

# Integrated approach of solid waste management to achieve urban sustainability : Asoam experoemce -Case study of Namgkok and Dhaka City

メタデータ	言語: eng 出版者: 公開日: 2017-10-05 キーワード (Ja): キーワード (En): 作成者: メールアドレス: 所属:
URL	<a href="http://hdl.handle.net/2297/6005">http://hdl.handle.net/2297/6005</a>

## **Integrated Approach of Solid Waste Management to achieve Urban Sustainability: Asian Experience - Case Study of Bangkok and Dhaka City**

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**Abstract - Urban development in the Asian region is faster than ever and due to rapid urbanization city managers are experiencing diverse problem, solid waste management is one of them. Unsustainable management of solid waste causes urban environmental quality deterioration in most of the cities of developing Asia. Sustainable management of solid waste of a city can only improve the urban environmental quality to achieve urban sustainability. Bangkok Metropolitan Administration (BMA) is responsible for management of solid waste of Bangkok Metropolitan area, while Dhaka City Corporation (DCC) is responsible for Dhaka Metropolitan area. BMA has taken necessary measures to improve urban environmental quality by adopting modern strategy and technology for solid waste management and directing towards further improvement to make sure urban sustainability. DCC's existing practice of solid waste management is deteriorating urban environmental quality. It will be further deteriorated if timely measures such as sustainable management strategy and modern technologies are not adopted. Integrated approach of solid waste management of Bangkok and Dhaka Metropolis could only help to improve further the urban environmental quality and to achieve urban sustainability.**

### I. Introduction

Rapid urbanization and growth of urban populations has become a major concern to urban planner and policy maker. At present, about 1.6 billion live in the developing countries as the City's in the developing countries are growing faster than ever. About 37% of the urban population of the developing countries, at least 600 million people live in an environment that pose a threat to health. It is estimated that by 2015, 23 cities in the world will have population more than 10 million. In the developing countries each and every year number of city dwellers increasing and incremental addition of population put diverse impact on urban ecosystem in many ways such as accommodation, transportation, food, water and sanitation, solid waste management and other ecosystem services. It has been estimated that in next 25 years 2 billion people will move to cities. City authority has to put lot of effort to ensure goods and services to the newly entered city dwellers.

Asian Cities are growing faster due to infrastructure development to accommodate population migrated in the city to avail the opportunities exist in city such as job, educational institutions, hospitals, accommodation, better transportation, water supply & sanitation facilities, electricity supply, safety and security. Rapid population rise in the city due to migration, as well as city dwellers life style change, socio economic condition and behavioural change causes enormous increase of solid waste production in the city which put lots of pressure on city managers with regards to proper disposal of solid waste. Similar problem is experiencing in cities of most of the developing countries, least developed countries (LDCs)

and countries of transition in different continent. Thus far this paper, discussion will be restricted to Asian countries. Most of the Asian cities are experiencing similar trends of rapid urban development and facing problem in solid waste management. Among them, two mega cities were chosen to represent developing Asia those are Bangkok and Dhaka City. In this paper, both cities development, solid waste generation trends, existing solid waste management practices, problem experiencing in solid waste management will be highlighted. Finally, set of recommendation will be provided to improve solid waste management practices and to resolve existing problem in solid waste management those are detrimental to urban ecosystem with an aim to achieve urban sustainability.

## II. City Development and Waste Generation Trends in Bangkok and Dhaka Metropolis

### A. Bangkok Metropolis

Bangkok Metropolis was established in 1782 as the new capital of Thailand by King Rama I, the First Monarch of the Chakri Dynasty on flood plain along the Chao Phraya River with a consideration as the natural defense from the enemy and at that time the total area of the Bangkok city was only 4.14 square kilometers. In 1900, the area of Bangkok city was 18 sq km and hosted 600,000 population [1]. After 2<sup>nd</sup> World war, city growth rapidly and people migration rate rises rapidly due to huge investment in the infrastructure and public utilities in Bangkok. Bangkok city population was 1.6 million in 1958, while it increased to 5.4 million in 1986 and 5.6 million in 1999. The total area of Bangkok Metropolitan is now about 1,568.737 sq km housing population of 5.77 million [2].

Solid waste generation in Bangkok city is increasing with the rise of population. In 1985, the amount of solid waste generated in Bangkok was 3,260 ton/day that turns to double in 1995 with an amount of 6,633 ton/day [3]. The average amount of solid waste generation in Bangkok in 2002 was approximately 10,185 ton/day with a per capita generation rate at 0.80 to 1.0 kg/person/day. But, BMA collected 9,600 ton/day which was 94.25% of the total waste generated and rest of the waste remains in the city (BMA, 2002). Among the collected waste, the amount of non-hazardous industrial waste was 58.353 tons/day. Beside these, BMA also collected infectious hospital waste from Bangkok City which was about 15.41 tons/day [4].

Based on physical composition, solid waste generated in Bangkok Metropolitan can be divided into two categories such as combustible and non-combustible. Combustible waste include paper, textiles, plastic and foam, wood and leaves, garbage, leather and unclassified; while non combustible waste include metal, glasses, stone and ceramic, bones shells.

The trends of combustible and non-combustible solid waste generation in Bangkok Metropolitan area are shown in Fig. 1. Increasing trend of combustible solid waste generation of Bangkok Metropolitan was observed from 1991 to 1995 than dropped in 1996, but increasing trends continue until 1999, while decreased again in 2000. On the other hand, declining trends of non-combustible solid waste generation observed until 1995, while suddenly increased in 1996, but again declining trends continue until 1999, while increased trends observed in 2000.

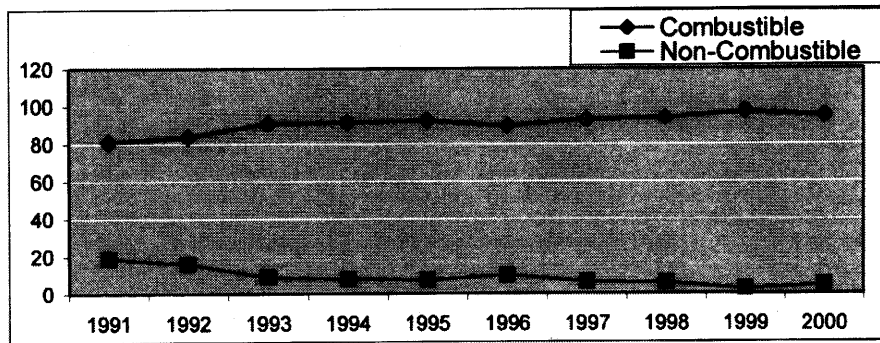


Fig. 1: Trends of combustible and non-combustible waste generation in Bangkok Metropolitan from 1991-2000 [3]

### B. Dhaka Metropolis

Dhaka is the capital city of Bangladesh and experienced rapid urbanization in the last half century (50 years). In 1951, Dhaka City's area was only 73 sq km with a population of 335, 928 [5]. City's population rose suddenly to about 1,500,000 after the independence of Bangladesh on December 16, 1971 and in 1974 it was about 16,100,000. At present Dhaka turns from a large town to megalopolis of over 9.3 million with an area of 1530 sq km.

The Dhaka Metropolitan area includes Dhaka City Corporation (DCC) area and five other adjacent municipalities. DCC area is about 360 sq km and housing about 6 million population [5,6]. Dhaka City Corporation is responsible for the management of solid waste generated within its jurisdiction, while five municipal authorities is managing waste generated within their own municipalities. Rapid urban development, fast growth of population and increase of consumption, the amount of solid waste generation in Dhaka City gradually increasing. The amount of waste generated in 1985 was 1040 tons/day, while in 1990 it was 1776 tons/day and in 1998 was 2398 tons/day. The gradual increase of waste generation continued and in 1999, it was 3,500 tons/day and in 2002 was 4,00 tons/day [5,6,7]. At present, Dhaka City generating 4,000 tons of solid waste per day with a per capita generation 0.5 kg/day (Ali, 2001; Kazi, 2001 and DCC, 2002). According to joint study of JICA and DCC, if the present growth of population and city development continue, waste generation will also increase and by 2010, waste generation in Dhaka City will be 10,000 tons/day, which might be reached to 40,000 tons/day by 2025 [5,7,8].

In Dhaka City, household waste is augmented by over 1,000 industries of various nature and capacities including 149 tanneries, about 500 hospitals and clinics, and construction wastes [6]. Waste generated from these different sources as well dump with household waste though they contains huge amount of toxic chemicals, pathogens and infectious diseases as there is no separate collection system exist so far exist in Dhaka City. The major sources of solid waste in DCC areas are from the residential areas, commercial establishment, industries, hospitals and city streets [6,7].

### III. Solid Waste Management Practices in Bangkok City

According to Bangkok Metropolitan Administration Rule for Solid Waste and Sewage Management in Buildings, Places and Public health Service Facilities, B.E. 2545 (2002) [9]; The Public Health Act, B. E. 2535 (1992) [10]; The Public Cleanliness and Orderliness Act, B. E. 2535 (1992); The Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (NEQA 1992) [11] and

The Factory Act, B. E. 2535 (1992) [12], Bangkok Metropolitan Administration (BMA) is responsible for the solid waste management of Bangkok Metropolitan area. Besides non hazardous waste, BMA is also responsible for the collection and disposal of hazardous household and infectious hospital waste. Ministry of Industries is responsible for the management of hazardous industrial waste generated from industries and non-hazardous industrial solid waste is managed by BMA.

*A. Non hazardous solid waste Management*

The solid waste management by BMA can be divided into two components such as solid waste collection and disposal. The process of solid waste management in Bangkok Metropolitan is shown in Fig. 2.

*Solid Waste Collection*

The Public Cleansing Service Division of the Public Cleansing Department of BMA is responsible for over all supervision and the Public Cleansing and Public Park Section of 50 District Office of BMA are responsible for collection and transportation of solid waste from Bangkok Metropolitan area to transfer station. BMA applied both direct and indirect approach of collection of solid waste.

*Direct approach* of solid waste collection include solid wastes were collected by vehicles and boat from door to door of houses in various part of the city where accessible by road or by boat. If the road/boat is not accessible, residents of that locality need to carry the solid wastes to waste collection vehicles in certain day of particular time

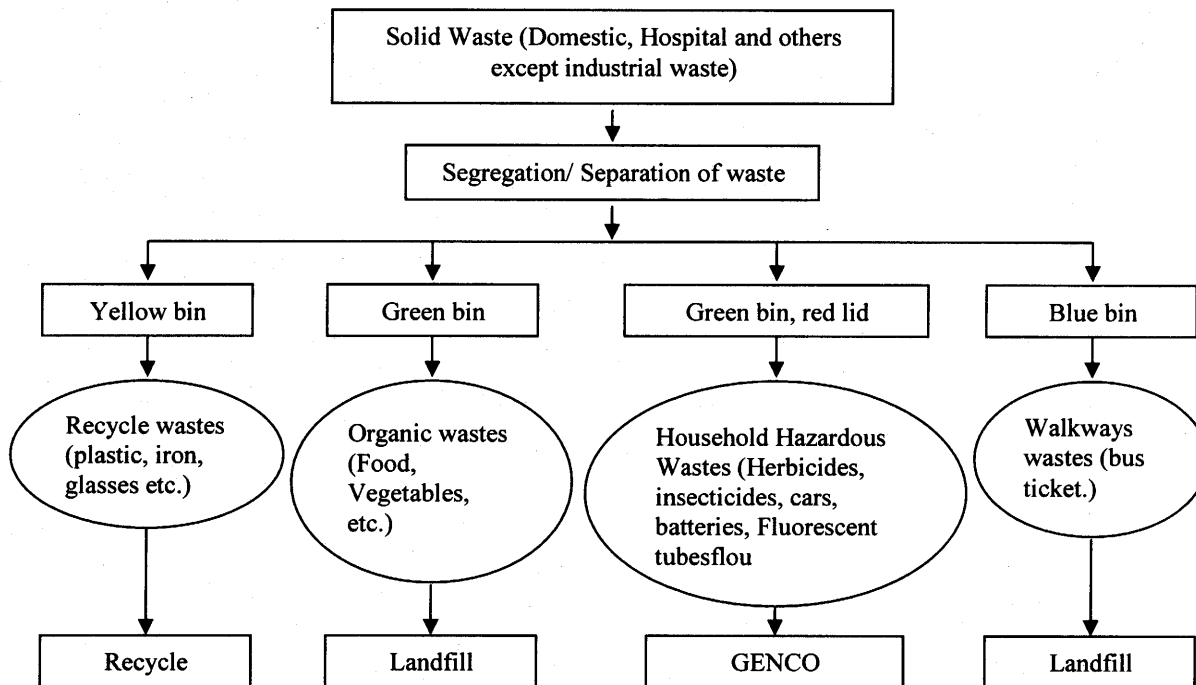


Fig. 2: Solid waste management processes of Bangkok Metropolitan Administration [3]

*Indirect approach* of solid waste collection is a system that BMA placed dustbin in designated areas and along the road for collection of waste from various sources such as market, departmental stores and pedestrian walkways. Plastic bags are selling at the super market and department stores is marked as this plastic will be used for dropping this type of waste. Moreover, four types of dustbins were places along the street in some part of the city those are as follows:

- i) Yellow bin for recyclable wastes (plastic container, glasses and iron etc.);
- ii) Green bin for dropping organic waste (food, vegetable, etc.);
- iii) Grey bin with red lid for dropping hazardous house hold waste (herbicides and insecticides cans, batteries, fluorescent tubes); &
- iv) Blue bin for dropping walkways waste (bus ticket)

The number of bin provided by the BMA in different part of Bangkok Metropolitan area to drop solid waste is shown in TABLE 1. A total of 49,317 bins (excluding blue bin for dropping bus ticket) were provided by the BMA in Bangkok Metropolitan area [3,4].

TABLE 1  
Categories of waste bin supplied by the BMA in Bangkok Metropolitan area to drop waste

Type of bin	Capacity (litre)	No./Unit
Open Waste bin	18	5,790
Open Waste bin	120	20,000
Open Waste bin	240	19,061
Green and Yellow bin		3,466
Grey with Red lid bin		1,000
Blue bin		NA
Total		49,317

The collection of solid waste from Bangkok Metropolitan is following two steps such as collection of waste from city and transport to transfer station and than transport those waste from transfer station to sanitary landfill or compost plant. Primary collection of waste entails collection of waste and transportation of waste from collection points to transfer stations and this is directly conducted by BMA.

A total of 2,732 refuse collection vehicles are owned by BMA. BMA refuse collection vehicles are consist of compactor trucks, skippers, dump trucks, roll-on roll-off trucks, in addition to containers equipped with a compaction device [4]. A total of 2,127 drivers and 7,605 waste collection workers are engaged in solid waste collection and transportation of solid waste from the collection point to transfer station in Bangkok Metropolitan [3,4].

A total of 276 boats of different capacity are also employed to collect waste from the household nearby riverside in Bangkok where roads are not accessible to vehicles [4]. The size of the boat and number of boat engaged in solid waste collection is given in TABLE 2.

TABLE 2  
Number and size of the boat engaged in solid waste collection in Bangkok Metropolitan area

Size of the boat	Number/Unit
Large size Boat (in Chao Phraya River)	2
2 X 6 meter (in small canals)	138
2 X 8 meter (in small canals)	136

#### Transfer Station

Transfer station is the place where collected solid wastes were dumped at the transfer station before load to big trucks or trailer or semi-trailer to carry to sanitary landfill. There are three transfer stations which are located in the district of On-Nuch, Tha Raeng and Nog Khaem. Unload of waste from the truck of BMA at the transfer stations and loading waste into a large trailer is the responsibility of BMA. Transportation of waste by large trailers from transfer station to sanitary landfill sites for final disposal is the responsibility of private contractor.

When BMA garbage collection truck arrive at the transfer station to unload, they have to be weighted at the entrance of transfer station before go to the second floor to unload waste either at the transfer site or into big truck (trailer/semi-trailer). After unloading, empty garbage collection truck again have to be weighted before leave the transfer station to know the quantity of waste dump at the transfer site by that garbage collection truck. Scavengers are engaged at the transfer station to separate recyclable materials from the biodegradable waste immediate after dump from the BMA garbage trucks. Similarly, empty big truck (trailer/semi-trailer) also weight while enter to transfer station to load waste. Big trucks (trailer/semi-trailers) were placed on the ground floor and waste from the 1<sup>st</sup> floor were pour into trailer through a hole. After loading waste and before departure from the transfer station for final disposal at the landfill sites full big truck (trailer/semi-trailer) have to be weighted again to know the quantity of waste carried to final disposal site (sanitary landfill). When the big truck is full with waste, impermeable canvas is used to cover the waste to prevent spilling of waste along the way.

#### Disposal of Non-Hazardous Solid Waste

Two types of non-hazardous solid waste disposal system exist at present for final disposal of BMA collected solid waste and those are composting and sanitary land filling.

#### Compost Plant

There is a compost plant located in On-Nut which is a activated sludge treatment plant. The capacity of compost plant at On-Nut is 1,200 tons/per day. Unfortunately, this plant is not functioning for long 5 years due to major break down and necessary steps were taken to make it functional, but it will take significant time to do so. There is a plan to construct another compost plant at Nong-Khaem near future.

#### Sanitary Land filling

It was mentioned earlier that there are three solid waste transfer stations operated by BMA located in On-Nuch, Nong Khaem and Tha Raeng. These wastes are carried to Sanitary landfill sites [Rachathew and Kampaengsaen (1) and Kampaengsaen (2)] from transfer stations. BMA contracted transportation of waste from waste transfer station to sanitary landfill sites to three private companies since November 2002

those are Pairoj Compong Panich Co. Ltd., Wasaduphan Tutakit Co. Ltd. and Group 79 Co. Ltd. These three companies are owned by same person/group as they use the same human resources, equipments, headquarter/offices and their landfill sites also the same. These three companies transported wastes from transfer stations to sanitary land fill sites. The capacity of the Rachathew landfill site is 7.5 million cubic meter and operation started since July 2000. At present, daily 3,800 tons wastes were brought to this site from On-Nuch transfer station. Rachathew landfill site is expected to reach its capacity limit by July 2004 [3,4].

In both sites of sanitary landfills proper mechanism of lechate collection and treatment of lechate are exist. In order to collect lechate, PVC pipes covered by textile is laid on the sand protection layer on the permeable liner. Collected lechate is pumped up and than redirect to the pond for treatment. After treatment lechate used to spray on waste at the landfill sites. Land fill area is surrounded by open drain to intercept run off water and inflow to minimize lechate generation. An HDPE layer laid on the final layer of waste to prevent run off water infiltration and there by minimize lechate generation.

### *B. Hazardous solid Waste Management*

#### Hazardous Household and Industrial Waste Management

Hazardous waste household origin include fluorescent tubes, batteries, insecticides and herbicides can etc., while industrial origin includes solvent, batteries, heavy metals and sludge chemicals etc. and hospital waste included infectious, sharp and pharmaceuticals. As mentioned earlier, management of hazardous industrial waste is the responsibility of Ministry of Industries. General Environmental Conservation Public Company Limited (GENCO) is responsible for disposal of hazardous industrial waste. BMA placed grey bin with red lid at appropriate place of the city to drop hazardous household waste. Public Cleansing and Public Parks Section of each district office of BMA collect and transported to three transfer station sites and stored there before transport to General Environmental Conservation Public Company Limited (GENCO) for final disposal. The process of hazardous waste management in Bangkok Metropolitan is shown in Fig. 2.

#### Infectious Hospital Waste Management

According to Public Cleansing Department, BMA, the approximate average generation of infectious hospital waste per day in Bangkok Metropolis from January to December 2002 with a range from 10.44 to 13.34 tons/day. The amount of hospital waste generation increases as the number of clinics and hospitals are increasing. The amount of infectious hospital waste collected from 584 to 644 hospitals of Bangkok City and incinerated at the Bangkok Metropolitan Administration Incinerator in 2003 (January-November 2003) ranges from 13.591 to 14.805 tons/day.

BMA contracted private sector namely Krungthepthanakom Company Ltd. for collection and disposal of infectious hospital waste from Bangkok Metropolis. The waste from hospital is used to collect daily, while from the clinics waste collect once or twice a week. A total of 9 air conditioned vehicles are engaged in collection of infectious waste with total capacity 23 tons. A total of 48 staffs are employed to collect and disposal of infectious waste [4].



Infectious waste from the hospitals, polyclinics and other medical centers comprises of tissues, gross, blood, paper, medicine, chemicals, glass, bottles, clothes, hazardous waste and pathogens. Those waste contaminated other general waste for many years. BMA tried to resolve this problem and had initiated the steps of installation of Incinerator.

BMA installed two incinerators to incinerate infectious hospital wastes at On-Nut and each incinerator has the capacity to 15 tons per day with total costs 73 million bath. Installation of two incinerator took one year and started operation since 21 June 1995. Disposal of infectious hospital waste by incineration at On-Nuch site is equipped with waste water and emission treatment facilities. The ash generated from the process of incineration is disposed at the nearest sanitary landfill.

#### IV. Solid waste Management Practices in Dhaka City

Dhaka City Corporation (DCC) is responsible for the management of solid waste of Dhaka City Corporation area, while five other municipalities of Dhaka Metropolitan area are managing solid waste of their own jurisdiction. Dhaka City Corporation is responsible for the collection, transportation and dumping of 4,000 tons of waste generated within DCC area of 360 sq km of 6 million population. Dhaka City Corporation collects only 50 percent of the generated solid wastes and rest of the waste remains behind and accumulated on the road sides, dump in the low lying areas, or collected by the scavengers to recycle which is about 15% of the waste generated in Dhaka City [6,7].

Dhaka City Corporation area is divided into 10 administrative zones. A Conservancy Officer for each zone (10 conservancy officers), 5779 cleaners and 149 supervising/inspecting staffs are employed for the solid waste management of Dhaka City [5,6,7]. The other support facilities for solid waste management of Dhaka City are shown in TABLE 3.

TABLE 3  
DCC's Solid Waste Management Support Facilities

Facilities/Items	Quantity/Number
Dustbin	
i) Concrete	1,595
ii) C. I. sheet	2,450
iii) Demountable container	409
Vehicles	
i) Covered trucks	35
ii) Demountable solid waste trucks	104
iii) Normal trucks	130
iii) Hand drawn carts	3,000
Average manpower per Ward	
Conservancy staffs	58
Supervisory staffs	15
Other equipments	
i) Broom	1/sweeper/month
ii) Long poles	200 for all/month
c) Baskets	3,000 for all/month

A total of 5,779 cleaners are employed to sweep the road and clean the drains. The cleaners accumulated the waste by the roadside after sweeping and cleaning the drains. At last, they collected those waste in a basket made of cane or bamboo, or hand carts and then used to dump into the nearest dustbins/containers/collection points. DCC provides dustbin in a designated area and city dwellers from the neighbourhood dump household waste at the nearest dustbins. There are about 4,454 designated garbage collection points including 1,595 fixed concrete dustbin, 2,450 C. I. Sheet container dustbins and 417 demountable mobile container dustbins in the Dhaka City provided by the DCC. As it is difficult for the large transport of DCC to enter in the narrow and crowded road or streets, most of the cases DCC dustbins or containers are located besides main roads from where large transport or vehicles can easily carry waste to final disposal site or dumpsite. Waste from narrow road/street and crowded area usually carried to dustbin using handcarts which lead to inefficient and inadequate collection of solid waste. While in the old part of the city, waste generally collected from very narrow lane and by-lanes using small trucks.

A total of 224 covered trucks, demountable solid waste trucks and normal trucks ranging capacity from 1.5 to 5 tons carrying the waste from collection sites/bins to dumpsites. DCC also used hauled container system employs vehicles that are equipped with hydraulically operated hoisting arms to move large detachable containers between the floor of the vehicles and the ground and about 25 such container carrying vehicles are employed to carry the waste to dumpsite [7].

According to instruction of the DCC, solid waste from different location of the city will be transported to dumpsite at night. Because rotten waste produce a obnoxious smell which is intolerable as well as city dwellers might fall in sick due to bad odour and diseases if they exposed. At night, usually city citizen stay inside their residence and collection crews can easily collect and transport those waste to dumpsite. Very unfortunately, it was observed that during peak moment about 8.30 or 9.00 a.m. when city citizen started to rush for office or everyday work at that time collection crews collect waste and transport to the dumpsite. City's road and street turn to a place of unbearable and intolerable smell and that smell last several hours. City citizen movement suffers and such an intolerable situation is experiencing almost always by the city citizens even though they took it notice to the proper authority. Proper monitoring of waste collection and transportation can resolve such problem if the concern authority showed their good interest.

#### *A. Privatization of Solid Waste Collection*

DCC has handed over to four private organizations the waste management services for the eight wards at Uttara, Gulshan, Baridhara, Banani and Tejgaon for one year since 2003 [13]. DCC has divided the eight wards among different organizations for collecting solid waste is as follows:

<b>Organisation</b>	<b>Area/Jurisdiction</b>
1. Poribesh Unnayan Forum	Uttara
2. LN Corporation	Tajgaon
3. Bangladesh Integrated Environment Development Forum:	Gulshan & Baridhara
4. Rhythm:	Nikunjo-2 in Banani.

According to Chief, City Planning Unit, DCC, every year DCC spent 65 million Taka for collection and disposal of solid wastes of above mention 8 wards. While through privatization of solid waste collection, DCC have to pay only 37.5 million Taka. DCC not only save the money for waste disposal, also efficiency of the solid waste management will improve through privatization and city citizen

will get the proper service and DCC will be able to provide healthy neighbourhood for the residents of these wards [13].

### *B. Community Based Solid waste Management in Dhaka City*

#### Community and NGO's Initiatives

It was mention earlier that solid waste management is the responsibility of DCC. Unfortunately, DCC's conservancy services are not satisfactory and waste remains throughout the city. DCC is complaining that they don't have the physical and financial facilities to perform the job efficiently, though they have that intension. On the other hand, it is also complain against DCC's concern fraction of employees that they are not discharging their responsibility properly. Solid wastes become a great concern for city dwellers, and turn it to environmental and social problem in many part of the city. Many part of the city, citizens started their own initiatives such as Kalabagan, Kathalbagan, Shamoly, Mirpur, Banani and Uttara area with an idea to keep clean their area solid waste free and get a nice environment in their neighbourhood.

Community based solid waste management practices in many part of the Dhaka City is practiced which is house to house to waste collection system in a particular day and they carried those waste to nearby waste collection dustbin/containers. To perform this responsibility, each household paying Tk. 15/20/25/30 per month and collection crew are also happy as they got employment and they able to recycle a significant fraction of waste which also allow them to earn extra money. House to house solid waste collection by using a Three Wheeler man drive Cart practices in Dhaka City. It has been reported that in 90 Wards about 130 such community-based initiatives are operating. Some of them are private operators and many of them organized with the assistance of NGOs and covering over 10,000 households [6,14]. Among many community based solid waste management initiatives, Parichchanna Kalabangan in Kalabagan and Kathalbagan area, Earth Watch in Baitul Aman Housing Society and Shamoly, Pallabi Paribesh Sangrokhan in the Pallabi area of Mirpur-10 in Dhaka City's are most prominent. Residents of those areas are happy as their neighbourhood is not dirty and smelly anymore and they appreciate those have taken such initiatives.

#### Waste Concern Initiative

A local NGO namely "Waste Concern" initiated a small-scale community based waste recycling process since 1995. They started a recycling project of converting municipal waste to organic compost through recycling. The initiators have got a piece of small land form local Lions Club for the composting project in January 1996 and they started composting in a small scale which is a first such initiative in the country. The technique they adopt is to separate the non-biodegradable waste and convert biodegradable waste to compost through aerobic process. They produce 200 kg of compost from one metric ton of solid waste and compost is selling in the market as organic fertilizer [15] Even, those are providing a cart of waste to them, Waste Concern paying them Tk 10. Waste Concern "Trash to Treasure" initiatives is widely appreciated. Initiators of Waste Concern won the UN award for the sustainable management of city waste and protection of environment with such an innovative idea especially in Dhaka City.

### *C. Waste Disposal*

There are two sites where solid waste from Dhaka city is dumped and both waste sites are managed by DCC. According to DCC official, at present DCC is now dumping larger quantities of waste in Matuail dumpsite and a small quantities in the Gabtali dumpsite besides Dhaka City Protection embankment. Crude dump is practiced in both dumpsites of DCC.

Government provided permission to acquire 72 acres land for Matuail dumpsite. Unfortunately, compensation of 72 acres land didn't pay to the owner of the land; they paid only 50.83 acres land and DCC got the possession of the 50.83 acres land only, while 21.17 acres land compensation was not paid that's why DCC didn't get the possession of that land. According to DCC, Matuail solid waste dumpsite of Demra, Dhaka City is already filled up and will be possible to dump maximum one and half an year only.

DCC is trying to extend Matuail waste dumpsite by another 50 acres of land which is under process of approval. Besides this, DCC is also trying to acquire another patch of 53 acres land in Amin Bazar. This process also stopped due to negligence of RAJUK and Department of Environment. According to DCC, they had given reminder several times, unfortunately both RAJUK and Department of Environment didn't response at all. They are trying to get land for dumping site in Kranigonj or Rayer Bazar outside the flood protection embankment. DCC is also exploring to get land in Joydevpur and as an alternative in Domohani or a nearby area. According to DCC proposal, each of the dumping ground must be minimum 50 acres of land. These proposals were given long before to develop four dumpsites in four side of the city, unfortunately due to crisis of land, the process delaying. At this stage, DCC forced to dump waste on both sides of flood protection embankment in Gabtoli. In the long run which might create threat to embankment itself as well as fill up of wetland might be harmful for ecology and human health.

Due to obnoxious bad odour and smell of rotten waste at the Matuail dumpsite, residents in the neighbourhood and over 500 scavengers those are engaged in collection of recyclable materials are exposed to bad odour and thus pose serious health risk associated to air pollution and diseases. On the other hand, surface and ground water pollution is a major concern as there is no mechanism of lechate collection in the present practice of crude dumping. Lechate from the open dumpsites may cause severe problem of surface and ground water pollution as lechate drained to water bodies where pisciculture is in progress. Lechate contain many toxic chemicals those enter to food chain such as from water to fish and from fish to city citizen as they consume fish those are grown in water bodies where lechate from solid waste drained to the water bodies. It could be serious health concern for city citizen. During the site visit, it was observed that vegetables are growing on Matuail dumpsite by illegal trespasser and selling vegetables in the city market. Generally, solid waste contains toxic heavy metals and also other chemicals which are harmful for human health. Due to consumption of those green vegetables cultivated on Matuail dumpsite can cause threat to health of city citizen.

## V. Problem and Challenges for Solid Waste Management of Bangkok and Dhaka Metropolis

The extent and intensity of problem and challenges experienced by the BMA and DCC for sustainable management of solid waste of Bangkok and Dhaka Metropolis is varied from one another. The major problems and challenges experienced by the BMA and are briefly discussed below.

### A. Bangkok Metropolitan Area

- i) A total of 94.25% of waste of Bangkok Metropolitan area is collected by BMA and rest of them remains in the city.

- ii) Waste collectors, helpers and scavengers come into physical contact of solid waste as they are engaged in collection, separation of recyclable and non-biodegradable waste and can be infected by pathogens and other diseases as they don't wear proper gloves or shoes. Moreover, they are exposed to bad odour and smell which might cause a problem in terms of health and hygiene as they don't wear a proper mask during handling waste to protect their health.
- iii) Difficult to find suitable land for landfill site as well as the present disposal system is expensive and requires an alternative waste disposal system such as composting and incineration of household waste with an aim to recycle compost as fertilizer and generation of electricity from the incinerator.
- iv) Disposal costs are higher than the waste collection fee paid by the citizen and disposal fees need to be raised.
- v) The rate of waste generation in Bangkok Metropolitan is 6 to 8%. Steps for reduction of waste generation must be taken to reduce waste volume.
- vi) Fund unavailability is the barrier to introduce environment friendly technology or those technologies viable in the context of society which respect environmental quality.
- vii) Environment friendly technology of waste collection, transportation and disposal is yet to be introduced.
- viii) Recycle and Reuse of waste is not yet extensively popularized.

#### *B. Dhaka Metropolitan Area*

About 50% of the city waste is collected by the DCC, while 15% are recycled and the rest 35% are discarded into streets, drains, ditches, canals and open spaces. In Dhaka City, about 35% of the city dwellers live in slums and squatters in the Dhaka City and among them only 9% of the slum and squatter dwellers have solid waste collection services facilities, the remaining 91% slum and squatter dwellers don't have that access and they dump wastes into low-lying lands, road side drains or local drains and khals (canals). It was observed during the study site visit that collection crews don't wear gloves and proper shoes, due to physical contact with different infectious waste, they can easily be infected. Although they are handling rotten waste which creates an obnoxious smell within the city area, unfortunately, collection crews as well as vehicle drivers don't wear masks during handling and transportation of smelly waste. It was also observed at the dumpsite that scavengers separate recyclable waste using their hands and don't wear appropriate shoes, gloves and masks through this process, 150,000 scavengers of Dhaka City are exposed to diseases. They are engaged in separation of recyclable waste which is 15% of the total waste generation and they are in contact with different diseases as infectious hospital and hazardous waste are disposed in the same bin as well as dumped in the same dumpsite. During the visit of Matuail dumpsite, it was observed that over 500 scavengers were engaged in collection of recyclable waste and they take rest in between their work on the dumpsite where they made temporary shade to take rest as well as eat their food. Though the whole area is full of flies, but scavengers eat their food on the dumpsite in an unhygienic environment which is a great health concern for them. Young children (boys and girls), women and men are engaged in collection of recyclable materials on Matuail dumpsite, but they are exposed to an unhygienic and vulnerable environment which can cause severe health problems for them.

It is also already mentioned above that according to DCC policy solid waste should be collected during the night starting from sunset and finished before sunset. Unfortunately, collection crews and vehicle drivers, they don't comply with the rules and regulations. They collect and carry waste in Dhaka City during the day time and expose city citizens during busy and rush hour in an obnoxious smelly environment which causes diarrhoeal disease in the city.

Matuail and Gabtoli both dumpsites are mere practice crude dumping and there is no system of lechate collection. Lechate infiltrate and can cause ground water contamination. Moreover lechate drainage to neighbouring water bodies such as wetland where pisciculture is in progress and through food chain city citizen could be affected and can create a great health concern for city dwellers due to unsustainable practice of solid waste management.

Corruption of drives of vehicles engaged in solid waste collection cause great loss for DCC. Such as vehicles carry waste once, but they claim fuel for two trips and through this way every year DCC 's losing about 60 million Taka only from fuel. There is no mechanism of monitoring how many vehicles carried waste to dumpsite and how much they carry. There is no device or system to weight the waste carried to waste dumpsite which is very important and urgent. Even total quantity of waste generation is fixed based on estimation, not actually based on practically applicable method or weight.

Open truck is used for collection of waste and when they carry waste to dumpsite, they don't cover the waste and along the way, waste continue to spread bad odour and obnoxious smell which can be control by taking simple measures by the DCC and collection crews. City citizen and news media try to draw the attention of the city authority, but now significant positive response so far have seen by the city citizens.

## VI. Recommendations for Sustainable Management of Solid Waste in Bangkok and Dhaka Metropolis

### *A. Bangkok Metropolis*

The issues need to be intervened for the sustainable management of solid waste of Bangkok Metropolis were identified and discuss above. A holistic and integrated approach of solid waste management is essential for the sustainable management of the waste of Bangkok Metropolitan area. Such a holistic approach can help to formulate proper policy for the sustainable management of Bangkok Metropolis solid waste.

There are many steps so far taken by the BMA for the sustainable management of solid waste of Bangkok Metropolitan. Still then BMA need to intervene the following sectors:

1. Formulate and updated policy of waste management in light of ecosystem approach and vision of solid waste management need to be clarified and adopt the mission to achieve the vision of BMA.
2. Make sure 100% collection of solid waste from Bangkok Metropolitan area.
3. Make sure use of shoes and gloves by the collection workers, helpers and scavengers.
4. Ensure using mask by the collection workers, helpers and scavengers
5. Public participation: Encourage city citizen to separate waste at source by promoting public awareness programme and education on solid waste problem including economic aspects as well as law enforcement.
6. Improvement of waste collection system: Efficiency of waste collection using modern technology and privatize waste collection system
7. Improvement of waste disposal system such as upgrade sanitary landfill with modern technology and facilities.
8. Integrated approach of solid waste disposal including sorting out biodegradable and non-biodegradable, composting, wastewater treatment, sanitary landfill and incineration. Electricity

can be generated from the incinerator and methane gas can be trapped at the compost plant and sanitary landfill site and those gas can be used in garbage collection transport.

9. Waste separation should be introduced at the household level with different container.
10. Separate collection of plastic bottles, glass bottles and other recyclable waste need to be introduced. It will reduce the transportation cost as well as will increase management efficiency.
11. Increase waste collection fees.
12. Campaign for reduction waste generation: A massive campaign is essential to raise the awareness of city citizen through mass media, seminar, leaflet and other awareness raising programme.
13. Adequate budget is essential for the successful implementation of plan of integrated solid waste management.

### *B. Dhaka Metropolis*

To improve the solid waste management of the DCC, it requires an efficient management, proper plan, maintenance of vehicles, proper monitoring and supervision of cleaners works, maintain proper roster of solid waste collection and carrying to dumpsites using vehicles and above all effective supervision of over all activities. Moreover, need to change the mindset set of the city citizens through involving them in the solid management system as well as raising awareness. An integrated and holistic approach of solid waste management is essential to attain urban sustainability in Dhaka City.

There are many problems associated with the solid waste management of Dhaka Metropolitan area is discussed above. To resolve those problems for the sustainable management of solid waste of Dhaka Metropolitan, the following recommendations were put forwarded.

2. Formulate and updated policy of waste management in light of ecosystem approach and vision of solid waste management need to be clarify and adopt the mission to achieve vision Participatory approach of solid waste management should be practiced in the city and local people need to be involved in solid waste management programme.
4. Raising the awareness of the employee engaged in solid waste management through training to change their mind set and city citizen through education and mass media publicity
5. Collate and make sure availability of information for employees as well as city dwellers Strong political support and supportive legal framework needed to successful implementation of waste management plan
7. Transparency in administration and legal provision to dismiss or hire and fire corrupt employees from the organisation engaged in solid waste management. Short, mid and long –term solid management strategies must be entail with separation of waste at source, recycle and reuse of waste, composting of waste, incineration of waste and set up of standard landfill and stopping crude dumping
9. Raise awareness of the city citizen through education/mass media to generate less waste and dump waste in proper place and also by involving teachers and leader of religious institutions such as Imam of the mosque, priest at the Church/Pagoda/temple
10. Capacity development of the employees through training, as well as increase physical facilities to perform efficiently.
11. Continuous technical training is essential to developed technically sound and skill manpower for the sustainable management of solid waste
12. Adequate budget is essential for the successful implementation of plan
13. Legal framework needs to be framed for the separate collection and disposal of hazardous waste (household and industrial origin) and infectious waste.
14. Immediate need of set up of incinerator for the disposal of hospital waste

15. Integrated solid waste management approach needs to be adapted in Dhaka Metropolitan areas solid waste management for sustainable urban management as well as to protect the urban and its neighbouring ecosystems.
16. Make sure 100% collection of solid waste from Bangkok Metropolitan area.
17. Make sure use of shoes and gloves by the collection workers, helpers and scavengers.
18. Improvement of waste collection system: Efficiency of waste collection using modern technology and privatize waste collection system
19. Waste separation should be introduced at the household level with different container.
20. Separate collection of different types of waste such as biodegradable, burnable, non-burnable. Separate collection of plastic bottles, glass bottles and other recyclable waste need to be introduced. It will reduce the transportation cost as well as will increase management efficiency.
21. Increase waste collection fees as the present waste collection cost is higher than the tariff paid by city citizen.

## VI. Conclusion

The steps of Bangkok Metropolitan Administration for the management of solid waste is better compare to Dhaka City solid waste management practices. BMA has the better transportation system, recycle mechanism and disposal system compare to Dhaka. BMA disposed household waste at the sanitary landfill, while in Dhaka practice crude dumping. BMA incinerated hospital waste and in Dhaka there is no separate collection system and dump with household waste without any treatment. Industrial waste in Bangkok is managed by the Ministry of industries and practice proper treatment to dispose hazardous household and industrial wastes. But, in Dhaka hazardous household waste and industrial waste also dump directly into waste dumpsite without any treatment. Still there is a potential scope to improve BMA solid waste collection system as well as improve disposal system of Bangkok waste. There are scopes of better performance of solid waste management of Dhaka City's waste by the DCC within existing facilities. Proper management and improvement of disposal system and steps of installation of scientific disposal system could improve the waste management system.

Integrated approach of solid waste management will improve further the environmental quality of the Bangkok Metropolis as well as will encourage adopt environment friendly technology to achieve urban sustainability. In Case of Dhaka City, integrated approach of solid waste management will encourage to prepare master plan as well as to dispose solid waste using scientific and environment friendly way rather than crude dumping practice which will lead to improve urban environmental quality as well as drive towards achieve urban sustainability.

## Acknowledgement

The work reported in this paper is funded by the research grant of Japan Society Promotion of Science (JSPS). The support of the Bangkok Metropolitan Administration and Dhaka City Corporation is greatly acknowledged. Without the support of the concern officials in providing data as well as assistance during site visits, it would not have been possible to prepare this paper. My special thanks to Mrs Nathanon Thavisin, Permanent Secretary, Bangkok Metropolitan Administration; Mrs Prapim Basiruti, Director, Environmental Quality Control and Pollution Management Division, Permanent secretary Office and other staffs of Environmental Quality Control and Pollution Management Division for their kind and generous support. I also acknowledge the support of Mr. Tapan Das Gupta, Chief, Planning Division, Dhaka City Corporation (DCC), as well as all officers and staffs of Conservancy Department of DCC for their kind



and generous support for providing data as well as assist during visit dumpsites. My thanks to Organizing Committee of Kanazawa University COE-IICRC International Symposium on Environmental Management: Air Pollution and Urban Solid Waste Management and Related Policy Issues” for kind invitation to present this paper as well as for providing financial support to attend and present paper. My special thanks and gratitude to Professor Dr. Pablo Martinez Lestard, Director, IICRC for inviting me and include me as one of the presenter at the symposium.

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