time - 550 ###		325	350	330	330	210	270
Calorific value	750-950 #		800-1000	1650	1130	1468	1388	750
Waste Generation kg/cap/day	0.5 #		.5-.6	.75	.88	.5	.98	1.29
Vehicles	159 **		744	100	773	532	277	38.4
Trans. rate (ton/worker/ day	0.17 ***		.6	7.5	.6	.97	1.5	
Avg. No. of Trip	1-2 **		2	3	1.8	2	2.59	1.5
Pop/Vehicle	22535***		11079	6150	7257	14210	9422	2708
Expd (US$/capt)	0.82 ***		7.6	12.9	2.1	4.8	20.4	2.3
Expd (US$/ton)	10.75 ***		54.7	49.6	7.7	32	56.6	4.6
Generation ton/day	1792 ***		3151	438	4932	3781	-	2000
Collection ton/day	750 ***		3151	438	4200	3123	-	2000

Source a) For column 2 compiled from the following sources :

Shukur, et. al 1993

BBS, 1993

UNCHS, et.al 1991.

* Ahmed, 1993

** UNDP, et.al 1992

*** Estimated by the researcher

b) For colums 3 to 8 : Furedy, 1990, P.6

Table A-5 : Major land use categories of Dhaka

Type of land Use	Area(Hectare)	Percentage
Residential	3520	19.3
Commercial	410	1.5
Industrial	340	1.2
Institutional	1630	5.9
Roads & others	2930	10.6
Village	1110	4.0
Agricultural	12370	44.9
Water Bodies	3430	12.5
Grand total	27540	100
Distribution:		
Urban use sub-total	10630	39.0
Rural Use sub-total	16910	61.0
Grand total	27,540	100

Source: Louis Berger, et.al 1991, P. 1-6

Table A-6 Land Use Pattern Of Privately Owned Land In And Around Dhaka City.

Name of Tahsil	Industrial/ Commercial (acres)	Residential Land (acres)	Agricultural Total (acres)	Total (acres)
Gulshan**	32.0	2513.0	16378.0	18923.0
Tejgaon*	260.0	542.0	29	831.0
Mohammadpur**	26.0	738.0	1267.0	2031.0
Mirpur**	258.0	1696.0	9242.0	11196.0
Demra**	259.0	2405.0	10462.0	13126.0
Lalbagh	320.0	929.0	-	1249.0
Sutrapur	208.0	486.0	-	694.0
Motijheel	52.0	777.0	-	829.0
Kotwali	107.0	171.0	-	278.0
Dhanmondi	254.0	1153.0	-	1407.0
Ramna	32.0	636.0	-	668.0
			-	
Grand Total	1808.0 (3.5%)	12046.0 (23.5%)	37388.0 (73%)	51242.0

Source : Siddiqui, et.al 1993, P.25.

** Considerable part of Tahsil is not included in the city Area

* A small part is not included in the city area.

We, a group of young and dedicated citizens of Dhaka, turn to you asking for your help and contribution to keep our city clean !

How ?

By making sure, that the garbage and waste from your household are always put into the proper place, provided by the city corporation.

By not turning a blind eye to garbage thrown just anywhere,

- # may be near your or your neighbour's doorstep because the dumping place is a few yards away;
- # at the lake shore behind your house, because nobody will see it;
- # not properly into or onto the dumping site, because nobody cares anyway.

We care. **PLEASE JOIN US !**

Modern life produces garbage at an always bigger rate. We must make sure that it will not spoil our surroundings with ugly sight and bad smell.

Garbage put into the proper place will be regularly cleared away, garbage just thrown anywhere will remain and endanger our health, apart from making our city an unpleasant place to live in.

WE WOULD LIKE TO DROP BY AND MEET YOU IN ORDER TO TALK ABOUT THE MATTER AND, MAY BE, HEAR FROM YOU ABOUT THE DIFFICULTIES YOU ENCOUNTER AND YOUR SUGGESTIONS TO BETTER THE SITUATION.

PLEASE RECEIVE US FRIENDLY !

WITH THANKS,

THE TASK FORCE

GERMAN CULTURAL CENTRE, GOETHE - INSTITUT DHAKA

House No. 23, Road No. 2, Dhanmondi R/A, Dhaka-1205

Telephone Nos. : 501879, 507325

নটঁর রূপকথা

পরিবেশকে সুন্দর ও পরিচ্ছন্ন রাখার প্রয়াসে ঢাকা লিট্‌ল থিয়েটারের নিবেদন

'৯৪—র রূপকথাঃ

একদল উচ্ছল শিশু–কিশোর খেলার ছলে গল্পের উপমায় আবিস্কার করে ফেলে এক চলমান সত্যকে। রূপকথার গল্পের মত কোন এক তিলোত্তমা নগরীর সমস্ত বোবা প্রাণী আর অবজেক্টগুলো হঠাৎ কি এক অজানা কারণে কথা বলতে শুরু করে মানুষের ভাষায়।

"মানুষের এইসব অত্যাচার আর সহ্য করা যায় না, এর একটা প্রতিকার অবশ্যই দরকার।" মানুষের বিরুদ্ধে মনে প্রাণে ক্ষিপ্ত সবাই। কি এত অপরাধ মানুষের? সাহসী পদক্ষেপ নিল ডাষ্টবিন। ডেকে বসল এক অতি জরুরী সভা। আমন্ত্রণ পেয়েই হন্ত দন্ত হয়ে হাজির হল সবাই। কুকুর, বেড়াল, কাক, ল্যাম্প–পোষ্ট, রাস্তা, গাছ এমনকি শহরের সবচেয়ে ক্ষুদ্র প্রাণী মাছিও।

তখন প্রায় মাঝ রাত, ঝক ঝকে রূপোলী চাঁদের আলোয় বসল তাদের আজব প্রতিবাদ সভা। কল্পণায় মানুষকে আসামীর কাঠগড়ায় দাঁড় করিয়ে এক এক করে সাক্ষী দেয় সমস্ত সভাসদ বৃন্দ ..... "মানুষের অসংযত আচরন অসহনীয়।"

এক সময় বাধাও এলো। কখনও কুকুর, কখনও কাক কখনও আবার মানুষ স্বয়ং। তবুও –– নানা বাধা–বিপত্তি আর বাদ–প্রতিবাদের মাঝেও তারা পেশ করল তাদের ৪ দফা দাবী। প্রয়োজনে অনশন ধর্মঘট করতেও দৃঢ় প্রত্যয় তারা। অথচ, তারা ভুলেও ভাবেনি বিদ্রোহ করতে পারে তাদেরই কোন সহকর্মী বন্ধু, জাগিয়ে তুলতে পারে তথা কথিত মানুষদের।

কিন্তু, ভাবনাকে ছাপিয়েও যেমন ঘটে যায় অনেক ঘটনা। তেমনি কোন অপ্রত্যাশিত অঘটন দিয়েই আমাদের রূপকথার গল্পের শেষ। কে জানে, নাটকের হয়তো এখানেই শুরু।

কিভাবে জড়িয়ে গেলামঃ

"ঢাকা লিট্‌ল থিয়েটার শিশু–কিশোরদের প্রতিষ্ঠান। কোন শিশু–কিশোরদের? যারা স্বপ্ন দেখে না, ভবিষ্যৎ দেখে। যারা নুতন সমাজ চায়, নতুন জীবন চায়।" কথাগুলো আমাদের কথা। আমাদের আদর্শের কথা। সুরতারং এ কথা আর বলাবার অপেক্ষা রাখে না যে, আদর্শগত বৈশিষ্ঠ্যের কারণেই নতুন প্রজন্মের জন্য একটি বাসযোগ্য পৃথিবী গড়ার লক্ষ্যেই আমরা স্বপ্ন দেখি না, দেখি নুতন জীবনের ভবিষ্যৎ।

'৯৩–এর আগষ্টে জার্মান সাংস্কৃতিক কেন্দ্রের সহযোগীতায় 'ঢাকা লিট্‌ল থিয়েটার' এক মাস ব্যাপী কর্মশালার আয়োজন করে। কর্মশালা শেষে সনদ বিতরণের দিন আমরা দুটি কর্মশালা প্রযোজনার সাথে একটি ছোট ইম্প্রোভাইজেশন উপস্থাপন করি। যার বিষয় ছিল, আমাদের পরিবেশ। ঐ দিন আমন্ত্রিত সকলের অকৃপণ প্রশংসা এবং স্বভাবগত মৌলিক আদর্শের অভিপ্রায়েই লিট্‌ল থিয়েটার পরিবেশ নিয়ে আরো বড় কিছু করার তাগিদ অনুভব করে।

Appendix B - 3

Composting process (Indonesian Type, Manual Method)

(Source : CPIS, 1993)

In this method of composting the operation takes place under a shed and about 40 days is requred for active composting. The land required for a typical 5 tɔn plant is 400 squaremeter. Figure B.1 shows the typical site layout. Different composting steps are described below.

a) Sorting

As soon as the waste arrives at the plant, the waste is separated by hand into recyclables, compostable and the residue. The residue is transported to the landfill. It should be noted that residue contains some organic materials such as coconut husks, banana stalks, wood and brush. These materials are not used in the composting process since they need to be chopped up inorder to decompose within 40 days. Such size reduction is generally not cost beneficial in manual method.

b) Pile Formation

The compostable organic waste is heaped into piles, which allows the beneficial micro-organisms to decompose the organic waste efficiently. Pile temperature above 65 degree celcius experiences reduced decomposition rates. To enable the micro - organisms to obtain sufficient oxygen, the pile is aerated using bamboo tunnels (figure B.2). Generally one pile contains an average of 2 tons of organic material. Composting pile arrangement is shown in fig B.3.

c) Watering

For rapid decompositing, the moisture content in the composting piles should be maintained at a level 40 to 60 (which corresponds to being able to squeeze a few drops of water out of handful of piled waste).

d) Turning

Compost pile temperature reflects the health and activity of decomposing organisms. In tropical environment it is relatively easy for the piles to reach excessively high temperatures. Turming along with the use of bamboo aerators, is the primary method used to maintain the pile temperature within optimum range. Temperatures can also drop below optimum ranges due to the need of the decomposing organisms for oxygen, water, or fresh organic material. Thus, turning, with associated watering, maintains the conditions for rapid decomposition. Turning also moves non-decomposed material from exterior of the pile into the pile interior, thus, providing a new food source for the bacteria. The critical indicator of when to turm the compost is the temparature of the pile. Turning the compost allows the quality control and sorting to continue throughout the entire composting process. Workers continueally remove items that are non-compostable and whose presence would reduce the quality of the final product.

e) Maturing

After 40 days, the material in the piles resembles soil, and the pile temperature cannot be maintained aboue 55 degrees celcius. In essence, decomposition is near completion thus the compost goes into curing or maturing phases during which the entire pile cools down to ambient temperatures and organisms that normally inhabit soil environment begin to reinoculate and spread through out pile material.

Figure B-1
Example of a Site Layout

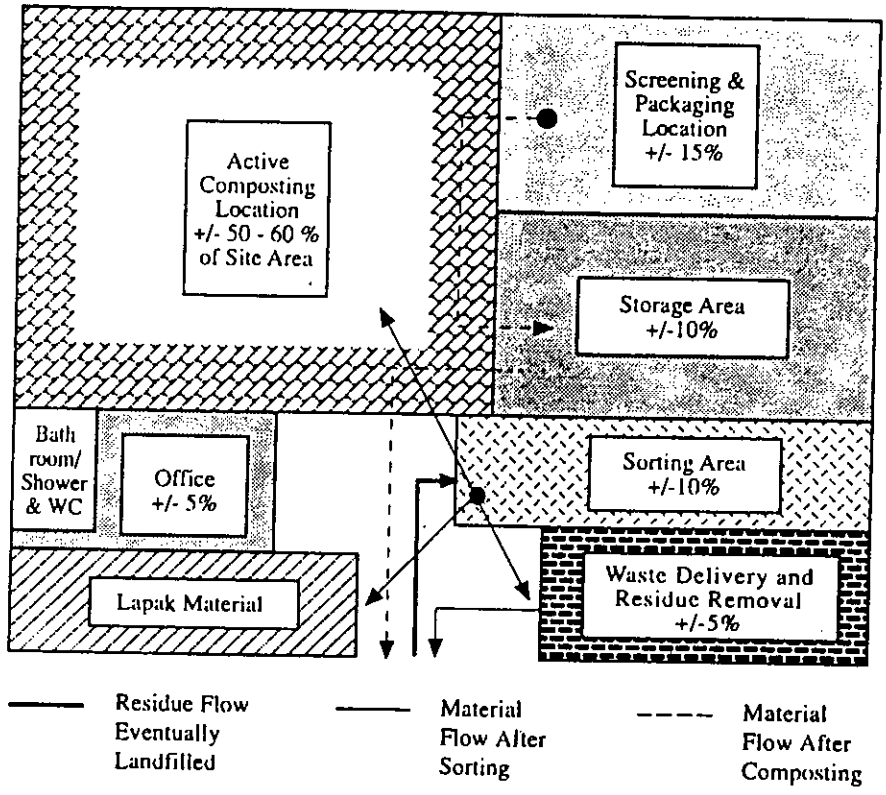
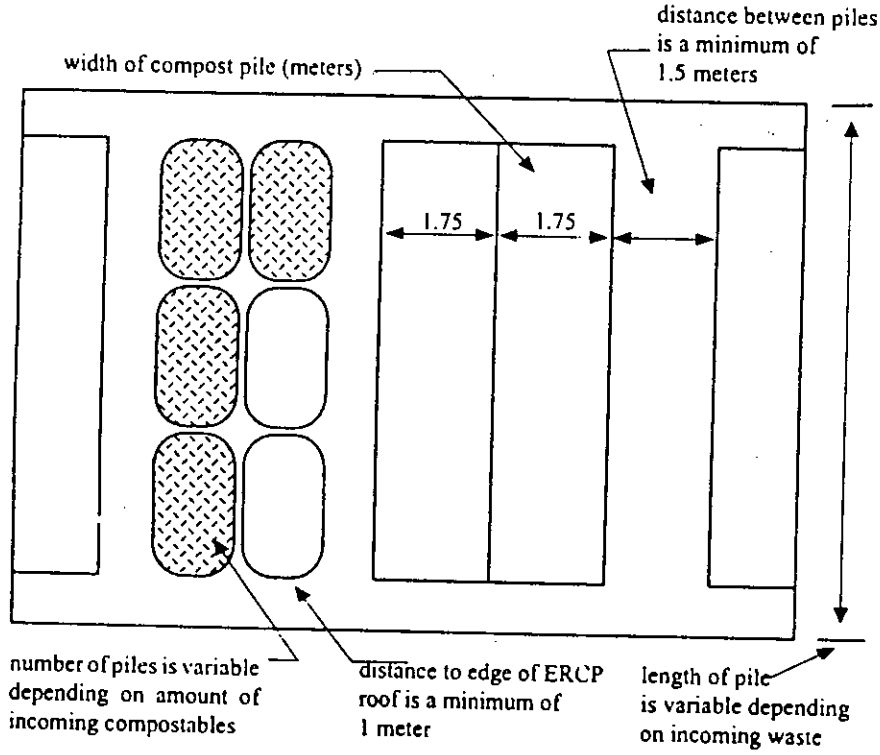
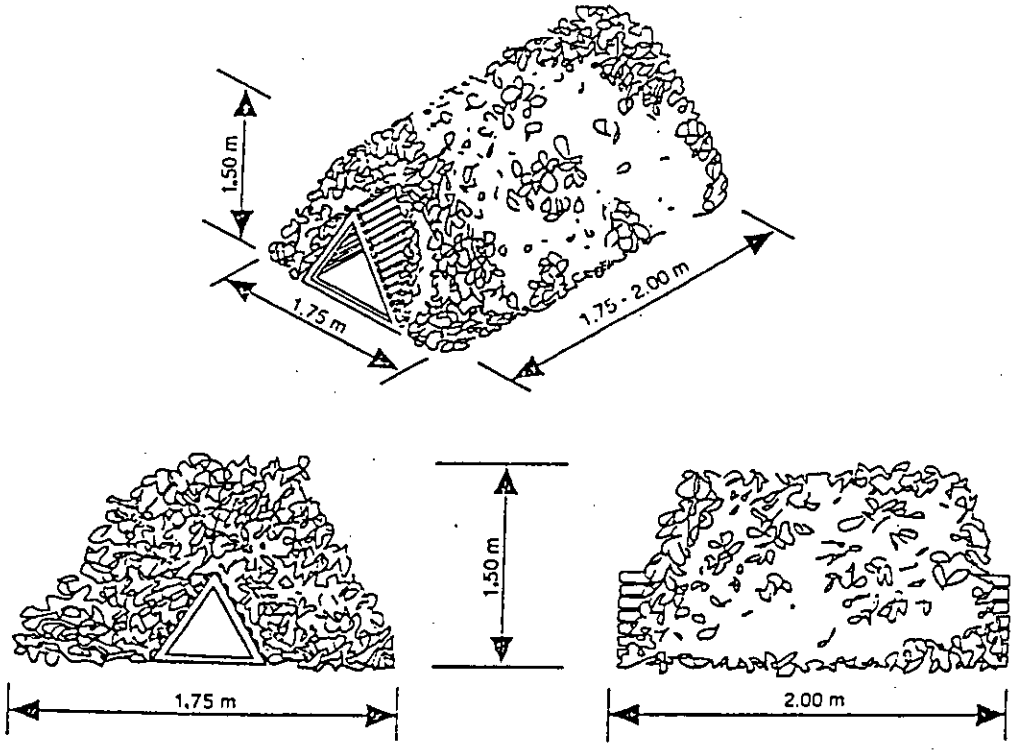


Figure B-2
Composting Pile Arrangement



The total volume of the material being composted is variable, depending on the difference in the length site. However, pile height averages 1.5 meters and pile length averages 1.75 meters.

Figure B-3
Aeration



Bamboo aerators were designed both to provide needed oxygen for aerobic organisms and to excessive high heat generated by the micro-organisms.

The construction of the aerator was based on providing the optimum requirements for the decomposers, but also by using indigenous, low cost materials

Appendix B-4

Composting Process Chinnese Type,

(Source : Obeng, et. al. 1987)

In this method of composting, refuse (70-80 percent by weight) and night soil (20-30 percent by weight) are mixed and heaped in piles 4 meters at the base, 2 meters at the top, 1.5 meter high and 4 meter long. Bamboo poles for aeration are inserted at 30 centimeter levels and removed on day two. The pile is sealed with a 40:60 percent soil-cinder paste. Temperatures of 50-55°C are achieved and maintained for 25 days.

Appendix C-1

Calculation Of Waste Collected Per Day By DCC

Out of DCC's total fleet of 159 trucks for collection and transportation of solid wastes, 63 (17 Nos of 5-ton capacity, 22 Nos of 3 ton capacity, 10 Nos of 2 ton capacity and 14 Nos of 1.5 ton capacity) remained idle being out of order

Waste collected by 96 trucks in operation :

1.5 ton x 25 trucks x 2 trips per day = 75 tons / day
2 ton x 15 trucks x 2 trips perday = 60 tons / day
3 ton x 25 trucks x 2 trips per day = 150 tons / day
5 ton x 31 trucks x 2 trips per day = 310 tons / day.

Waste collected per day = 595 tons/ day
say, 600 tons/ day

Assuming 25% over loading of trucks = 150 tons / day

Total waste collected per day by DCC = 600 + 150
= 750 tons / day

Appendix C-2

Calculation Of Space Requirements For Landfill Per Year At Dhaka.

Waste collected per day by DCC = .21 kg /cap / day
Population of DCC area = 35,83,000 (1991).

Total waste collected per day = 750 tons / day (with on truck density of 550 kg/ m^3).

(In Calcutta, refuse has on truck density of 550 - 600 kg/ m^3 on a non compaction truck, after disposal by open dumping where no compaction was performed, refuse consolidated to a density of 1100 kg/ m^3. (Source Cointreau, 1986, p. 13).

Density at Landfill after final settlement in Dhaka = 1100 kg/ m^3 (assumed).

Total waste collected per year = 750 x 1000 x 365 kg.

$$\text{Total volume of space required per year} = \frac{750 \times 1000 \times 365}{1100}$$

$$= 2,48,863.63 \text{ m}^3$$

$$= 202 \text{ acre - ft.}$$

Space available at Matwail is 37 acre with 5 m depth

Total space available at Matwail = 149719.07 x 5 m^3
= 748595.37 m^3

Per year space required = 248863.63 m^3

$$\text{Life of the site} = \frac{748595.37}{248863.63} = 3 \text{ years}$$

Appendix C-3

Estimate Of Manual Compost Plant (5 ton / day capacity) on DCC Or Govt Land

1. Construction cost of C.I. sheet shed covering 400 m^2 with R.C.C. columns, timber rafters and purlins, plinth wall all around, filled with carted earth and topped with brick flat soling, complete with necessary anchor bolts, J-hooks, ridging and wind ties. @ TK 1116/- per square meter (Based on latest PWD Schedule of Rates of October, 1993).

   400 m^2 x TK 1116/ : TK 4,46,400/-

2. Cost of Rickshaw van for collection of wastes 5 Nos (2.5 m^3 capacity each) @ Tk 10,000 per van

   5 Nos x Tk. 10,000/- : Tk. 50,000/-

3. Labour Cost :
   (For collection of wastes), 15 Nos,
   @ Tk. 40/- per head for 365 days.

   15 Nos x 365 days x TK 40/- : Tk.2,19,000/-

   Total cost of production of compost @ 5 ton / day for first year : Tk.7,15,400/-

A) Cost for Production of 1 ton of compost for the first year = $\frac{\text{Tk. } 715,400}{5 \times 365}$

   = Tk. 392/-

B) Cost of production of 5 ton of compost per day for second and subsequent years = TK. 2,19,000/-

Therefore cost of production of 1 ton of compost for second

and subsequent years

$$= \text{Tk. } \frac{2,19,000}{5 \times 365}$$

$$= \text{Tk. } 120/-$$

C) Assuming the project life of 5 years average cost of production per ton of compost

$$= \frac{\text{Tk. } (392 + 4 \times 120)}{5}$$

$$= \frac{\text{Tk } 872}{5}$$

$$= \text{Tk. } 175/-$$

QUESTIONNAIRE SURVEY ON
A STUDY OF SOLID WASTE MANAGEMENT FOR ENVIRONMENTAL IMPROVEMENT OF DHAKA CITY

Dept. of Urban & Regional Planning
(BUET), Dhaka.

Household Case No ☐☐☐ 1-3

Area Code : ☐☐ 4-5

Date of Survey :

Name of the Respondent :

Address of the Respondent :

1. Total Family Members : ☐☐ 6-7

2. Information Relating the family :

Serial Number	1	2	3	4	5	6	7	8	
Age									8-15
Sex									16-23
Educational Qualification									24-31
Occupation									32-39

Age:	Sex:	Educational Qualification	Occupation
1. 0 - 4	1. Male	1. Illiterate	1. Govt. Service
2. 5 - 9	2. Female	2. Primary	2. Private Job
3. 10 -14		3. High School	3. Bussiness
4. 15 -17		4. S.S.C.	4. Student
5. 18 -34		5. H.S.C.	5. Housewife
6. 35 -59		6. B.Sc & Above	6. Retired Service Holder
7. 60 & above.			

3. What is your monthly Income ? ☐☐☐☐☐☐ 40-45

4. What is your monthly Expenditure ? ☐☐☐☐☐☐ 46-51

5. Is present SWM system of your area polluting the environment ?

☐ 52

1. Yes 2. No.

6. If 'Yes', what are the three main reasons.

	Code	53-55
* Offensive odour from scattered solid wastes all over the area due to lack of dustbin	1	
* Waste is not properly removed from the area	2	
* Waste is disposed in drains	3	
* Waste is scattered outside the bin	4	
* Waste is disposed on road side	5	

7. Who disposes your domestic solid waste ?

	Code	56
* Servant	1	
* Family Member	2	
* Waste is collected from house by DCC sweepers	3	
* Collected by private person engaged by the area	4	

8. Where do you dispose your domestic Solid waste ?

	Code	57
* Dustbin	1	
* Due to absence of dustbin in the area waste is disposed on road or drain side.	2	
* In a vacant lot	3	
* In own compound	4	
* Do not know where waste is disposed	5	

9. What problems do you face while disposing solid waste ?

	Code	58-59
* Absence of dustbin in the area	1	
* Dustbin is not easily accessible	2	
* Dustbin is not in appropriate location	3	

* Dustbin is not within walking distance 4

* Offensive odour near the dustbin 5

* Lack of manpower for waste disposal 6

10. How much money do you spent at present exclusively for solid waste disposal (Per month) ?

Code ☐ 60

* No money 1

* Tk 1-10 2

* Tk 10-20 3

* More than Tk 20 4

11. How would you rate the present SWM system of DCC

Code ☐ 61

* Good 1

* Fair 2

* Poor 3

* Unsatisfactory 4

12. If unsatisfactory, what are the main two reasons?

Code ☐☐ 62-63

* Waste of the area is not removed daily 1

* Road and drain not properly cleared 2

* Waste is collected in open trucks 3

* There is no dustbin in the area for waste disposal 4

13. What is your frequency of waste disposal ?

Code ☐ 64

* Daily 1

* Alternate Day 2

* Every two days 3

14. What material do you use for waste disposal ?

	Code	65
* Polythene packet	1	
* Small Bucket	2	
* Others (Specify)	3	

15. When do you dispose your domestic waste ?

	Code	66
* No Fixed Time	1	
* Between 6AM - 6PM	2	
* Between 6 PM - 10PM	3	

16. What is the frequency of waste collection from your area by BCC ?

	Code	67
* Daily	1	
* Alternate day	2	
* Every two day	3	
* Irregular	4	

17. What time does DCC collects wastes from your area?

	Code	68
* Morning	1	
* Afternoon	2	
* Evening	3	
* Night	4	
* No fixed time	5	

18. What are the type of items which you generally place for disposal ?

	Code	69-73
* Kitchen & Vegetable Wastes	1	
* Paper Wastes	2	
* Plastics	3	
* Glass (Broken)	4	
* Metal / Tin items	5	

19. Do you seperate your kitchen & Vegetable wastes from other wastes (old newspapers, old khatas, books etc) ?

1) Yes 2) No ☐ 74

20. If 'yes,' then what kind of items do you separate ?

	Code	75-7
* Newspaper, old books, magazines, khatas	1	
* Plastic Material	2	
* Glass Bottles	3	
* Rubber Items	4	
* Metal / Tin Hens	5	

21. Do you sell the separated items ? ☐ 6

1) Yes 2) No

22. What is the frequency of selling these items ?

	Code	7
* Every month	1	
* Every two month	2	
* More than two month	3	

23. Whom do you sell these items ?

	Code	8
* Hawkers	1	

* Shops 2

* Others 3

24. What problems do you face due to improper disposal of solid waste in your area (any four according to your priority) ? Code 9-12

* Blockage of open drains with wastes 1

* Clogging of sewerline with wastes 2

* Encroachment of road ways by disposal of garbage on roads 3

* Offensive odour from uncollected wastes from drain or dustbin 4

* Presence of disease vectors (mosquitoes/Flies) due to indiscriminate disposal of wastes in the area 5

* Degradation of environment due to indiscriminate disposal of wastes in the area 6

25. Which of the following disease vectors are found in solid waste ? Code 13-16

* Flies 1

* Mosquitoes 2

* Cockroaches 3

* Rodents 4

* Do not know 5

26. Which of the following diseases are related to solid waste ? Code 17-21

* Fever (Typhoid) 1

* Dysentry 2

* Malaria 3

* Viral hepatitis 4

* Conjuctivities 5

* Do not know 6

27. Do you think the present design of waste disposal bin is satisfactory ? ☐ 22

1) Yes 2) No.

28. If 'no', then, what type of communal bin should be provided ?

29. What type of collection system do you prefer for disposal of your household waste ? Code ☐ 23

* Community Bin	1
* House to House Collection	2
* Block Collection	3
* Curb side Collection	4

30. If waste is directly collected from your house, how much you are willing to pay ?

Code ☐ 24

1. Tk. 10	1
2. Tk. 20	2
3. Tk. 25	3
4. Tk. 30	4
5. Tk. 40	5
6. Tk. 50	6
7. No contribution	7

31. If waste is directly collected from your house, what frequency would you prefer ?

Code ☐ 25

* Daily	1
* Alternate day	2
* Twice week	3

32. What time do you prefer if waste is collected from your house ?

Code ☐ 26

* Morning	1
* Afternoon	2

* Evening 3

* Night 4

33. Do you know that organic manure can be made from kitchen & vegetable waste, which is environmentally friendly and does not degrade the soil fertility unlike chemical fertilizer. ?

1) Yes 2) No ☐ 27

34. Do you want to use this organic manure in your garden or flower pot.?

1) Yes 2) No ☐ 28

35. Do you like to seperate your kitchen & vegetable wastes of your house with other waste ?

1) Yes 2) No ☐ 29

36. If 'No', then in case a container or plastic bag is supplied, would you like to seperate kitchen & vegetable wastes with other wastes ?

1) Yes 2) No ☐ 30

37. Do you agree that in order to improve the solid waste management system and overall environment of your area, peoples participation is essential ?

1) Yes 2) No ☐ 31

38. Do you have any idea about Community Based Organizations (CBOs) ?

1) Yes 2) No ☐ 32

39. Is there any such organization in your area ?

1) Yes 2) No ☐ 33

40. If 'yes', please describe :

41. Do you like to participate in Community Based Organizations (CBOs) to improve the waste disposal system & over all environment of your area ?

1) Yes 2) No ☐ 34

42. Which of the following media do you think can help educate people about solid waste problem, its proper disposal and environmental awareness (any four acording to your preference) ?

	Code	☐☐☐☐ 35-38
* Newspaper	1	
* Radio	2	
* TV	3	
* Leaflet	4	
* Poster	5	
* Teaching in School and colleges	6	

43. In your opinion how waste disposal at proper place can be achieved?

	Code	☐ 39
* By enforcing proper laws	1	
* By community participation	2	
* By awaring people by DCC	3	

44. In order improve the waste management of your area are you willing to spend some money ?

1) Yes 2) No ☐ 40

45. If 'yes', then how much ? ☐☐☐ 41-43

46. According to your opinion which of the following civic services in your area should be improved (any three according to your priority).

	Code	☐☐☐ 41-43
* Water	1	
* Electricity	2	
* Solid Waste Management	3	
* Gas	4	
* Open Space	5	

47. Any suggestion regarding improvement of swm of your area:

48. Any suggestions regarding improvement of SWM of Dhaka city:

FOR DCC

QUESTIONNAIRE SURVEY ON A STUDY OF SOLID WASTE MANAGEMENT FOR ENVIRONMENTAL IMPROVEMENT OF DHAKA CITY

Dept. of URP, BUET,Dhaka

1. How big is your solid waste collection area of DCC ?
2. What is the population of DCC area ?
3. Do you know how much waste is generated daily by the residents for which DCC is responsible? If yes, how much?
4. In your estimate what percentage of the daily waste generated is collected and subsequently disposed?
5. What type of equipment do you use for collection and haulage of solid waste?
6. How many vehicles do you have for solid waste collection?
7. How many vehicles are out of order?
8. How many shifts do you work with vehicles and how many trips they make in a day?
9. How many workers are engaged in the collection and disposal of solid waste?
10. How much waste is collected and transported daily?
11. How many days a week the collected quantity is handled?
12. What methods are used for collection of waste?
13. How many dustbins are provided by DCC?
14. How much money is spent each year by DCC on solid waste management?
15. What percentage of the municipal budget is spent on conservancy?
16. Do you dispose of solid waste by open dumping or sanitary landfill or other methods?

17. Do you have any Criteria for selection of landfill site?

18. Are there large accumulations of uncollected solid waste in DCC area? If so, where?

19. On a typical working day, what percentage of the usable fleet goes out of order?

20. Is there any incentives for workers to obtain maximum collection effort?

21. What type of "upward mobility" opportunities are available to collection workers? Can they advance to become Drivers, Supervisors etc?

22. Is any training imparted to the conservancy staff and workers?

23. What opportunities for recycling and resource recovery are available at present and what are other opportunities in your area?

24. Is there any existing law for solid waste management?

25. If so, do you think the law is adequate to protect environment and provides DCC enough power to control solid waste pollution?

26. What in your opinion are the major problems which DCC is facing at present with regard to solid waste management?

27. Do you maintain data regarding waste generation rate waste characteristic and leachate characteristic of your area?

Particulars of the Respondent

Name :

Designation :