FINAL MASTER PLAN REPORT FOR SOLID WASTE COLLECTION AND DISPOSAL MANAGEMENT IN NARAYANGANJ CITY CORPORATION

Volume I

Narayanganj City Corporation

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PROJECT SUMMARY

Client	**Narayanganj City Corporation**
Client Representatives	**Md Kamrul Ahsan, Superintending Engineer, Narayanganj City Corporation, Narayanganj**
Client Reference	**Memo no: 46.16.6700.015.09.217.19.121**
Project Name	**Solid Waste Collection and Disposal Management in Narayanganj City Corporation**
Contract Date	**27th November, 2019**
Contract Duration	**6 months**
Document Title	**Master Plan for Solid Waste Collection & Disposal Management in Narayanganj City Corporation**

EXECUTIVE SUMMARY

Narayanganj is characterized by a high population growth rate. Currently about 10,63,576 (Based on BBS, 2011) permanent residents live in the area. The number of seasonal laborers and commuters from Dhaka and other surrounding areas is estimated to 1.572 million people. According to the recent development the population growth rate can be estimated as 4.05 % per year. Many industrial branches provide a large number of jobs. First of all, the garment industry dominates the industrial sector of the area and generates a large amount of specific waste. The population growth and the increasing industrial sector generate fast-growing waste amounts. The raining living-standards will intensify this process. Currently the household and commercial waste amounts have been estimated to 922 Tons per day (Based on household survey, commercial survey, industrial survey and polythene beg distribution and collection survey). According to our surveys and analysis, not more than 50 % of this amount is currently collected and transported to a dumping site.

In 2025 the potential of household and commercial waste will increase to more than 1000 Tons per day. A basic regulation on waste management is given and assigned for the urban local government institutions of Narayanganj City Corporation with responsibilities regarding the removal, collection and management of waste; nevertheless, the waste management lacks in collection equipment and collection staff and environmental-friendly disposal facilities. The common illegal dumping of waste in water bodies, canals and on river banks as well as the use of uncontrolled and unsanitary dumping sites causes to heavy hazard on soil and groundwater and pollute the air with emissions of uncontrolled burning waste. The waste composition is characterized by nearly 70 % of food waste which causes to high moisture contents which is accompanied by low calorific values.

Solid waste management is one among the basic essential services provided by municipal authorities in Bangladesh to keep urban centers clean. However, it is among the most poorly rendered services. Most of the systems applied are unscientific, outdated and inefficient where population coverage is low and the poor are marginalized. Municipal laws governing the urban local bodies do not have adequate provisions to deal effectively with the ever-

growing problem of solid waste management. With rapid urbanization, the situation is becoming critical. The urban population has grown fivefold in the last six decades.

The Study covers three types of solid wastes generated in the jurisdiction of the Narayanganj City Corporation namely, Domestic waste, Commercial and Industrial waste and Medical waste. Liquid and gaseous wastes are not included in the scope of this study. The master plan has been prepared for only Domestic, Commercial, Industrial and Medical waste in of NCC Area. With regard to Industrial waste and Medical wastes, surveys were conducted to identify the problems and possible solutions will be proposed separately from Domestic waste.

Lots of the problem can be fenced if the municipal solid waste management is properly executed in Narayanganj. The activities that are usually performed as part of health care waste management involve segregation, storage, collection, transportation and disposal of Biomedical waste. It includes organizational, planning, administrative, financial, engineering aspects, legal, and human resource development and their management involves interdisciplinary relationships. Management of municipal waste requires commitment at all the levels from healthcare providers. A system that is managed by irresponsible and untrained staff, the risks and the importance of their “contribution” is dreaded.

Awareness regarding rules of disposal of municipal waste needs to be taught even among qualified personnel of commercial areas and industries, households, including hospital administrators, private and governmental institutes, hospitals, school and colleges. Knowledge regarding the significance of municipal waste, its relationship with the ecosystem, the environmental toxins used in health care industry and the impact of callousness on public health, remain very minimal. For better result we need to increase the level of training and education regarding disposal of municipal waste and environment-friendly health care with optimum priority, under rules and legislation.

ACRONYMS AND ABREVIATIONS

ADB	**Asian Development Bank**
BBS	**Bangladesh Bureau of Statistics**
BGS	**British Geological Survey**
BM	**Bench Mark**
BMD	**Bangladesh Meteorological Department**
BOQ	**Bill of Quantities**
BTM	**Bangladesh Transverse Mercator**
BUET	**Bangladesh University of Engineering and Technology**
BTM	**Bangladesh Transverse Mercator**
BWDB	**Bangladesh Water Development Board**
DEM	**Digital Elevation Model**
DGPS	**Differential Global Positioning System**
DHI	**Danish Hydraulic Institute**
DOE	**Department of Environment**
DPHE	**Department of Public Health Engineering**
FAP	**Flood Action Plan**
GDP	**Gross Domestic Product**
GIS	**Geographic Information System**
GoB	**Government of Bangladesh**
GPS	**Global Positioning System**
GSB	**Geological Survey of Bangladesh**
JICA	**Japan International Co-operation Agency**
LGRD	**Local Government and Rural Development**
LR	**Literature Review**

MIS	**Management Information System**
MoEF	**Ministry of Environment and Forests**
MSL	**Mean Sea Level (at Cox's Bazar)**
MSW	**Municipal Solid Waste**
NCC	**Narayanganj City Corporation**
NGO	**Non-Government Organization**
ODP	**Open Dumping Point**
PCO	**Project Coordination Office**
PD	**Project Director**
PPP	**Public-Private Partnership**
PSP	**Private Sector Participation**
PWD	**Public Works Department**
RM	**Research Methodology**
SOB	**Survey of Bangladesh**
STS	**Secondary Transfer Station**
SWM	**Solid Waste Management**
TBM	**Temporary Bench Mark**
ToR	**Terms of Reference**
UNICEF	**United Nations International Children's Emergency Fund**
WM	**Waste Management**

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COMMON SWM TERMS

Commercial collection company – a private-sector company that collects garbage, recyclables, and organics from residents and businesses.

Compost – the product resulting from the controlled biological decomposition of organic waste, including yard waste, food scraps, and food-soiled paper, which is beneficial to plant growth when used as a soil amendment.

Construction and demolition debris (C&D) – recyclable and non-recyclable materials that result from construction, remodelling, repair or demolition of buildings, roads or other structures, and requires removal from the site of construction or demolition. Construction and demolition debris do not include land clearing materials such as soil, rock, and vegetation.

Landfill gas – gas generated through the decomposition of waste buried in the landfill, which consists of about 50 to 60 percent methane and about 40 to 50 percent carbon dioxide, with less than 1 percent oxygen, nitrogen, and other trace gases.

Leachate – water that percolates through garbage at the landfill and requires collection and treatment before being sent to a wastewater treatment plant.

Municipal solid waste or MSW – includes garbage (putrescible wastes) and rubbish (nonputrescible wastes), except recyclables that have been source-separated; the residual from source-separated recyclables is MSW.

Solid waste – all materials discarded including garbage, recyclables, and organics.

Special waste – wastes that have special handling needs or have specific waste properties that require waste clearance before disposal. These wastes include contaminated soil, asbestos-containing materials, wastewater treatment plant grit, industrial wastes, and other wastes.

Sustainability – an approach to growth and development that balances social needs and economic opportunities with the long-term preservation of a clean and healthy natural environment. This approach to action and development integrates environmental quality, social equity, fiscal responsibility, and economic vitality.

Waste conversion technologies – non-incineration technologies that use thermal, chemical, or biological processes, sometimes combined with mechanical processes, to convert the post-

recycled or residual portion of the municipal solid waste stream to electricity, fuels, and/or chemicals that can be used by industry.

Waste prevention – the practice of creating less waste, which saves the resources needed to recycle or dispose of it such as choosing to purchase items with less or no packaging.

Waste-to-energy technologies – recover energy from municipal solid waste and include both waste conversion technologies and incineration with energy recovery, such as mass burn waste-to-energy, refuse derived fuel, and advanced thermal recycling.

Zero waste of resources or zero waste – a planning principle designed to eliminate the disposal of materials with economic value. Zero waste does not mean that no waste will be disposed; it proposes that maximum feasible and cost-effective efforts be made to prevent, reuse, and recycle waste.

CHAPTER 01: INTRODUCTION

Background of the Study

Urban areas of Bangladesh are most densely populated areas and have been rapidly urbanizing. While the country's total population has been increasing at about 1.38% per annum, its urban population has been growing at about 6% per annum and 39.4 % (64,814,953 people in 2019) of total population of Bangladesh lives in urban area (World meters, 2019). Narayanganj City Corporation is one of the most populated urbanized area of Bangladesh with 7, 09, 381 populations and almost 10,000 populations per sq. kilometer (BBS, 2011). This rapid urbanization has resulted in most of the urban local bodies, that are mandated to provide urban health and environment related services which includes solid waste management, facing a severe strain in keeping up with the increased demand on its infrastructural facilities and urban services. The urban local bodies do not have the requisite institutional and financial capacities to address such a worsening situation of solid waste management due to rapid urbanization. Solid waste discarded by NCC households, markets, medicals, industries both inside and outside of the city corporation premises lacking management and disposal, is likely to lead to outbreaks of waterborne diseases such as cholera, typhoid fever, diarrhea and malaria. Environmentally, uncontrolled solid waste will also cause contamination to surface and groundwater sources. The situation will deteriorate in the monsoon season.

The NCC Solid Waste Management project is targeting the protection of NCC city dwellers including women and children, for the prevention of diseases, as well as the promotion of hygiene and proper sanitary standards. In line with developing a solid waste management system, it is planned to construct a new infrastructure facility covering a sanitary landfill and a material recovery facility. Sanitary landfill will be the near-term foundation of the integrated waste management disposal system, which over the long-term will include an appropriate level of materials recovery, and composting, based on market conditions for materials, soil amendment and energy.

1.2 Study Area

Narayanganj is a city in central Bangladesh. It is in the Narayanganj District, near the capital city of Dhaka and has a population more than 1 million. It is the third-largest city in Bangladesh. The city is on the bank of the Shitalakshya River. The Port of Narayanganj is an important shipping and industrial center. It is also a center of business and industry, especially the jute trade and processing plants, and the textile sector of the country. It is nicknamed the Dundee of Bangladesh due to the presence of its many jute mills (Dundee was the first industrialized 'Jute polis' in the world). Narayanganj was a former sub-divisional town of Dhaka district and now it is characterized as an important trade and manufacturing center of Bangladesh. The district lies under the zone of influence of the capital city Dhaka which is one of the fast-developing mega cities in the world.

On May 05, 2011, the government established Narayanganj City Corporation with a total of 72.43 sq. km area with the powers given in Rule 6 of the establishment of Local Government (City Corporation) Rules, 2010, by combining three municipalities, Narayanganj, Siddirganj and Kadamrasul respectively. It consists of 27 wards including 9 reserve seats for women. Before its establishment as City Corporation, it was a municipal corporation. Narayanganj City Corporation is a formation under the local government administration of Bangladesh to regulate the city area of Narayanganj, which is under the Ministry of Local Government & Rural Development (LGRD). Narayanganj City Corporation's total area is 72.43 square kilometers with approximately has the population of 7, 09,381 people in the city corporation area (BBS, 2011). Narayanganj Municipality, situated on the bank of the Shitalakshya River, has been playing an important role in business trade for more than a hundred years and the capital is known as "The gateway of Dhaka". The NCC is also dotted with many industrial units for its easy transportation linkages with other parts of the country. It also plays a vital role on food security for both Dhaka and Narayanganj.

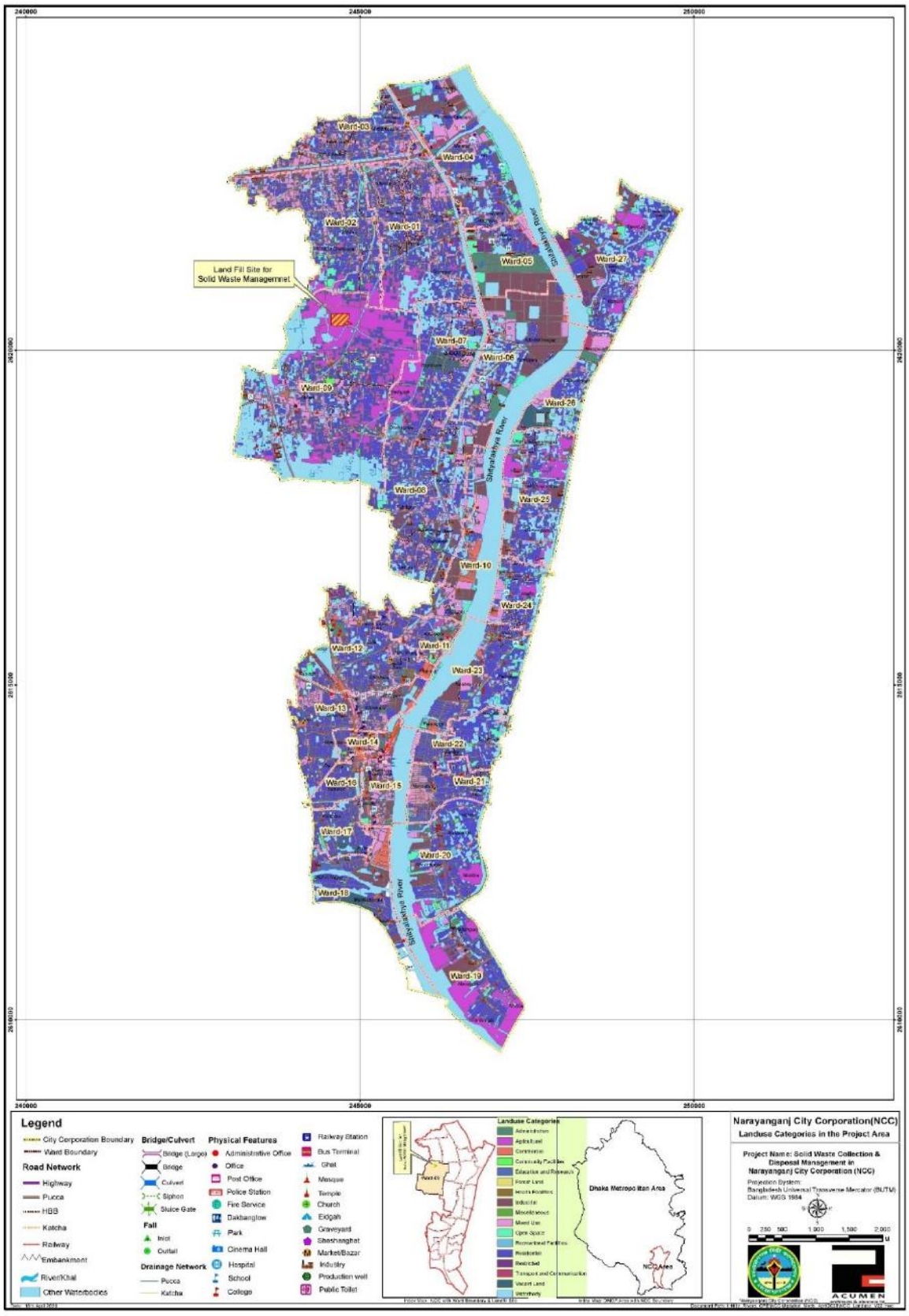

Figure 1.1: Land use Map of NCC (Study Area Map)

1.3 Detail about Proposed Landfill Site

The Solid Waste Management (SWM) Plant of NCC is proposed at Jhalkuri area along the Siddirganj Jhalkuri Road (south-east direction) considering its current land use, connectivity with surrounding areas, transport, locational suitability. Dhaka Narayanganj Highway is situated at west-south direction of the project area.

Location of proposed site: Jhalkuri (Shiddirgonj-Jhalkuri Road, Narayanganj). Total Area: 23 acres (70 Bigha approx.). To see more detail about the proposed landfill site, please see the following figure and annexure part.

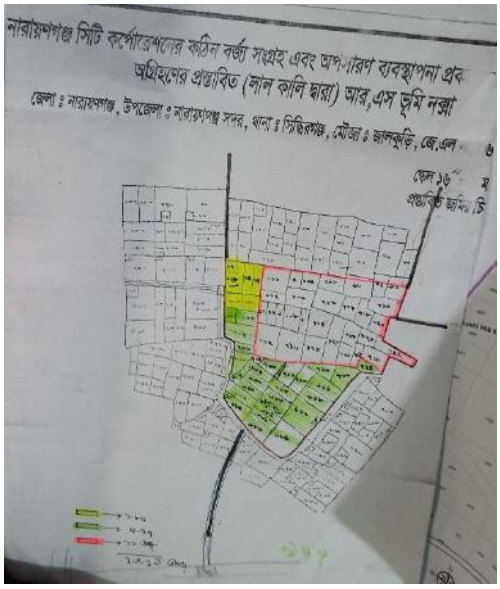

Figure 1.3: Muza Map of Proposed Landfill Site (Source: NCC)

Figure 1.2: Google Map of Proposed Landfill Site

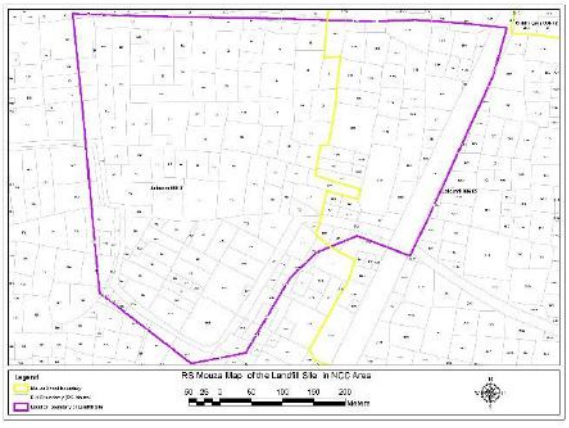

Figure 1.4: RS Muza Map of Proposed Landfill Site of NCC

Figure 1.5: UAV Map of NCC's Proposed Landfill Site

1.4 Time Frame of the Master Plan

According to urban planning dictionary, a master plan is a dynamic long-term planning document that provides a conceptual layout to guide future growth and development. Master planning is about making the connection between social, community, building development, social settings, and their surrounding environments. A master plan includes analysis, recommendations, and proposals for community facilities developments, and land use plan. It is based on public input, surveys, planning initiatives, existing development, physical characteristics, and social and economic conditions.

Generally, any kind of master plan is proposed for 20 years. The master plan for solid waste collection and disposal management can be for 50 years even 100 years based on its capacity. But for Narayanganj, Acumen (the consultant) think that it will not be a suitable and feasible plan for more than 20 years. Now a days, Narayanganj is a city of hope and livelihood for about 2 million people (Including floating people; source: Town Planner, NCC). Its rapid urbanization makes it unpredictable in terms of development growth as well as urbanization rate. Rapid industrial development pulls the surrounding people as well as the people from the whole country to come here for their livelihood. There are lots of floating people who come at NCC at day time and go back after evening. These people live in the surrounding areas of NCC. Some people also come here for short period of time for the search of employments and other purposes. By considering all the above mentions issues, the consultant has come up with a 20-year time framed master plan. The consultant also proposed that this master plan will be revised and updated where necessary after every 5 years. The waste management department and NCC's authority will be responsible for the implementation and revision of this master Plan.

The revision and update will include the following issues,

1st Revision:

1. Revision of Waste Collection System
2. Installation of STS (Secondary Transfer Stations)
3. Garbage Vehicle needs and gaps analysis
4. Capacity Building

5. Man staff
6. New infrastructures development for SWM
7. Procurement of new Modern SWM equipment

2nd Revision:

1. Installation of STS (Secondary Transfer Stations)
2. Garbage Vehicle needs and gaps analysis
3. Capacity Building
4. Man staff
5. New infrastructures development for SWM
6. Procurement of new Modern SWM equipment
7. Compost production
8. Biogas Production
9. Power Generation
10. Searching for new location for Landfill site
11. Extend the service area

3rd Revision:

1. Garbage Vehicle needs and gaps analysis
2. Capacity Building
3. Compost production
4. Biogas Production
5. Power Generation
6. Petroliam Generation
7. Market creation for the product of waste management plant
8. Landfill site extension or preparation for new landfill site
9. Searching for new location for Landfill site
10. Extend the service area

4th Revision:

1. Compost production

2. Biogas Production
3. Power Generation
4. Petroliam Generation
5. Market creation for the products and bi-products of waste management plant
6. Landfill site extension or preparation for new landfill site
7. Searching for new location for Landfill site
8. Extend the service area

1.5 Introduction of Consulting Firm and Their Consultancy Service

Acumen Architects and Planners Ltd is a dedicated and promising **Planning, Engineering & Architectural Consultancy Firm**. It is a team of proficient and dedicated professionals who have developed their skills and enriched their experience in the fields of **Planning**, **Engineering** & **Architecture**. The strength of this firm is to do supervision, design, construction, research / study and consultancy works regarding Planning, Architectural and Engineering related works.

What we do:

- Study the ways waste is disposed in the Bangladesh
- Analyze the implications of waste disposal
- Suggest effective waste management strategies
- Develop and Practice 3R, 5R and 7R strategies for SWM
- Prepare SWM Master Plan

How important our task is:

- We believe that our decisions, suggestions and strategies will impact upon your environment and help to make it a much better place.

To develop the SWM system of NCC, the honorable Mayor of NCC wants to prepare an effective, dynamic and modernized master plan for their solid waste management system. Hence, the City Corporation recruited **Acumen Architects and Planners Ltd.** as consulting firm to prepare the master plan to develop the existing SWM system. The Solid Waste Management Consultant team will assist & support Project Coordination Office (PCO) for Solid waste management in Narayanganj City Corporation (NCC) such as waste collection, transfer and transport, treatment and disposal facility. Consultant was involved in preparation of

preliminary and detailed engineering design of waste collection and transfer stations, technical specification of the heavy equipment to be used in landfill operation. The consultant has designed the sanitary landfill including the waste treatment facility such as composting, bio-methanation etc. The consultant also has identified the types and composition of waste generated and looked into the existing waste management process and find out the gaps and opportunities for improvement and recommend ways to improve performance, reduce waste amount through improved recycling and waste-to-energy, and provided cost-effective operation and maintenance. Consultant already carried out the study related to waste generation, collection along with the prospect of community engagement in waste management. Acumen has prepared the environmental screening and ready to assist NCC to get Environmental Clearance from Department of Environment. Consultant has prepared a roadmap for short, medium, and long-term interventions for Integrated and sustainable solid waste management for the City Corporation. We have found out the stakeholders and their participation in the waste management cycle in particular the scope of private sector involvement and explore possibility Public-Private Partnership (PPP) arrangement. We have also identified the scope of public participation and develop awareness and advocacy tools for solid waste management for the general public as well as policy makers.

1.6 Objectives of the Study

The main goal of this project was to achieve **"Neat & Clean Narayanganj City"**. To achieve this goal, the main objectives of this project were as follows:

- To find out the existing situation and identify the problems of solid waste management system in Narayanganj by digital household survey.
- To identify the critical issues of waste management and spotting the areas to improve.
- To develop a comprehensive Solid Waste Management (SWM) Master Plan of NCC.
- To ensure optimum use of land & proposed landfill site.
- To determine the cost benefit ratio of their proposed land
- To prepare a comparison among proposed land use plan with Sanitary Landfill site.

The detail tasks to Fulfill the Objectives were following:

A. Study, Design of waste collection and transfer stations and design and improvement of Sanitary Landfill site.

B. Supervision

   i. Provide top Supervision by the member(s) of the term consultants from time to time & when required.

   ii. The Consultants will engage & out site professional for supervising the improvement & New construction works along with landfill site

   iii. The Consultant will arrange bi-monthly (**twice** a **month)** meetings with NCC officials to review the Progress of the Project

C. Land use Plan

   i. Design Optimum use of land & proposed landfill site.

   ii. Show cost benefit ratio of their proposed land.

   iii. Propose minimum 3 alternate plans to maximum use of proposed landfill site.

   iv. Consultant will present land use plan by using 3D perceptive view.

   v. Consultant will fix the best option by consulting with NCC authority.

1.7 Scope of This Study

The detailed scope of the study is as outlined below:

i. Conduct experiments to identify the types and composition of waste generated and look into the existing waste management process and find out the gaps and opportunities for improvement and recommend ways to improve performance, reduce waste amount through improved recycling and provide cost effective operation and maintenance

ii. Carry out the study related to waste generation, collection along with the prospect of community engagement in waste management

iii. Prepare the environmental screening and assist NCC to get Environmental Clearance from Department of Environment

iv. Prepare a roadmap for short, medium, and long-term interventions for Integrated and sustainable solid waste management for the City Corporation

v. Find out the stakeholders and their participation in the waste management cycle in particular the scope of private sector involvement and explore possibility Public Private Partnership (PPP) arrangement

vi. Identify the scope of public participation and develop awareness and advocacy tools for solid waste management for the general public as well as policy makers

vii. Prepare cost benefit analysis for the proposed improvement and infrastructure design for the SWM

viii. Preparation of preliminary and detailed engineering design of waste collection and transfer stations, technical specification of the heavy equipment to be used in landfill operation

ix. Design of a Sanitary Landfill site including the waste treatment facility such as Composting, bio-meth nation etc., considering all environmental issues & conditions specific to Bangladesh.

x. Prepare the bid documents and Bill of Quantities (BOQ) of the components to be tendered under the project.

xi. Supervision of all contracts awarded.

xii. Study of the option of different land use plan.

xiii. Find out best option of land use plan with the consultation of NCC authority.

xiv. Comprehensive SWM Master Plan of NCC.

CHAPTER 02: LITERATURE REVIEW

Waste is the ever-present issue for every society and the management of solid waste is also an ancient phenomenon. Bangladesh has had a traditional waste management system since its independence in 1971. Early waste management in Bangladesh allowed indiscriminate open dumping and burning, disposal of wastes into water bodies, landfilling, and direct disposal into agricultural land in rural areas. Night soil collection was handled through Bullock Cart for solid waste, along with nighttime waste collection, house-to-house collection performed by the Water Supply and Sewerage Authority (WASA) in urban areas. With the advent of time, the country shifted its waste management system from traditional to a modern approach. Wastes are now considered resources, so Bangladesh has shifted from waste management to resource management (Ashikuzzaman & Howlader, 2019). Several solid waste management related books, research papers, journal articles, swm related news from newspapers, national and international swm related laws, acts, world best swm practices and landfill site design standards were reviewed to conduct this study. The findings of those reviewed studies are discussed in the following section.

2.1 Waste, Solid Waste and Municipal Waste

Waste is a material, which is thrown away or kept aside as worthless element. According to Bangladesh Environment Conservation Act, 1995, waste is, “any solid, liquid, gaseous, radioactive substance, the release, disposal, and throwing away of which may cause deleterious changes to the environment.”

As a concept waste is subject to the value judgment of the primary owner or potential consumer. Waste is viewed as a discarded material, which has no consumer value to the person abandoning it (Cointreau, 1982).

United Nations Environment Program defines waste according to the Basel Convention, as **“**Wastes are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. (Basel Convention, 1989) United Nations Statistics Division defines-—Wastes are materials that are not prime products (that is products produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose.

However, the management of these wastes generated by various sources is the toughest task for the city authority. It requires adequate emphasis in order to make a city clean and user friendly for the city dwellers. Management of waste comprised of collection, carrying, treating or disposal of discarded materials and substances (Unnisa & Rav, 2012). Sustainable solid waste management is one of the prerequisites for sustainable environmental management because the unsafe disposal of solid waste pollutes the environment and causes human health hazards (Ashikuzzaman & Howlader, 2019).

Solid Waste and Municipal Solid Waste

Solid waste can be defined as the useless and unwanted products in the solid state derived from the activities of and discarded by society. It is produced either by - product of production processes or arise from the domestic or commercial sector when objects or materials are discarded after use. The definition of Solid Waste is not based on the physical form of the material, but hinges on the fact that the material is no longer usable. So, "solid" waste encompasses all those wastes, which are neither waste water discharges nor atmospheric emissions. According to the World Health Organization (WHO, 1976), solid waste can also be defined as useless, unwanted or discarded materials arising from domestic, trade, commercial, industrial and agricultural as well as from public services. In urban area it is called refuse; in the countryside it is called littering and in general, it is called solid waste. It is a conglomeration of dust, ash, vegetables and putrescible matter, paper and packing of all kinds, rags and other fabrics, glass and much other combustible and non-combustible debris. It is non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances.

In an average person; solid waste is usually being said as the following term:

a) **Garbage:** the term given principally to food waste, but may include other degradable organic wastes.

b) **Rubbish:** consists of combustible and non-combustible solid waste, excluding food wastes.

c) **Refuse:** the collective term for solid wastes, includes both garbage and rubbish.

d) **Litter:** odds and ends, bits of paper, discarded wrappings, bottles etc. Left lying around in public places.

On the other hand, Municipal Solid Waste (MSW) commonly known as trash or garbage (US), refuse or rubbish (UK) is a waste type consisting of everyday items that are discarded by the people. Municipal solid waste includes all domestic refuse and non-hazardous wastes such as commercial and institutional wastes, street sweepings and construction debris. MSW primarily comes from households, but also includes wastes from offices, hotels, shopping complexes/shops, schools, institutions, and from municipal services such as street cleaning and maintenance of recreational areas.

2.2 Classification of Solid Waste

Wastes can be classified in various ways depending on their source of generation, nature of consumption, way of collection, transportation and disposal. They can also be classified according to their origin, content, characteristics, impact on the environment, hazard potential and so on. Typical classification of solid waste was suggested by Hosetti and Kumar (1998) and it is as follows.

Classification of Solid Waste:

- **Depending upon the characteristics**

1. Perishable waste
2. Non-perishable waste

- **According to the place of generation**

1. Domestic waste
2. Industrial waste
3. Commercial waste
4. Medical waste

- Based on waste composition, it can be classified as

1. Food Waste

2. Plastic waste
3. Polythene waste
4. Textile/cloths waste
5. Rubber and Leather
6. Paper
7. Street Sweep
8. Construction Debris
9. Broken Material
10. Others

It can also be classified as

1. Hazardous waste
2. Nonhazardous solid waste

Hospital and pharmaceutical industries produce three types of wastes-

1. Infectious waste - (Pathological tissues, organs, body parts, blood and blood products, body fluids, placenta, human excreta, culture materials from laboratories and other infectious materials.)
2. Sharp Waste (Needles, syringes, intravenous set, scalpel, saw, blades, broken glass, nails and sharps generated from support service, etc.)
3. Non-infectious Waste (Expired drugs, waste contaminated with Cytotoxic drugs and leftover Cytotoxic drugs & radioactive waste)

Source: Manual for Hospital Waste Management, Ed. By A.K.M. Saiedur Rahman, General of Hospital Services, Ministry of Health and Family Welfare, 2001.

Table 1: Typical classification of solid waste and their sources with composition

Source	Location	Waste Type
Domestic	**Households**	**Kitchen waste, wood, metal, plastics, etc.**
Commercial	**Commercial firms, restaurants, offices,**	**Paper, plastic, e-waste, metal, oil, batteries, etc.**

	shops, hotels, and banks	
Industrial	**Small, medium and large manufacturing and processing units**	**Solid and liquid wastes, ashes, concrete, debris, metal, residues, etc.**
Municipal	**Cleaning of urban facilities and treatment plants**	**Plastics, dust, sludge, debris, concrete, etc.**
Educational Institutions and Hospitals	**Classrooms, teacher/office rooms, student hostels**	**Paper, plastics, useless furniture, food waste, glass, hazardous waste, metals, etc.**
Agriculture	**Cropping fields and farms**	**Crop residues, metal, plastics, dust, and other organic wastes**

Source: Kumar, 2016

2.3 Solid Waste Management (SWM)

Solid-waste management, the collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful. According to the process of functioning and/or administering by the authorities concerned, solid waste management is meant as collection, transportation and disposal of solid wastes. The related activities are generation, storage, collection, transfer and transport, processing and disposal of solid wastes. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease—that is, diseases spread by rodents and insects. The tasks of solid-waste management present complex technical challenges. They also pose a wide variety of administrative, economic, and social problems that must be managed and solved.

In spite of having tremendous efforts of GoB and Non-Governmental Organizations (NGOs), waste management is far from the desirable status in Bangladesh. Even in Dhaka, the capital city of Bangladesh has proved to be a nightmare for waste management as the amount generated per day is approximately 4124 tons, of which almost 40% goes uncollected (Kabir, 2015). Because of low awareness, lack of motivation, financial, and technological paucity, 40-60% of wastes remain uncollected and are not disposed of in a safer manner (Ahsan et al., 2014). Thus, low or inadequate collection, insufficient transport coverage, and inappropriate

processing technology and treatment are accountable for substandard management of MSW that leads to environmental pollution, great health hazards and environmental risks. So solid waste management is a conundrum for Bangladesh (Ashikuzzaman & Howlader, 2019).

On the other hand, solid Waste Management (SWM) is an important fact of environmental hygiene and it needs to be integrated with total Environmental Planning (WHO Expert Committee, 1971). A solid waste management system is the framework by which the entire activities concerning solid waste come to pass. The ever-increasing global concern on environmental health demands that wastes should be properly managed and disposed of in the friendliest and acceptable way (Ayotamuno & Gobo, 2004).

In developed countries, waste management has changed from relatively passive management of waste arising to an active management integrating economic and environmental concerns. It reduces or eliminates adverse impacts on the environment and human health and also supports to achieve economic development and improved quality of life. Henceforth, SWM is related with other tangible and intangible factors namely environment, health, community, education, finance, technology, governance, policy and regulation. If these factors are addressed properly, SWM can be sustainable and can enhance urban government ‘s capabilities. The related factors are shown in following figure:

Figure 2.1: Solid Waste Management Related factors (Source: JICA 2005:34)

Therefore, solid waste management is an intensive and integrated function which accommodates several components/factors for proper management. This includes-

- Waste Generation,
- Waste Handling and Storage,
- Waste Collection,
- Waste Transfer and Transportation,
- Waste Treatment, and
- Waste Disposal.

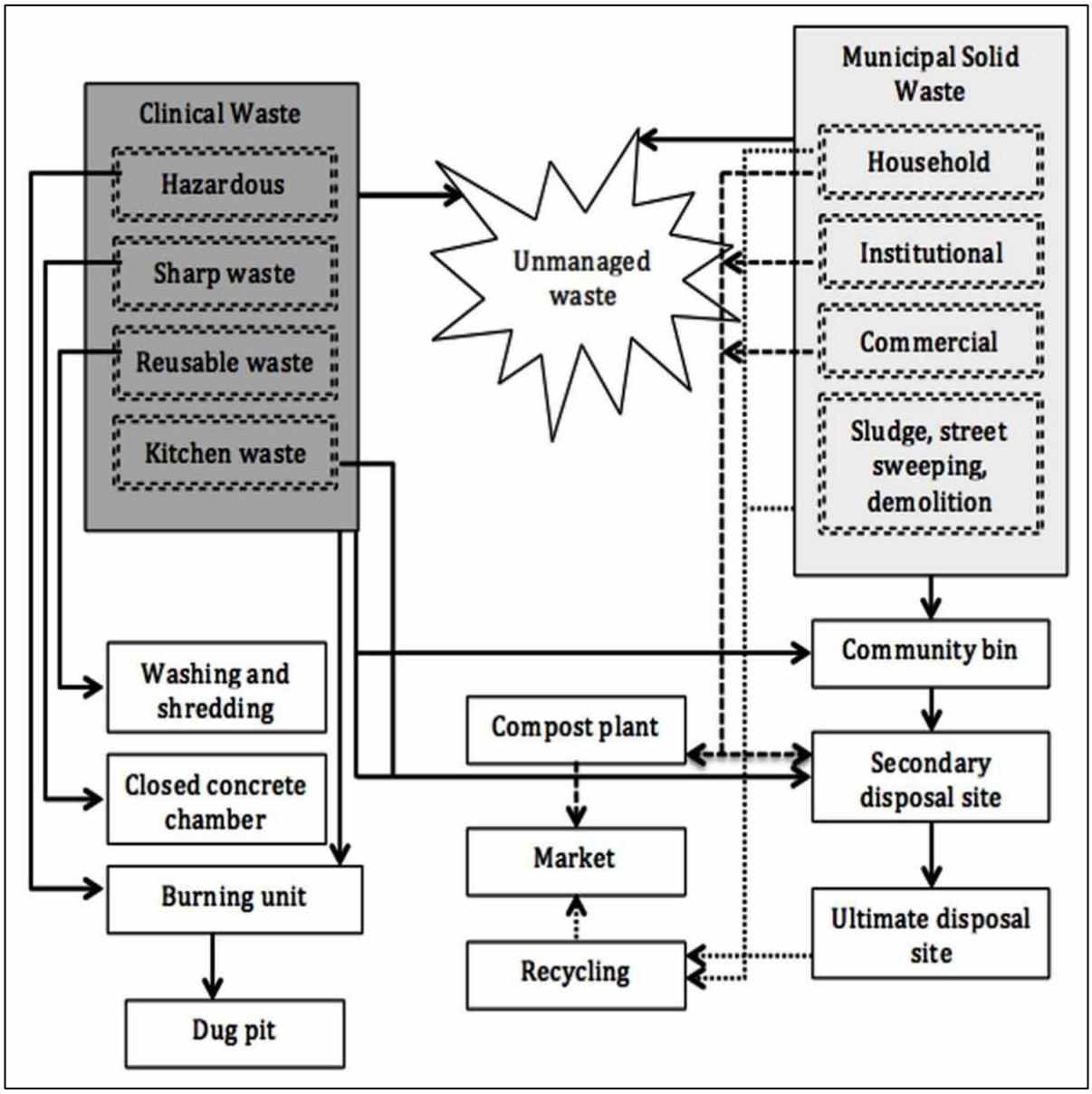

Figure 2.2: The flow of MSW in Bangladesh *(Source: Ahsan et al., 2014)*

The management of waste become complex and the facilities provided cannot cope with the increasing demand and needs. Therefore, best approach needs to be implemented immediately while considering environmental, social and economic aspects (Aye & Widjaya, 2006). The drivers of sustainable waste management were clarified by Ahmed & Huq-Hussain (2011), which include human, economic, institutional and environmental aspect. The study suggests some measures for taking necessary steps to keep the city nice and healthy.

According to department of environment, 2004, solid waste management is a complex, uncontrol and inefficient process. Details about solid waste management process of Bangladesh are shown in the below figure.

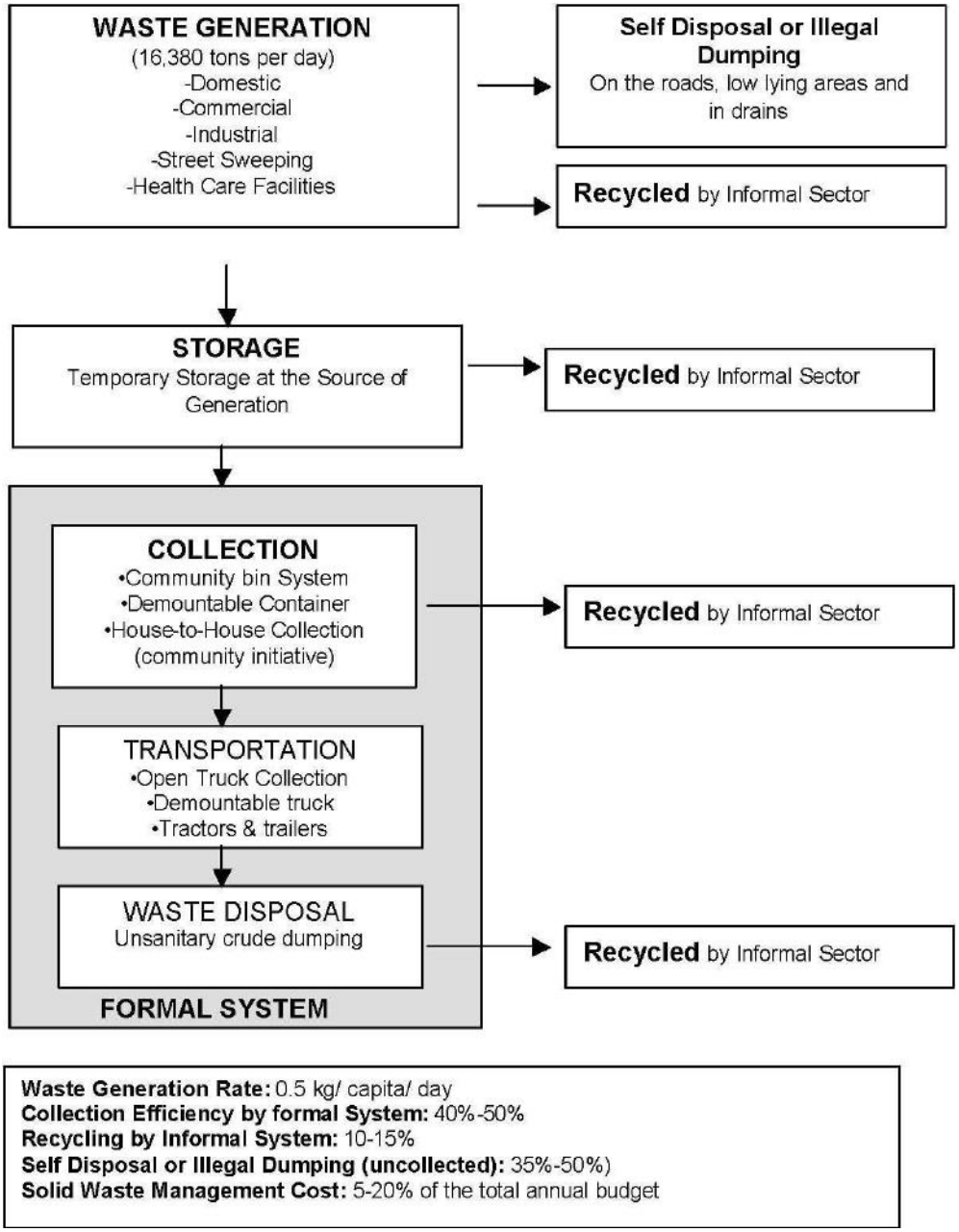

Figure 2.3: Solid waste management process in Bangladesh (DOE, 2004).

Waste is generated by the consumption of different sources. These wastes are stored at the source accordingly. Some are stored in organized way, some are left here and there, and some are dumped in open place and road sides. The collection procedure is also diverse. In some places, collection is made from door to door, in some areas collection is made from open

places and dumped at the dumping zone. As regards to waste transfer and transportation, some open and covered vans are engaged to carry waste from collection points. These collection vans carry wastes to the dumping zone and dispose of. Disposal takes place only in some designated places, limited reuse or recycle happens thereafter. Major collaborative initiatives of Solid waste management in Bangladesh are shown in the following table.

Table 2: Major collaborative initiatives of Solid waste management in Bangladesh

Sl no.	Major Initiatives	Inception Year	Funding Organization (s)
1	Recycling Training Centre	2006	Government of Bangladesh (GoB) and United Nations Development Program (UNDP)
2	Strengthening of Solid Waste Management in Dhaka City	2007	Japan International Cooperation Agency (JICA), Dhaka City Corporation (DCC) and Local Government, Rural Development and Co- operatives (LGRD&C)
3	Improvement of Solid Waste Management in Dhaka toward the low carbon society	2009	JICA partnership with DCC and LGRD&C
4	Preparation of Solid Waste Management Plan for 19 towns of Bangladesh	2009	United Nations International Children's Emergency Fund (UNICEF), GoB and Waste Concern
5	Urban Public and Environmental Health Development Project	2010	GoB, Asian Development Bank (ADB)
6	Bangladesh towards zero waste	2013	European Union (EU)
7	Value for waste (First Phase)	2013	Waste Concern, Swiss contact

Source: Authors' compilation 2019

2.4 Waste Management Technologies

In Bangladesh, the system of managing waste is unorganized. Figure 9 shows the process of managing waste in Bangladesh. From the functional point of view, the country has three (formal, informal and community) systems of waste management (Abedin & Jahiruddin, 2015). In the formal system, the municipal authorities are solely accountable for the overall management of waste-related activities. Informal waste management is done by a huge labor force mainly engaged in the trade of recycling (DoE, Waste Concern, & ITN-BUET, 2004; Ahsan et al., 2014). The initiatives of the CBOs and NGOs for collecting and managing the wastes from primary sources are known as community initiatives.

The technologies and methods used by the city authorities in Bangladesh are traditional and similar to other developing countries that are highly labor-intensive. The words “source reduction” seem to be unheard of by waste managing authorities. Informal sectors are involved in doing the recycling and reusing activities (DoE, Waste Concern, & ITN-BUET, 2004). People typically segregate valuable wastes to sell them to vendors. Pickers retrieve recyclable wastes from dumpsites, community bins or roadsides. With smart waste management technology, businesses are able to track their trash more closely than ever before. Not only can smart waste collection systems help to cut costs, but they can help to reduce your business's environmental impact. Waste management technologies basically depends local behavior and life style as well as development growth of the specific region or area. Department of environment have some specific technologies to manage waste in a systematic way in the urban areas of Bangladesh. The following figure and table show the detail of waste management technologies practices in Bangladesh.

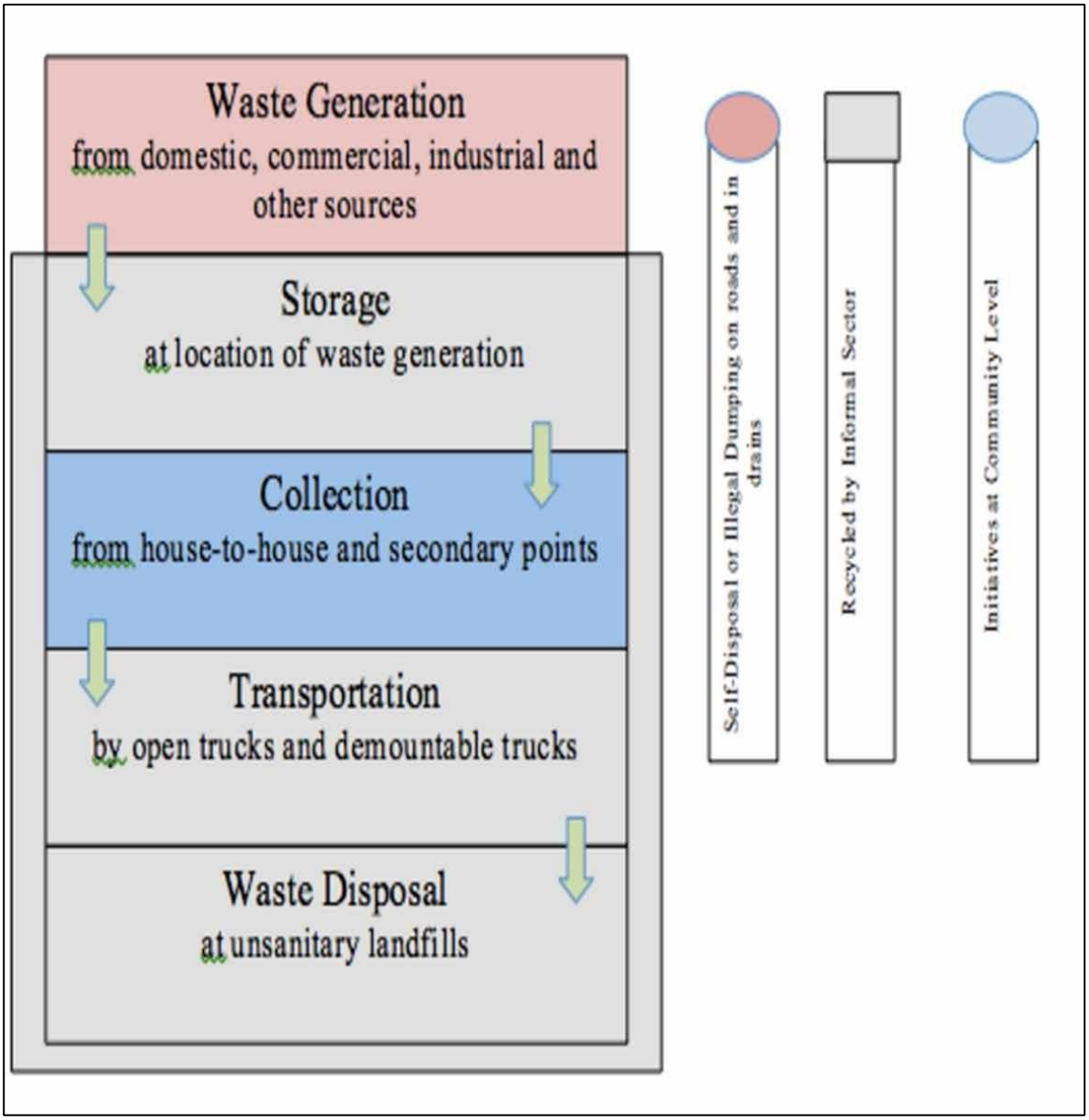

Figure 2.4: Waste management process in Bangladesh (Adapted from Abedin & Jahiruddin, 2015; DoE et al., 2004)

Table 3: Technology/ method used to manage urban solid waste (DOE, 2004)

Activity	Status in Bangladesh
Source Reduction	Reuse and recycling are done Segregation of recyclable waste with economic value (such as newspaper, bottles, cans, glass, plastic, metal, rubber and different containers. Soiled recyclables materials from the source of waste, dustbins and dumpsites are retrieved by waste pickers for their survival.
Collection	No provision storage exists at or near the point of sour. Waste is community bin System (brick, concrete or House-to-House Collection Designated Open Spaces).
Transportation	Conventional open trucks, demountable containers and tractors and trailers. No provision of transfer stations to transfer waste. The Multiple handling of waste exists. Waste mixed with contaminated. Transportation does not synchronize with the capacity of collection points.
Recycling	Most recycling is done through the informal sector and waste picking. Presently local government bodies are replicating. Waste Concern's model of community-based composting in a Recently using Clean Development Mechanism (CDM) under the Kyoto Protocol. Waste Concern along with WWR (a Dutch company) took an initiative for a 700 tons/ day capacity composting plant and land fill gas recovery project at the Mutual landfill site of Dhaka city.
Incineration	Not common or successful because of high capital and operation costs, high moisture content and low calorific value of waste makes waste not viable for at present few incinerators are used to manage health care related waste in a number of town and cities.
Land filling	Usually open crude dumping is adopted. This system is most unhygienic and Hospital waste, toxic waste and untreated industrial waste are also disposed of at the municipal landfill.
Costs	5-20% of annual municipal budget is used for Solid Waste Management

2.5 Hierarchy in Solid Waste Management

The entire management process starts from consumption, collection and disposal which includes resource recovery, re-use, recycling. Resource recovery includes all activities of waste segregation, collection and processing which are carried out taking into consideration the economic viability of the material (Cointreau 1984:14). Re-use and recycling provide an opportunity to capture some of the values from the waste. Of these two techniques, reuse is

a simpler process involving reutilization of material and recycling, on the other hand, involves processing waste through remanufacture and conversion of parts to recover an original raw substance**.** EPA has ranked the most environmentally sound strategies for municipal solid waste where source reduction (including reuse) is the most preferred method, followed by recycling, energy recovery, and treatment and disposal as the least.

Figure 2.5: Waste Management Hierarchy (*Source: Environmental Protection Agency (EPA), USA)*

2.6 The Integrated Sustainable Solid Waste Management Approach

Another alternative approach for solid waste management is called Integrated Solid Waste Management (ISWM). According to the United States Environmental Protection Agency (US-EPA), Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment.[10] On the other hand, integrated solid waste management refers to the strategic approach to sustainable management of solid wastes covering all sources and all aspects, covering generation, segregation, transfer, sorting, treatment, recovery and disposal

in an integrated manner, with an emphasis on maximizing resource use efficiency (UNEP-IETC).

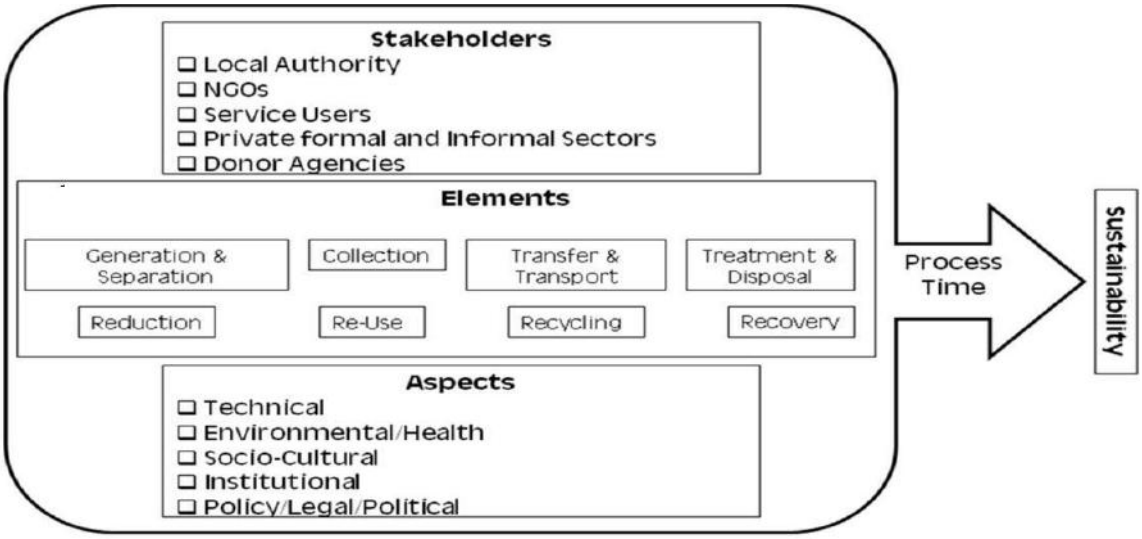

Figure 2.6: Integrated Sustainable Waste Management Framework (Source: UN-HABITAT, 2010 (adapted from WASTE, Gouda, Netherlands)

For the sustainable management of solid waste, the integrated sustainable waste management (ISWM) approach (as shown in the framework, Figure-12) that was first developed in mid 1980s by WASTE, a Dutch Non-Government Organization (NGO) and WASTE 's South partner organizations and further developed by the Collaborative Working Group on Solid Waste Management in Low-and Middle-Income Countries (CWG) in the mid-1990s. Since then it has become as a norm for waste management. The ISWM is a system approach that recognizes three main dimensions including stakeholders, elements, and aspects, which all need to be addressed when developing or changing a solid waste management system (UN- HABITAT, 2010:27).

The stakeholders are the people or organizations participating in solid waste management. This includes the waste generators who use the services, the service providers, the formal and informal private sector dealing with solid waste management, and other local or international institutions. Elements comprises the technical components of the waste management system starting from the generation of solid waste then the collection, transfer and transportation of waste to dumpsites or to treatment plant. Treatment ranges from reducing the size of the generated waste to recovery of the waste, in particular the

biodegradable component that comprises more than 60% of the total municipal solid waste generated in urban areas of the developing countries (Khatib, 2011:43).

In order to that the integrated waste management be sustainable, all required aspects, such as financial, social, institutional, political, legal, and environmental that assesses the feasibility of the management should be addressed in a sustainable way. The different dimensions are interrelated and their linkages institutionally, legally, and economically enable the overall function of the system. It could therefore, be indicated that ISSWM considers MSW management not just a technological system with infrastructure and facilities that facilitate handling and disposal of MSW, but it is a management system that consider and deals with many other elements including the socio-economic settings, the physical environment and growth in public demands and management scenarios.

2.7 Recycling and Composting

For the developing countries, large centralized and highly mechanized small-scale decentralized community-based composting plants can be considered as a suitable option for treating municipal solid waste as they reduce transport costs, make use of low-cost technologies, based mainly on manual labor, and minimize problems and difficulties encountered with backyard composting. Recently using Clean Development Mechanism (CDM) under the Kyoto Protocol Waste Concern along with WWR (a Dutch company) took an initiative for a 700 tons/ day capacity composting plant and land fill gas recovery project at the Matuail landfill site of Dhaka city. Very recently standard for composition of organic fertilizers including all wastes has been fixed in Bangladesh.

2.8 Generation and Management of Hazardous Waste

With the increasing use of chemical substances and electronic goods, the volume and number of hazardous wastes are also increasing rapidly in Bangladesh. Some people also buy the second hand or reconditioned electronic goods without considering the negative effects of these products on human health and environment. Majority of these end users dispose these goods and expose substances directly in their nearby environment (Nahar, 1998). The management of hazardous waste in Bangladesh is very much alarming. Most of the hazardous waste producers or importers are less conscious about the harmful effects of open dumping or exposing here and there. Aside of this, the legal and regulatory framework

is not followed properly. Govt. of Bangladesh introduce its regulatory framework in 1996 but it could not bring any significant changes to the behavior of people regarding hazardous wastes rather some people continuing their business on importing reconditioned goods and toxic chemicals. To control the transfer of hazardous waste outside national boundaries or transboundary movement, the Basel Convention was adopted in 1989 and in 1992 it entered into force. Transboundary movement according to his convention is "any kind of movement of hazardous waste at least between two separate nations or two separate national boundaries". In spite of being a signatory of the Basel Convention, Bangladesh could not strictly follow the provisions of the convention, as there prevails illegal imports of scrap and second-hand products from developed countries such as ship scraps and scrap metal from developed countries.

Brain-damaging mercury and toxic electronic and plastic wastes from the United States; cancer-causing asbestos from Canada; defective steel and tin plates from the EU, Australia, and the U.S.; toxic waste oil from the United Arab Emirates, Iran, and Kuwait; toxic zinc ash, residues and skimming; lead waste and scrap; used batteries; and waste and scrap of metals, such as cadmium, chromium, cobalt, antimony, hafnium, and thallium from Germany, Denmark, the Netherlands, the United Kingdom, Belgium, and Norway are all dumped on Bangladesh (ESDO, 2012).

2.9 SWM Practices in Bangladesh

Solid waste management in Bangladesh is now a growing concern. Although some municipalities have started and developed practices in managing huge wastes generated by city dwellers, they are not managed in a uniformed way. Bangladesh is one of the densely populated countries in the world (1,125 per sq km). Along with dense population, rapid urbanization is also a notable feature of the country. While the country 's total population has been increasing at about 1.4 percent per annum, its urban population has been growing at about 3.27 percent per annum. The above comparison clearly depicts the scenario of rapid urbanization. This process has resulted in most of the urban local centers that are mandated to provide urban health and environment related services. One of the most important services includes solid waste management which is facing a severe strain in keeping up with the increased demand on its infrastructural facilities and urban services. To analyze the SWM system of the country it should be considered the waste generation volume,

composition/characteristics of waste, its storage and collection process and the treatment & disposal activities.

2.10 Legal Framework for Solid Waste management

There are national and local levels of legal framework in relation to solid waste management. They are stated below.

National Environmental Management Action Plan (NEMAP): The Ministry of Environment and Forest (MoEF) has formulated this action plan. NEMAP has recommended for actions in the areas of sanitation, solid waste management, water supply and environmental awareness etc. Based on the findings and recommendations of NEMAP, the government has taken up projects like community-based water supply and sanitation, community based solid waste management and community-based wastewater treatment (GoB, 1995). **National Policy for Water Supply and Sanitation 1998:** The Ministry of Local Government Rural Development & Cooperatives has prepared this policy. Special emphasis has been given on participation of private sector and NGOs in water supply and sanitation in urban areas. Some solid waste and recycling related strategies under this policy are given below:

- Local Government Bodies (City Corporations and municipalities) may transfer, where feasible collection, removal and management of solid waste to the private sector.
- Measures to be taken to recycle the waste as much as possible and promote use of organic waste materials for compost and bio-gas production
- Private sector including NGO participation in sanitation is encouraged (GoB,1998).

Local Level Legal Framework: There is no adequate legislation in the country to address the growing problems of solid waste. The responsibility of removal and disposal of municipal solid waste lies with the City Corporations and municipalities. The six City Corporation Ordinances and Pourshava Ordinance 1977 are the only local law that gives some idea about disposal of municipal waste.

Following table shows the chronology of regulatory framework for waste management in Bangladesh.

Table 4: Chronology of regulatory framework for waste management in Bangladesh

Year	Legal Instruments	Key Features
1972	Constitution of Bangladesh (CoB) 1972	Article 18A of the CoB portrays that declares the state obligation to ensure and improve the earth and to protect and defend the characteristic assets, biodiversity, wetlands, woods, and natural life for the present and future citizens.
1992	National Environment Policy 1992	Distinguishes and manages exercises that degrade and pollute the earth.
1995	Environmental Conservation Act 1995	Provides definition of wastes and prescribes disposal standards for various kinds of waste.
	National Environmental Management Action Plan (NEMAP) 1995	3R is being advanced under the Sustainable Environment Management Program (SEMP).
1997	Environmental Conservation Rules 1997	Sets the standards for mechanical wastes and gushing release, and enterprises need to adhere with few principles to pick up a Clearance Certificate for their activity.
	Bangladesh Environmental Conservation Rules (ECR) 1997	Prescribes waste transfer benchmarks principally for industrial squanders.
1998	Urban Management Policy Statement 1998	Privatization of urban facilities for slum tenants, including arrangements of water and sanitation, and the waste transfer was prescribed.
	National Policy for Water Supply and Sanitation 1998	Guides the authorities of local government to engage private sectors for waste collection and management and taking waste recycling measures.
1999	National Agriculture Policy 1999	Advances utilization of manure and natural compost by farmers to enhance soil efficiency and food security.
2004	Private Sector Infrastructure Guideline 2004	Supports the private sector to invest in waste recycling and management activities. It has additionally distinguished the waste sector as one of the important sectors for private ventures.
	Dhaka Declaration on Waste Management by SAARC countries during 10-12, October 2004	The SAARC nations consent to support NGOs and privately-owned businesses to build-up community-based composting, segregation at the source, separate collection, and resource recovery from wastes, with specific focus on composting.
2005	National Industrial Policy 2005	Suggests the cleaner production practices in industries using Environmental Management Systems (EMS).
	Draft National Solid Waste Management Rules 2005	3R standard has been embraced unequivocally.
	Environment Management Plan 2005	Prioritizes reduction and recycling of wastes.
	National CDM Strategy 2005	Encourages CDM projects that are pro-poor by taking carbon financing into account.
	Poverty Reduction Strategy Paper (PRSP)	Emphasizes on source separation, recycle, reduce, and

	2005	reuse of solid wastes generated from various sources.
	Dhaka Environment Management Plan 2005	EMS was promoted among businesses along with recycling and less land filling. .
	Solid Waste Management Action Plan for Eight Secondary Towns in Bangladesh 2005	4R principle i.e. reduce, reuse, recycle, and recovery of waste was introduced in this plan.
	Private Sector Housing Development Guideline 2005	Proposes for waste recycling, composting and biogas generation space in housing areas.
	National Sanitation Strategy 2005	Assets recovery and recycling as an option in contrast to dumping is distinguished as key to improving urban sanitation.
2006	Fertilizer Act 2006	Composting was encouraged and a standard for compost was developed in 2008.
	National Urban Sector Policy 2006	"User pays" principle was proposed to extend services and reduce municipal costs.
	Lead Acid Battery (LAB) Recycling and Management Rules 2006	Brought changes in collection and recycling of LAB.
2007	Fertilizer Management Rules 2007	Management and standardization of fertilizer quality is emphasized.
2008	National Renewable Energy Policy 2008	Biogas production was promoted along with other green energy.
	Biomedical Waste Management Rules 2008	Source separation along with a separate SWM system development is recommended.
	Circular to Promote Compost by the Ministry of Agriculture (MoA), on 23 April 2008	Promotes compost use, reduce environmental impacts, as well as financial burden of subsidizing fertilizer.
	National Renewable Energy Policy, 2008	Promotes production of biogas and other green energy from waste and also supports incentives for CDM to encourage green energy projects.
2009	Local Government (City Corporations) Act 2009	Inhabitants should maintain buildings under city authority's jurisdiction.
	Local Government (Municipality) Act 2009	
2010	Bangladesh Environment Conservation (Amendment) Act, 2010	Amendment of ECA 1995.
	National Solid Waste Management Handling Rules 2010	Encourages 3R principles along with public participation in SWM process.
	National 3R (Reduce, Reuse and Recycle) Strategy for Waste Management 2010	Promotes user pay principles and 3R strategies as well as implementation of proper technology.

Year	Legal Instruments	Key Features
2011	Hazardous Waste and Ship Breaking Waste Management Rules 2011	Deals with ship-breaking and hazardous waste management.
	Sixth Five-year plan (FY2011-2015)	Emphasizes source separation and 3R approach.
	Ship-Breaking and Recycling Rules 2011	Deals specifically with ship-breaking and recycling issues.
	Land Use Policy 2011	Propose a definite site for managing e-wastes in every district.
	National Science and Technology Policy 2011	Encourages research and use of green technology for reducing waste as well as adverse effects of climate change
2012	National Agricultural Policy 2012	Promotes the use of compost fertilizer to improve soil productivity.
2013	National Environment Policy 2013	Recognizes 3R principles of waste management.
	National Information and Communication Technology Act 2006 (Amendment up to 2013)	Describes the relevancy to management of discarded ICT equipment.
2014	National Policy for Water Supply and Sanitation 2014	Recycling, composting and biogas production measures were promoted by GoB
	National Sanitation Strategy 2014	Regarding improving sanitation in urban area priority has been given to recycling and recovery than disposal only.
2015	Revised National Urban Policy 2015	Emphasizes Clean Development Mechanism (CDM) and recycling.
	National Information and Communication Technology (ICT) Policy 2015	For tackling climate change and managing disasters emphasize have been given on using green technology for e-waste management.
	Import policy Order 2015-2018	Forbids the import of products like reconditioned office hardware to reduce e-waste.
	Export Policy 2015-2018	For exporting e-devices and goods that are refurbished all restriction are withdrawn.
2016	National Industry Policy 2016	Administration will provide motivations to industry/businesses for properly managing waste using 3R techniques.

Source: Authors' compilation 2019

2.11 Problems of Solid Waste Management in Bangladesh

There are many problems and drawbacks of solid waste management in the urban areas of Bangladesh. The major ones are as follows:

- Absence of national policy to encourage recycling practice; Lack of proper handling rules and standard;
- Lack of finance, and inefficient tax collection; Inefficient practice of waste collection;
- Shortage of suitable lands for final disposal of solid waste;
- Lack of awareness about environmental problems associated with solid wastes
- Lack of partnership between public sector, private sectors and community groups

CHAPTER 03: Methodology & Approach of the Study

3.1 Research Design and Data Collection

Consultants and survey teams had gone through the Terms of Reference (Tor) with much deliberation, analyzed the main issues of the study background and identified the construction of the hypothesis to collect data from households, commercials, industries and medicals. Based on this analysis, the team had proposed a methodology for conducting the study, which covers the description of hypothesis, variables, study models, sampling methods, sample size, indicators for data collection, etc.

3.2 Study Methodology

The study had been designed to provide a comprehensive picture of the target households, commercials, industries, medicals and other relevant stakeholders with respect to documenting the pre-intervention data of the communities. Hence, to capture data on the present situation relevant to project interventions both qualitative and quantitative methods of data analysis was adopted.

All activities were revolved around the objectives set in the scope of work identified in the ToR. We understand that the baseline survey should include both the qualitative and quantitative approaches in the study. We had conceptualized our approach in a systematic and sequential manner. We had taken cognizance of the fact that some activities must precede some other works. Naturally, the activities were geared keeping in view the requirements of the project.

3.2.1 Data Sources Identification

For successful completion of the study, two sources of data - primary and secondary data were required. The main source of primary data was the sample household survey by using Face-to-Face Interview, which was covered under the quantitative approach. This study also suggested considering a qualitative approach under which it was conducted Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs).

The main sources of secondary data were the project proposal and other relevant documents that was suggested by the client. In some cases, information from the government sources were also considered if it requires supplementing the project-related data.

Accordingly, the structured questionnaire for Face-to-Face Interview (F2F) was used by ODK tools which was an open-source survey tool using smartphones as the main option for data collection from a household. Computer-Assisted Personal Interview (CAPI) was used for the collection of primary information.

Key Informants interviews (KII) were conducted to get more insights on the subject matter from the relevant stakeholders, including local government institutions. Key informants were selected from the NCC's staff, NCC's waste management department, conservancy officer, medical officer, general section of NCC, town planner of NCC, representatives from relevant NGOs, local leaders, councilors etc.

However, to develop the data collection instruments (DCI), and to crosscheck the collected data, the consultants had reviewed relevant literature and other documents. Similarly, for secondary data, articles from journals, newspapers, monographs, booklets and brochures published by the relevant government departments of the government were reviewed. NGOs, CBOs, and local groups were consulted for gathering overall information.

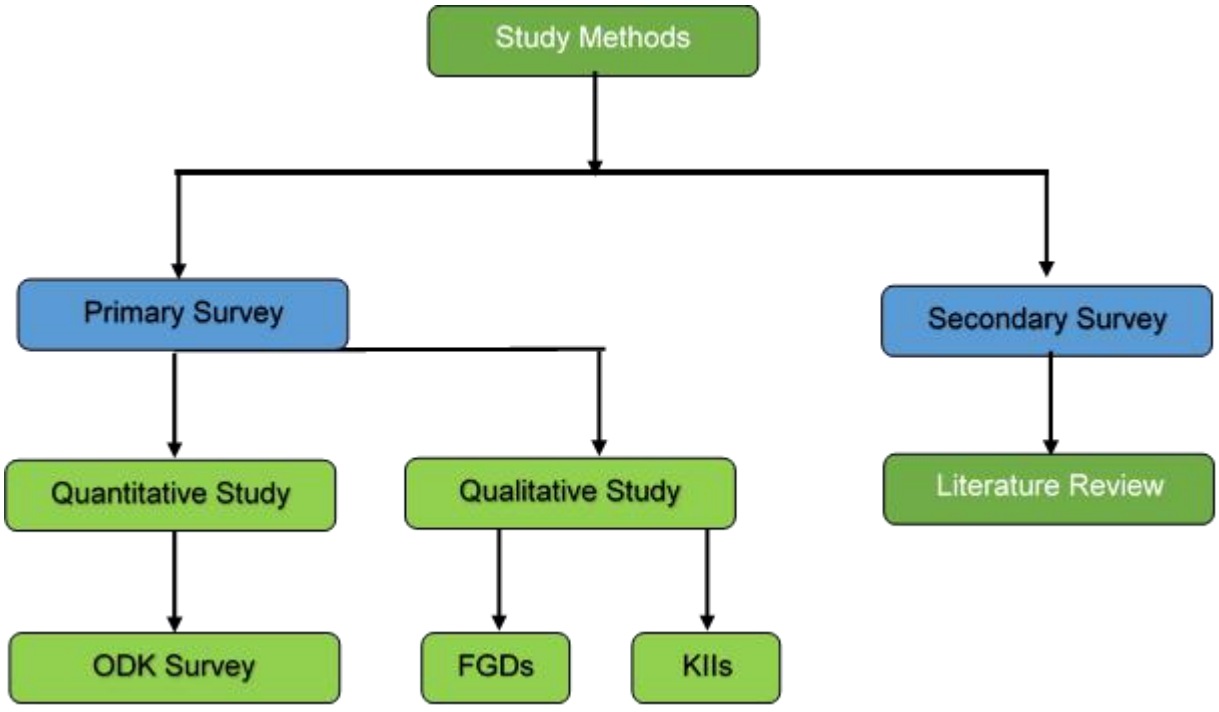

Figure 3.1: Detailed Data Source Process

3.3 The Study Tools

The developed tools and techniques were grounded in the study area for pre-testing. The study team conducted mock surveys for a proper quality check of the tools and techniques.

3.3.1 Field Staff Training/Pre-Testing of Questionnaire

The consultant research team arranged a day-long briefing for the field teams on study objectives, respondent identification and questionnaire administering and data collection process by using **Open Data Kit (ODK)**. The survey coordinator, supervisors, quality controllers, field controllers and interviewers, the data entry staff, and the data-entry manager participated in the training sessions, which was held at the Consultant's office. The Consultant arranged all the necessary coordination including interpretation. The training sessions conducted by the Survey Coordinator, covered:

- Debriefing on the objectives of the study, quality control mechanisms, and overall conduct of the project
- A detailed explanation of each question
- Instruction on how to properly fill out the questionnaires (convention for numeric variables, the importance of legal values, how to differentiate and write replies such as non-applicable, refusal to answer, do not know, and so on)
- Issues related to data entry and cross-checking of questionnaires
- Techniques to secure participation, interviewing techniques, how to handle demanding situations and common occurrences, probing techniques to secure the process of how to use a tablet device
- Mock interviews to test the interviewers
- Coordination and schedules

Pilot interviews were conducted under the supervision of the study coordinator to carry out actual field data collection, which was also used as a pre-test exercise for gathering information and understanding of the issues centering around the study as well as the processes and system involved in observations and data collection.

Figure 3.2: ODK Team preparation for field work

3.3.2 Field Work Logistics Plan

Four types of assessment tools were proposed at that stage: demographic data, present waste generation, and disposal, sanitation, recycle related data and focus group discussions (FGDs) with representatives from the local authority or, interviews of representatives from the local authority (KII) in NCC. Demographic data, quality-related data, sanitation, hygiene, and health-related data were collected, segregated by categories and quantities of each category measured by Surveyors with expertise on database management. FGD or KIIs; set of open-ended questions were set up allowing participants to voice their opinions and concerns and allowing moderators to measure answers.

Figure 3.3: Training with Open Data Kit (ODK) software

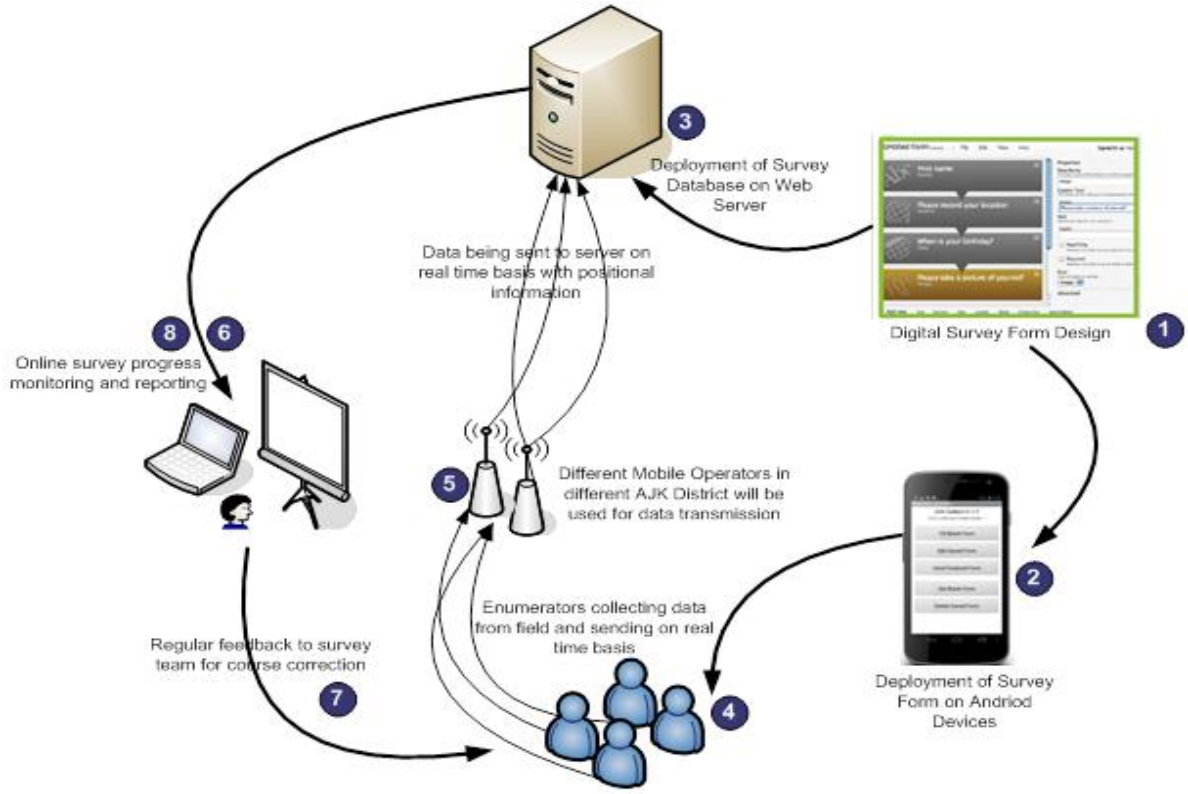

Figure 3.4: Survey process to collect the data

One expert and Coordinator supervised the study and recruited 6 external fixed surveyors. The coordinator and surveyors documented the survey activities and recorded the data following the customized questionnaire format. The required logistic support, Consultants & their remunerations, Coordinator & Surveyor recompenses, Transportation, Camera,

Stationaries, equipment etc. were provided at the expense of Onushandhani Creeds Ltd. Under the supervision of the Coordinator.

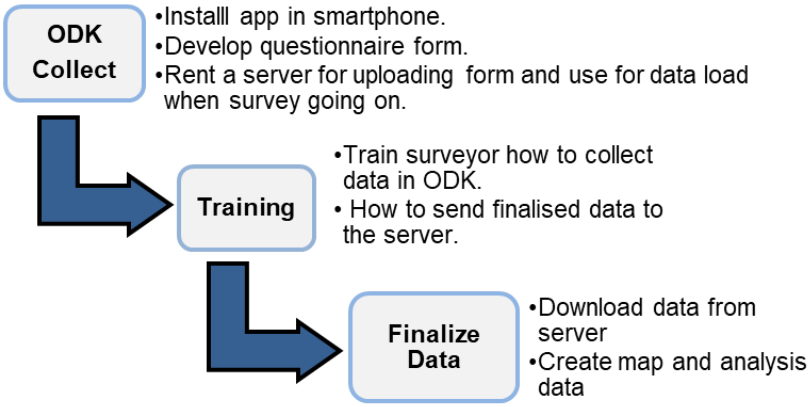

Figure 3.5: Open Data Kit (ODK) collection steps

3.4 Details about Data Source and Data Collection Procedure

This study has been conducted mainly based on the primary data which was collected through field survey, laboratory analysis of samples as well as structured questionnaire surveys, polythene beg distribution and collection survey, Key Informant Interviews (KII) and Focus Group Discussions (FGDs), landfill site visit, compost plant visit, observations and similar SWM project visit. Secondary data will also be collected from NCC office and other related authorities. Both qualitative and quantitative data were collected to conduct this study. A set of questionnaire and formats had been developed to collect the primary data. In addition to primary data, secondary data had been collected and reviewed, mainly regarding the recent Government of Bangladesh strategies, acts, rules and guidelines as well as PPP document for Waste to Energy projects in urban areas especially in NCC area. Moreover, Bangladesh Bureau of Statistics data regarding population of the city was reviewed, projected and updated.

Details of data collection approach for different tasks according to ToR are presented in the following sections:

- Collection of relevant SWM data of NCC
- Structured sample survey for households and commercial entities
- Structured sample survey for Industrial and Medical waste
- Structured sample survey for open dumping points of STS
- Polythene beg distribution and collection survey

- Key Informant Interviews (KII)
- Focus Group Discussions (FGDs)
- Observation of the consultant
- Alamin Nogor Temporary Landfill Visit
- Proposed Landfill Site Visit
- Ponchhoboti Compost Plant Visit
- Similar SWM Project Visit at Jessore
- Designated Open Dumping Point Visit
- Secondary data collection
- Review of strategies, acts, rules and guidelines
- Qualitative and quantitate study on waste generation
- Geological study of the proposed landfill site
- Topographic survey of the proposed landfill site and GIS mapping

All the collected data were analyzed and then a comprehensive SWM Master Plan is prepared for NCC. Detailed process of data collection, analyses and master plan preparation have been discussed below:

3.4.1 Collection of Relevant SWM Data of NCC

A structured 'Solid Waste Management Data Sheet' (attached in Annex 1) had been developed for collection of required SWM data of NCC. The data sheet focused on the data on current SWM practice, manpower, equipment and vehicles, collection & transportation mechanism, disposal site, budgetary provision and actual expenses on SWM by NCC. Current waste collection, transportation and disposal practice were reviewed – both gaps and good practices were identified. Budgetary provision of SWM and income and expenditure in the same field will also were reviewed. The data sheet also focused on data on current and future SWM projects of NCC. Besides, the study had given special focus on generation of kitchen, market waste, hospital waste, residential waste, fecal waste etc.

Data were collected on the current recycling practice of NCC and daily generation of recyclable wastes and how they are managed. Supply chain of different types of recyclable materials were reviewed. Exploratory study was carried out to reveal which recyclable materials are still discarded and why. Efforts was given to assess generation of different types

of wastes (including medical and hazardous wastes) from hospitals, clinics, diagnostic centers and other health facilities located at NCC. Provision of health facilities, annual health check-up facility and Personal Protective Equipment (PPE) were also reviewed for both SWM workers and van drivers involved in daily waste collection.

3.4.2 Structured Sample Survey for Households and Commercial and Industrial Entities

Two sets of structured sample survey questionnaires had been developed – one for residential household survey (attached in Annex section) and the other for survey of the commercial and industrial entities (attached in Annex section). The questionnaires had focus on quantity and quality of generation of different types of wastes, waste storage mechanism at source, waste collection process, behavioral pattern of waste generators and waste collectors, willingness to pay for better and environment friendly SWM, willingness to promote recycling and use recycled products.

Structured questionnaire for Face-to-Face Interview (F2F) had been used by ODK app which was an open source survey app using smart phones as the source for data collection from different households or commercial entities. Computer Assisted Personal Interview (CAPI) has been used for the collection of primary information.

Study Area: Whole of Narayanganj City Corporation (NCC) area.

NCC comprises of 27 wards and all of it was selected for survey. Sample size was selected using the sample size calculator with a confidence level of 95% and confidence interval at 5.

3. 4. 2. 1 Study Population

The ODK Survey was conducted with randomly selected households and commercial entities. At confidence level of 95% and confidence interval at 5, the maximum sample size for any population was 384. Hence, the sample size is defined as 384, and it was decided that random sampling survey was carried out representationally at each ward of NCC. Besides, it was also decided that around 90% of the total sample survey was carried out with residential households and the remaining 10% was carried out with commercial and industrial entities.

3.4.2. 2 ODK Data Collection Steps

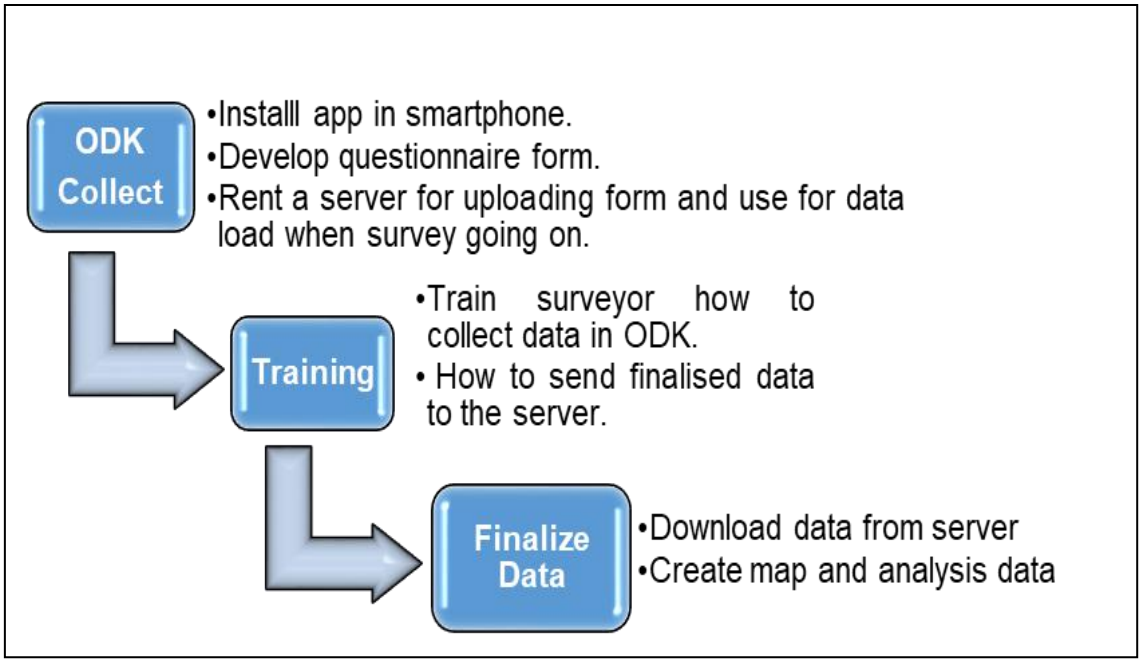

Figure 3.6: ODK Data Collection Steps

Study Tools: The ODK app was designed with mostly structured and few open-ended questions. Open ended questions were setup for allowing participants to voice their opinions and concerns and allowing surveyors to collect their opinions.

ODK Data Collection Training: The ODK Surveyors were provided training on the SWM questionnaires and process of data collection.

Study Team: The Solid Waste Management Expert and a Coordinator supervised the study area and also orientated surveyors. Coordinator and surveyors documented the survey activities and recorded the data following the customized ODK format.

Figure 3.7: ODK Data Collection Team

4. 2. 3 Key Informant Interviews (KII) and Focus Group Discussions (FGDs)

At least five key informant interviews and five focus group discussions were carried out for conducting the study. During KIIs and FGDs the focus was on quantity and quality of generation of different types of wastes and how they can be collected in source-separated manner, effective waste storage mechanism at source, environment friendly waste collection process, behavioral change of waste generators and waste collectors, willingness to pay for better and environment friendly SWM, willingness to promote recycling and use recycled products. During discussion on each of these topics, current practice and gaps were identified and focus was given how the gaps can be minimized and better and effective environment friendly practice could be promoted. Apart from all these, the issue of generation of hazardous wastes (solid, liquid and gaseous) at the local industries were discussed in detail – what is generated, how it is disposed (whether in environment friendly manner or not), where are the gaps and how the gaps can be minimized, whether any good practice is being done somewhere or not, how the good practices can be promoted etc.

Participants of KII and FGDs

1. Project PD
2. Assistant Engineer
3. Town Planner

4. Waste Management Department of NCC
5. Conservancy Officer
6. Medical Officer
7. Finance Department
8. General Section of NCC
9. Councilor of NCC
10. Workers who were involved with SWM of NCC
11. General People of NCC

Figure 3.8: Picture of focus group discussion and KII with the workers and supervisor of Alamin Nogor Temporary Landfill Site with SWM of NCC

3.4. 2. 4 Proposed Landfill Site Visit to Prepare the SWM Master Plan for NCC

Acumen Architects and Planners Ltd, the consultant had visited the proposed landfill site of Narayanganj City Corporation in the beginning of this consultancy service. This proposed landfill site is situated at Jhalkuri along the Narayanganj-Jhalkuri Road. The whole team visited the proposed landfill site to conduct this study as well as for the premilinary understanding about the whole project and assign tasks. Drone survey team had conducted drone survey to find 3D view of that site and connectivity with surrounding areas. The consultant also collected Muza Map of the proposed landfill site for design works and area demarcation. Soil test, hydrogeological survey and environmental analysis were done to prepare the master plan for this proposed landfill site. The following pictures show the picture of consultant's site visit and proposed landfill site at Jhalkuri of Narayanganj City Corporation.

Figure 3.9: Picture of proposed Landfill site at Jhalkuri in NCC

Figure 3.10: Picture of proposed landfill site visit with NCC authority and drone survey team

3.4. 2. 5 Alamin Nogor Temporary Landfill Visit to Understand the Existing SWM System of NCC

To conduct this study, the consultant had visited all the important solid waste management related sites and places. As a part of those visitation, Alamin Nogor temporary landfill site visit was one of them. All the solid wastes from households, commercial area, industrial area, open dumping points etc. are come at Alamin Nogor temporary landfill site. Now it is 70-80 % filled up. Basically, wastes from Narayanganj and Siddirganj are come at this temporary site. The waste of Kadam Rasul does not come here. Truck, van and hand trolley are used to transport the waste of Narayanganj City Corporation. It is not environmentally permittable, that's why Narayanganj City Corporation already has faced case by department of environment. To have a gross idea about solid waste management of Narayanganj City Corporation, this site visit was necessary. This site visit helped the consultant team to understand the whole existing solid waste management system of Narayanganj City Corporation. The following pictures show the temporary landfill site of Alamin Nogor.

Figure 3.11: Picture of Alamin Nogor Landfill site visit

3.4.2.6 Ponchhaboti Compost Plant Visit to Understand the Existing Use of Waste in NCC

To develop the consultant understanding about current NCC's waste management and waste market, the consultant had visited a compost plant at Ponchhaboti in Narayanganj. The consultant had a discussion with the supervision of Ponchhaboti compost plant about the source of raw waste, transportation of those raw waste, procedure of composting, incineration and waste to fuel production. This compost plant is producing organic fertilizer by using the perishable solid waste of Narayanganj City Corporation. They are also producing petroleum from plastic and polythene. They are struggling with the production of fuel from plastic and polythene. This site visit helped the consultant to understand and extend the scope of this consultancy service. It helped to think this waste not to think as waste but to think as wealth. It helped to create a market for solid waste in Narayanganj City Corporation.

Figure 3.12: Picture of Ponchhaboti Compost Plant Visit

3.4.2.7 Designated Open Dumping Point Visit to Calculate the Total Amount of Generated Waste in NCC

To calculated the total amount of commercial, small scale industrial and to some extent medical solid waste, the consultant had visited several open dumping points in Narayanganj City Corporation. According to Waste Management Department of Narayanganj City Corporation, there are lots of open duping point (designated and undesignated) in NCC. But Narayanganj city corporation is responsible for only 80 open dumping points which were designated and operating by the waste management department of Narayanganj City Corporation. Most of the open dumping points are along the main road and in market place of NCC. Not only the household waste but also the commercial and industrial waste is also thrown in these open dumping points. Waste from roadside commercial, industrial, household even hospital comes at open dumping points through individuals, hand trolley or rickshaw van. Every day city corporation truck comes and takes out the waste of those open dumping points at morning and sometimes evening. There are more than 20 open dumping points from where city corporation vehicle (Trucks) come twice (Morning and evening) to collect waste from those open dumping points. We can have a picture of existing amount and type of generated waste from this open dumping point visit. The consultant with waste management department of NCC has visited 23 open dumping points in Narayanganj. The following pictures show the open dumping site visit at Narayanganj City Corporation with the waste management department of NCC.

Figure 3.13: Picture of open dumping points visit with waste management department of NCC

3.4.2.8 Warehouses of Broken Material Visit to Calculate the Total Amount of Generated Waste in NCC

Acumen, the consultant had also visited the warehouses of broken material to calculate the amount of waste which come at those warehouses. There are more than 250 warehouses of broken material in Narayanganj city corporation. Broken materials, cloth or textile, wood, leather, rubber, plastic, paper and other wastage substances (miscellaneous items) are basically come from households and commercial area. These wastages are not only come from the Narayanganj City Corporation area but also from the outside of the city corporation area. The consultant has visited several warehouses of broken materials, cloth, wood, rubber, leather, plastic, paper and others wastage substances. The wastage of those warehouses can be recycled and reused and disposal waste also can be used in waste to energy production. The following pictures show the site visit of warehouse of broken materials.

Figure 3.14: Picture of visitation of warehouses of broken materials at NCC

3.4.2.9 Similar SWM Project Visit at Jessore to Enrich the Understanding about SWM of the Consultant and Waste Management Department of NCC

The consultant with NCC's authority and waste management department had visited a similar solid waste management project at Jessore. The consultant had arranged this field visit to enrich their understanding on municipal solid waste management.

Figure 3.15: Picture of Jessore SWM Plant visit by NCC & Acumen

Jessore SWM plant is one of the most advanced solid waste management plant of Bangladesh in recent time period. It was started its journey from 2017 with ADB fund. There is compost plant, bio-gas plant, waste to energy plant and fecal sludge management plant in the Jessore SWM plant. They are using modern technology to manage the waste of Jessore.

Figure 3.16: Picture of Jessore SWM Plant (New landfill site and bio-gas plant)

Figure 3.17: Picture of Jessore SWM Plant (Landfill site and waste separation and crushing plant

Jessore was not a populated city like Narayanganj City Corporation. Jessore is also not an industrial city like NCC. So, the development growth of Jessore is totally different from Narayanganj City Corporation. The urbanization rate of Narayanganj City corporation is much high compare to Jessore. This similar project visit helped the consultant to understand the local approach for solid waste management. It was also helped the NCC's waste management department as well as NCC's waste concern authority to develop more their current solid waste system of Narayanganj City Corporation. The Jessore SWM plant was considered to prepare the solid waste collection and disposal management of Narayanganj City Corporation. This plant also helped to prepare the land use plan/ site plan/ layout plan for the

proposed landfill site. Following pictures show the similar site visitation at Jessore with NCC's authority and waste management department of Narayanganj City Corporation.

Figure 3.19: Acumen's (Consultant's) Jessore SWM Plant Visit

Figure 3.18: Discussion with waste management worker of Jessore

3.4.2.10 Secondary Data Collection

Attempts were made to collect as much relevant secondary data as possible. Publications, journals, newspaper clips, media coverages were collected and reviewed to get as much secondary data on SWM of NCC as possible. Besides, BBS Census data was also be collected. Besides, the population data of BBS was also be projected to current date and further projection was done for future planning.

3.4. 2.11 Review of Strategies, Acts, Rules and Guidelines

This was included review of the recent government strategy, acts, rules and guidelines relevant to SWM of Narayanganj City Corporation. Following were the list of most plausible documentation that were collected and reviewed at least:

- 5R principles (Reduce, Reprocess, Reuse, Recycle and Recover) of waste management
- National Industry Policy 2016
- Revised National Urban Policy 2015
- National Environment Policy 2013
- Hazardous Waste and Ship Breaking Waste Management Rules 2011
- National 3R Strategy for Waste Management, 2010
- Local Government (City Corporation) Act 2009
- Solid Waste Management Handling Rules, 2010
- Bangladesh National Climate Change Strategy and Action Plan 2009
- Bangladesh Bureau of Statistics (Urban Area Report)
- Bangladesh Bureau of Statistics (Environment Survey Report)
- National Sanitation Strategy 2005
- National Policy for Water Supply and Sanitation, 1998
- 3 R project document for Dhaka and Chittagong
- Programmatic CDM project on composting in 64 districts of Bangladesh

3.4.2.12 Qualitative and Quantitative Study on Waste Generation

Based on data received from NCC as depicted above and household/commercial/industrial entities survey data as depicted above; average per capita daily waste generation was estimated. By multiplying the average per capita waste with the current population, total daily waste generation was estimated. These data sources were provided an estimation of generation of different types of waste – how much is bio-degradable, how much is non-bio-degradable but recyclable, how much is hazardous and how much are not worthy of recycling at all and will have to be disposed at the landfill site. In addition, few samples of generated wastes were sent to laboratory determination of chemical composition and viability of the generated waste towards 'waste to energy' recycling or any other recycling options.

3.4. 2.13 Geological Study of the Proposed Landfill Site

To conduct the master plan for SWM of NCC, it's required to collect the geological data (the liquid and solid substances that form the earth of NCC) of proposed landfill site of

Narayanganj City Corporation. Geology study was included the examination of the composition, properties, and history of the earth materials. The technique of their formation, movement, and changes involved were also studied during geological study. It was a systematic examination of an area to determine the character, relations, distribution, and origin or mode of formation of its rock masses and mineral resources. It included topographic mapping by using modern surveying instruments. This geological survey was also concerned with the methodical study of the subsurface for creation of geological maps. Several geological techniques were used for this purpose, including the conventional visual survey, studying of landforms, hand and machine-driven bore holes, remote sensing systems like satellite imagery and aerial photography. Its purpose might be either purely scientific or economic with special attention to the distribution, reserves, and potential recovery of mineral resources.

3.4.2.13.1 Geological Surveying Techniques to Conduct the Task

Numerous surveying techniques were used for geological surveys like laboratory test results, and modeling approaches to understand the characteristics of the earth. In the usual geological surveying, the primary information was concerning the study of rocks, their location, and the deformation and examination of the sedimentary layers. In addition, the soils, landscapes, rivers, and glaciers were examined. Usually the surveying tasks included:

a. Structural mapping to indicate the location of the main rocks and the faults due to which they were placed there
b. Surficial mapping for the location of soils
c. Survey of topographic features
d. Formation of topographic maps
e. Survey to identify changes in landscapes, erosion patterns, and river channels
f. Subsurface mapping by seismic surveys, ground penetrating radar, and electrical tomography

3.4.2.13.2 Preparation of Geological Maps

A geological map was produced for Narayanganj to illustrate geological features. Rock units was identified by color, while the structural features like faults and folds was indicated by

symbols. This geological map was considered to be one of the major tools to communicate or decode information relating to the surface of the earth. It was also used for the interpretation of the structure, mineralogy, stratigraphy, and paleontology of the earth crust. Geological maps were also used to identify potential hazards, for which necessary precautions can be taken.

3.4.13.3 Hydro geological Survey – Methodology

To collect essential information on aquifers, their extension, their boundaries and their lithology, and on the depth to water level need geological and hydro geological data. This information was sufficient to determine whether or not the aquifers were continuous within the area considered for the livestock water supply project. In addition to the classical geological and hydro geological maps, satellite images might provide complementary information on geological formations and structures. Aerial photographs might also be available and geophysical surveys have been made for many regions.

The results to be expected from a preliminary survey were summarized below:

- Geological setting,
- Hydraulic continuity,
- Groundwater quantity and quality assessment and expected water demand,
- Depth to water from the ground,
- Physical characteristics of the formation to be penetrated to reach water.

3.4.13.4 Soil Test

There are a few different soil testing methods used by labs today, but it is the results of those tests that are most important. Lab results were loaded with technical jargon, often with little explanation as to their meaning or how to use the information recorded. Labs might offer different types of tests or may only offer tests bundled together.

Most Common & Basic Lab Tests

Here were the basic soil tests:

- Testing for soil pH and buffer pH and required amendments if needed. The correct pH is based on grass species or plant requirements.
- The macro nutrients- Nitrogen, Phosphorus, Potassium.
- Your soil's composition with percentages. What is included varies with labs.

- Soil calcium.
- Micronutrients are sometimes included, while other labs will offer them with an additional charge.

The kit tests for soil pH, soil nitrates, soil salinity, soil compaction, soil texture, soil respiration, and more. Manufacturers offer kits with a wide variety of tests.

Field Works:

1. Exploratory Boring Drilling
2. Standard Penetration Test
3. Extraction of Soil Sample

Laboratory Tests:

1. Natural Moisture Content
2. Complete Grain Size Analysis
3. Waterberg Limits
4. Specific Gravity Test
5. Calorific Value Test
6. BOD and COD Test
7. TS (TSS & TDS) Test
8. Material Composition Test
9. Unconfined Compression Test
10. Consolidation Test

Engineering Properties:

i. Compressibility

3.4.14 Topographic Survey of the Proposed Landfill Site and GIS Mapping

A Topographic Survey is a survey that gathers data about the elevation of points on a piece of land and presents them as contour lines on a plot. The same phenomenon can be represented as the Digital Elevation Model (DEM). The purpose of a topographic survey was to collect survey data about the natural and man-made features of the land, as well as its elevations. This was especially important for the ground undulation for modelling purpose.

The project area is approximately 23 acres which is located in the ward no 09 of the Narayanganj City Corporation (NCC) as per ToR which is indicated in the Map below. In this connection, approximately 30 hectares' land had been surveyed including the surrounding land of the project site in order to assess the adjoining topographic elements accordingly.

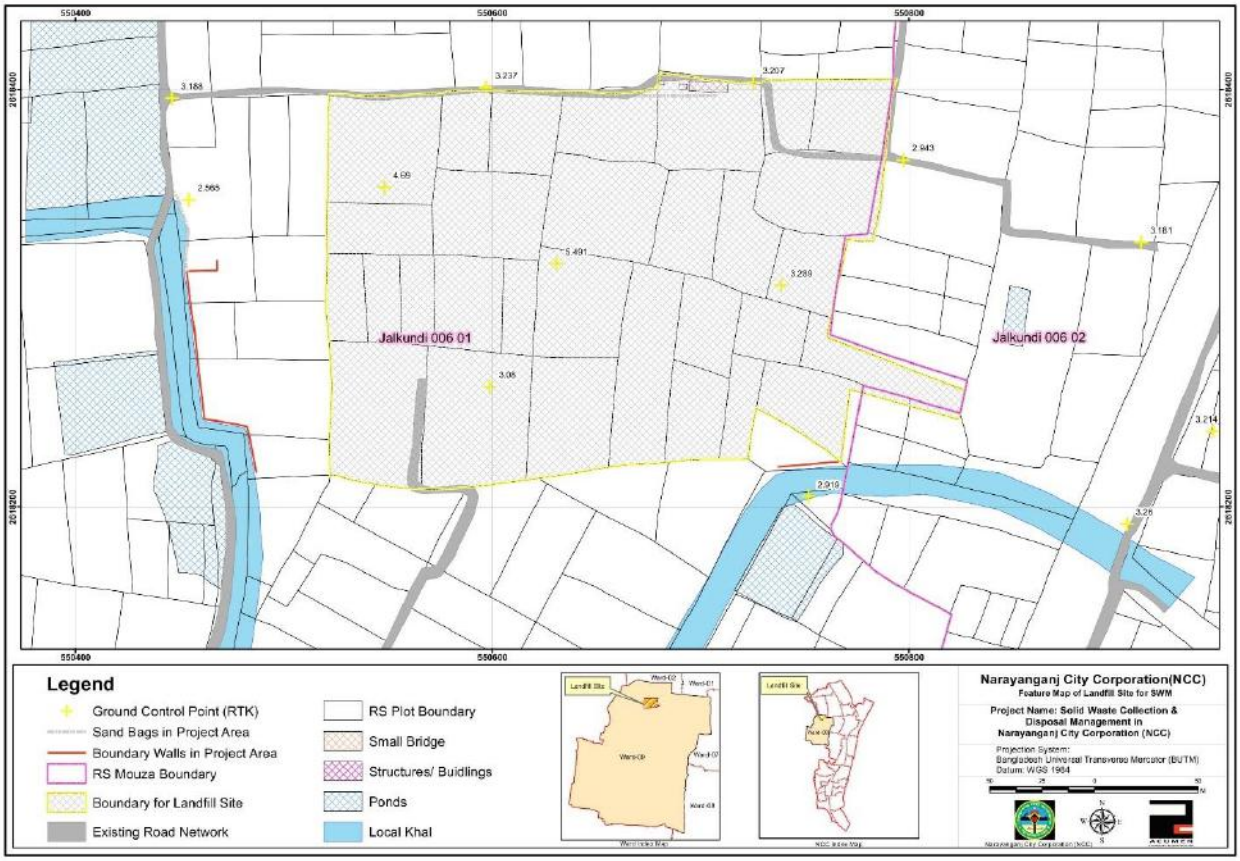

Figure 3.20: Base Map with RL value of Proposed Landfill Site

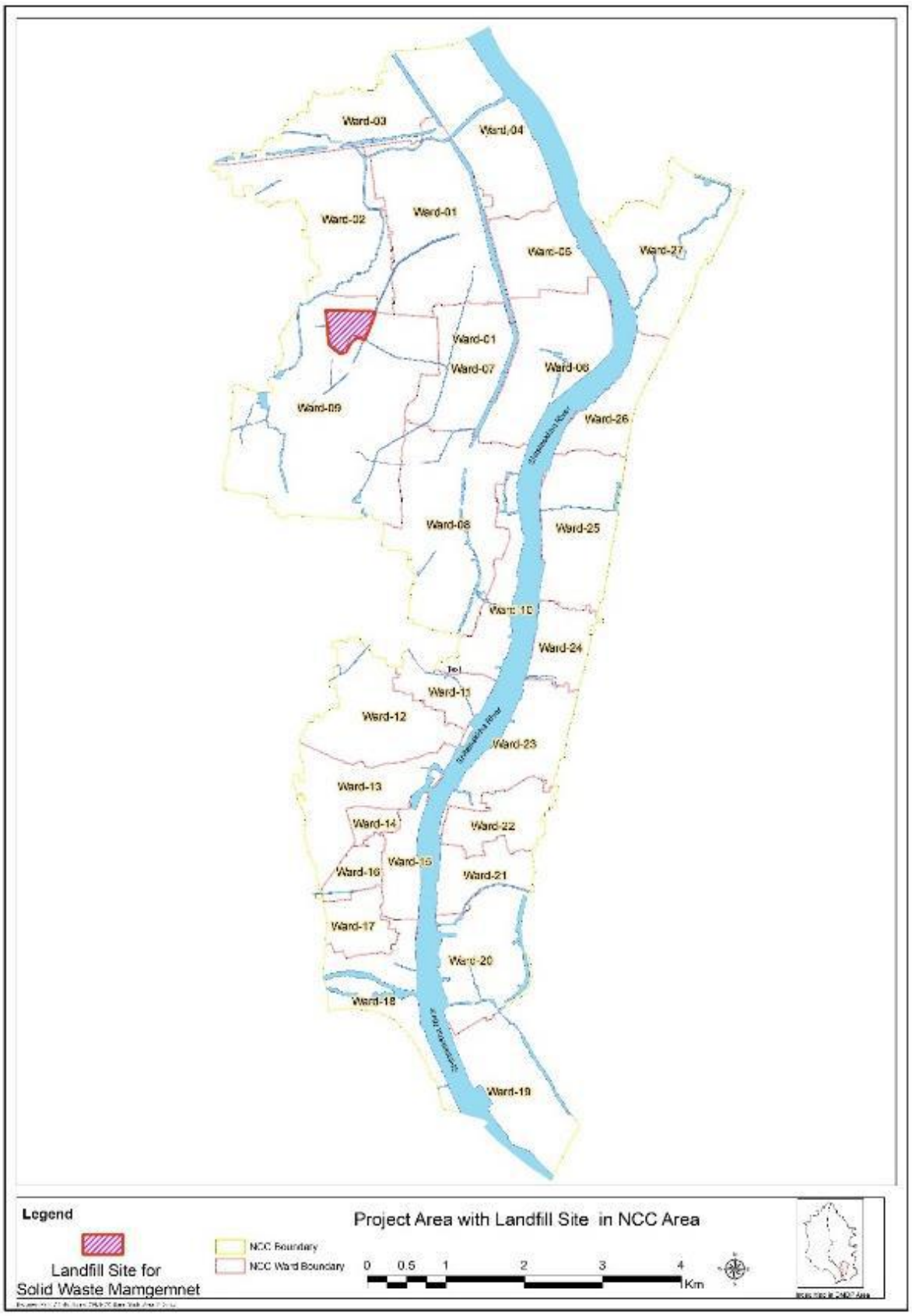

Figure 3.21: Proposed Landfill Site on Base Map of NCCC

3.4.14.1 Required Survey Items & Outputs

The survey was carried out for identifying both man-made and natural objects in the project area. This was done using Hand GPS for features, Total Station for Land Levels, RTK for the Ground Control Points (GCP) GPS for collecting information in the field. The UAV (Unmanned Aerial Vehicle) was used for collecting very high resolution of Images for the Land fill site with a view to making better plans for Implementation. The focuses were given on the following survey categories in order to fulfill the requirements of the Terms of References (ToR).

Feature Survey

This survey was covered the important man-made and natural feature's location with the help of GPS technology which were highly related to the solid waste management issues of the Narayanganj City Corporation (NCC). The result of this survey gave a clear understanding about the project area. This was paved the way for making effective plans for implementation. Feature Maps was composed with collected information for visualization of the features spatially arranged in the project area.

Land Level Survey

This survey was performed mainly with the Total Stations for collecting the height of land levels in accordance with the vertical reference of Survey of Bangladesh (SOB). The individual point measurement was connected to the permanent Bench Mark from the Survey of Bangladesh. We have had a look for identifying the permanent bench mark adjacent to the project area. We found the SOB BM GPS543. Contour Map and Digital Elevation maps was prepared for representing the ground surface undulation for the project area.

Land Use Survey

There are different types of land uses on ground which are connected to the generation of solid wastes of various types. Households, Factories, Market Places and Hospitals generate different types of wastes which needs special attentions for managements. We need to know the uses of the land parcels in and adjacent to the project area. Land use Maps was generated for demonstrating the uses of the different uses on individual parcels.

UAV Survey

This is one of the most state-of-the-art surveying techniques used for collecting spatial data for development projects. The procedure was better illustrated through the infographic

bellow. Here the UAV was equipped with Gimble, GNSS (Global Navigational Satellite System), INS (Inertial Navigation System) and other necessary sensor to accomplish the data acquisition as planned. The system maintained continuous connection through ground station with the radio link. The Ground Station helped the Pilot to control the UAV system as desired. Once the data was collected in accordance with the flight plan, the data sets were processed using high end computer with the help of Photogrammetry Software.

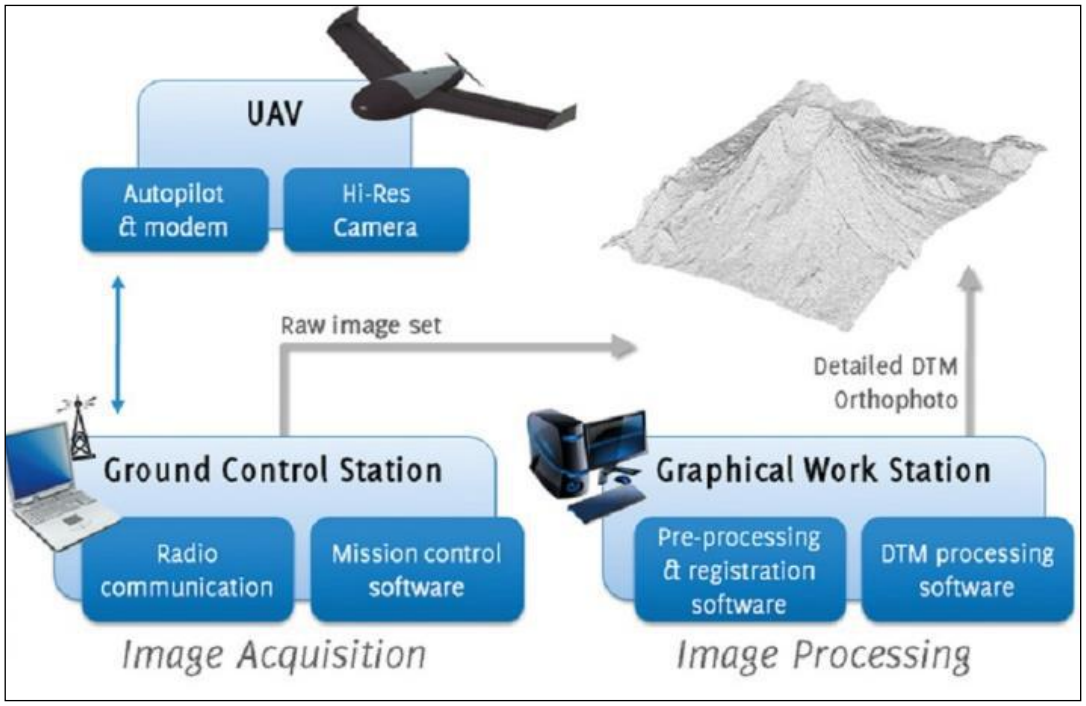

Figure 3.22: Working Principle of an UAV System

3.4.14.2 Control Point Survey: 2 Permanent BM

Permanent Bench Mark from SOB

Land level were measured with special reference to the vertical datum of the National Reference System (SOB). These were permanently constructed Bench Marks located all around the country. We had carefully investigated and found the SOB BM GPS543 was suitable for vertical reference to the project area. These values were measure from Mean Sea Level (MSL).

Bench Mark in the Project Area

When the Permanent Bench Marks were selected, there was two permanent Bench Marks which was constructed in the project area in consultation with the project Management authority in accordance with the terms of reference (TOR).

Contour Map

In mapping, a contour line (often just called a "contour") joins points of equal elevation (height) above a given level, such as mean sea level. A contour map is a map illustrated with contour lines, for example a topographic map, which thus shows valleys and hills, and the steepness or gentleness of slopes all around the project area.

This map was very useful in designing the master plan of the landfill site for solid waste management. This Map was prepared in a scale of 1: 1000 ratio for printing in paper in suitable size. The same map was prepared in soft copy as in pdf or jpeg format for sharing across the working groups.

Cross Section Leveling Horizontal

The UAV (Unmanned Aerial Vehicle) survey was generated the data for X, Y & Z values in every 1-meter interval. So, the cross section can be generated as require by the design team.

3.4.14.3 Plotting of all Physical Structure on the Maps

The data relevant to the master plan preparation was collected in primary field survey specifically related to the landfill site. The other necessary base-line data was collected from the Narayanganj City Corporation (NCC) with special reference to the management of the solid waste generated in the corporation area. This data collection was already in progress such as an official letter was sent the project office of the Detail Area Plan (DAP) of the Dhaka City which was a very important source of the spatial data of the infrastructure. This spatial data was contained the location of the individual households, schools, hospitals and other facilities in the project area. The data collected from both primary and secondary sources was mapped in accordance with the terms of references (TOR) for preparing the better management for the solid waste in the City Corporation area.

Maps of Digital Files

The preparation of Master Plan was included designing a lot of facilities for solid waste management. This was included preparing technical data and document in Computer Aided

Design (CAD) formats. So, all the necessary files was converted into digital files for using in the multi-disciplinary teams.

3.5 Development of SWM Master Plan

All the collected data was analyzed and then a comprehensive SWM Master Plan was prepared for NCC. The Master Plan will lead a roadmap towards short, medium and long-term interventions for Integrated and sustainable solid waste management for the City Corporation. The SWM Master Plan includes the following:

- Detailed analyses of current SWM situation at NCC
- Future projection of waste generation at NCC
- Detailed plan for source separated waste collection, transportation and environment friendly disposal of the collected waste
- Detailed land use plan of the proposed site – three alternatives are proposed for the site including cost-benefit analyses and using 3D perspective animation, from which best option are proposed with justification.

3.6 Preparation of Design and Bid Documents of Construction

Detail design was carried out for the best option identified for development of the proposed landfill site. After compilation of detailed design, necessary estimation was done and bid documents (for contracting out) and Bill of Quotations (BOQ) are prepared by the Consultant Team. After contracting out will be done by NCC, necessary supervision of the construction work can be carried out by the Consultant Team.

CHAPTER 04: PRESENT SITUATION OF SWM IN NCC

4.1 Over all Waste Management Scenario of Narayanganj City Corporation

Narayanganj City Corporation belongs Narayanganj, Kadamrsul and Shiddirgonj area. The daily generated waste amount from NCC (Including household waste) is about 500 tons (NCC, 2019). The amount of disposed Household waste by NGO/CDC: 40 tons. And the overall Percentage of the dispose waste in NCC is about 94 % (NCC, waste Management Data/2019-2020). Narayanganj Pourashava authority is the only formal organization responsible for waste management. Around 867 people are working in street sweeping and collecting waste. In the Pourashava area, the per capita rate of waste generation is around 0.5 kg/d. The major components of municipal solid waste include food, vegetables, fruits, polyethylene, paper and cloths. Among these, food and vegetables waste comprise the major component of the city waste, both in the residential and commercial areas.

Narayanganj City Corporation (NCC) is responsible for collection, transportation and treatment of solid wastes in Narayanganj City. Because of resource constraints and many other reasons, the NCC in general has not been able to provide a satisfactory waste management system in Narayanganj. The major sources of municipal solid wastes in Narayanganj are domestic, streets, market places, commercial establishments, industries, clinics and hospitals.

Commercial sources are one of the bulky sources of waste production. Commercial sources mean different industries like garments, pharmaceuticals company, shopping mall, market place, hospital and other industry. Basically, huge chimerical are used by different industries like sulfuric acid, chromium, ammonium sulfate, ammonium chloride, and calcium oxide. The wastes may contain chromium salts and/or tannic acid. The manufactures also use pesticide and fungicide. Metallic and non-metallic industries may produce solid waste containing some sort of heavy metals. Dust discharged from smelter or furnace of those factories may often contain heavy metals to some extent, so that, if dust is not disposed of appropriately, dust will be a pollution source of soil as well.

Figure 4.1: Dumping Sites among the neighborhood in NCC

At present, Narayanganj City generates about the density of solid waste is reported to be 600 kg/m3. There are over 1,000 smalls to large industries in Narayanganj area disposing a significant amount of toxic and hazardous wastes contributing environmental degradation in and around Narayanganj City. These industries mainly include chemicals, textiles, dying and printing, tannery, iron and steel, metal plastic, rubber and tobacco. Wastes from industries are dumped into the municipal bins and near-by low lying areas. There is no separate waste management system for industries. There are around 149 tanning industries in Adamjee area in Narayanganj producing 18,000 liters of liquid waste and 115 tons of solid waste during peak time and 75 tons during off-peak time. Liquid waste is dumped into the lakes or canals nearby. Solid wastes are collected by the NCC and parts of these wastes are used by the scavengers. Wastes from tanneries contain sulphuric acid, chromium, ammonium sulfate, ammonium chloride, calcium oxide which may seep into the groundwater. These wastes have adverse impacts on human being and can cause diseases like fever, headaches, respiratory and skin diseases.

Figure 4.2: Wastes dumped in different wards of NCC

There are over 500 smalls to large clinics and hospitals in Narayanganj City. Hospital wastes are dumped to the nearest municipal bins indiscriminately. It is most likely that the waste collectors, neighbors and people will be infected from these materials. Moreover, these dustbins are usually open. Therefore, spread of infectious organisms through various means from hospital wastes pollute the environment and increase the risk of infection diseases. Waste is collected from small bowls (plastic or metal) or plastic bins provided for each bed and emptied into larger containers. Wastes from operation theaters, laboratories, and kitchens are also dumped into these municipal bins. Since hospital wastes contain toxic and infectious materials, they are more unsafe than other types of wastes. In Narayanganj, all types of medical wastes, like syringes and needles are thrown into the municipal dustbin. For this reason, inflectional diseases spread out easily. NCC collects only half of the generated solid waste and the rest is left behind to dump in low-lying areas or to be collected by the scavengers.

Figure 4.3: NCC launches green waste collecting vehicles

People in some areas of Narayanganj City have come forward with some local initiatives for the solid waste management. The primary objective is to vendor a solid waste collection service from door to door so that the locality remains clean. Both household and some commercial solid wastes are collected from door to door and carried to the nearest NCC bins or demountable containers for the NCC trucks to collect them for final disposal.

Figure 4.4: NCC collecting wastes from different commercial entities

Local initiatives in the solid waste management has created positive impacts on the environment of the city. The localities with these initiatives are cleaner. The initiatives have been able to bring changes in the level of people's awareness. The households are now highly conscious about the management of solid waste.

4.1.1 Stakeholders of Solid Waste Management of Narayanganj City Corporation

The stakeholders are the people or organizations participating in solid waste management. In Narayanganj City Corporation this includes the waste generators who use the services, the service providers, the formal and informal private sector dealing with solid waste management, and other local or international institutions. Elements comprises the technical components of the waste management system starting from the generation of solid waste then the collection, transfer and transportation of waste to dumpsites or to treatment plant. Currently Narayanganj City Corporation (NCC) is responsible for collection, transportation and treatment of solid wastes in Narayanganj City. In order to establish the integrated waste management Narayanganj City Corporation (NCC) area here in the table below that stated the Categories & Participants activities;

Table 5: Stakeholder Categories & Participants activities

Category	Participants
Government	▪ Municipalities ▪ Government Officials ▪ Neighboring unions ▪ Federal and provincial agencies
Waste and recycling service providers	▪ Haulers ▪ Recycling processors ▪ Organics processors ▪ Industry associations ▪ Product stewardship producers and agencies ▪ Owners / operators of disposal facilities ▪ Collection facilities
Environmental organizations	▪ Local environmental groups formation ▪ Regular monitoring and awareness programs organizers
Community interests	▪ Community associations and ratepayers' groups ▪ Chambers of commerce, local businesses and business associations ▪ Consumer groups ▪ Educational institutions, school districts
Waste producers	▪ Industrial, commercial and institutional (ICI) interests (especially those producing special waste or large amounts of waste) ▪ Out-of-region interests, including sources of waste and receivers of waste products
Entrepreneurs	▪ Innovators, designers of processes to reduce, reuse, recycle or over waste
Interested individuals	▪ Residents living close to existing or proposed waste management facilities ▪ The public

4.1.2 Primary Collection of Solid Waste

Normally the households bring their refuse to the nearby communal bins/containers located on the street side (temporary open waste dumping points in NCC: 80), while in some specific areas the community has arranged house to house collection of garbage with their own initiatives and efforts. The household, commercial, institutional and medical wastes are deposited in the same waste collection bins located on the streets. Street sweeping is done manually and debris is loaded from the curb-side into the handcarts and delivered to the collection bins.

Figure 4.5: Primary solid waste collection van

Sweepers/cleaners sweep the roads and clean the drains and then place those wastes in the nearby dustbins or containers using a hand cart. Presently some CBOs are doing house-to-house collection of solid wastes at a reasonable charge, which is accepted by the city dwellers (NGO/CDC - 8.9% of the total disposed waste). These CBOs are playing a significant role in primary collection of solid wastes. However, most of the domestic, commercial & industrial solid wastes are still being accumulated in the dustbins/containers by the concerned

household owners themselves. Currently, Total Number of NGO/CDC to manage household waste is about 18 and 18 wards out of 27 are covered by Waste Management Department of NCC and rest of them (9 Wards of Kadam Rasul) are in the process of SWM.

4.1.3 Secondary Transfer Station (STS)

A transfer station is a building or processing site for the temporary deposition of waste, often called Waste Transfer Stations. Transfer stations are often used as places where local waste collection vehicles will deposit their waste cargo prior to loading into larger vehicles.

There are lots of transfer station and handover points or open temporary dumping point, which receive wastes from primary source and transferred to the designated location for processing/recycling/treatment and mostly for ultimate disposal. Sometimes secondary disposal site is the facilities where large amount of wastes is accumulated and finally transferred to the desired sites by large vehicles such as open or closed Trucks, Demountable haul container truck, etc. SDS may be an open space or roadside demountable large steel haul containers, roadside spaces and unused open low-lying areas. There are lots of open dumping points which are now using as STS but most of them are unplanned without following any design standard even structure.

Figure 4.6: Picture of STS which are now using as temporary open dumping points

4.1.4 Transport and Road

Wastes are transported by fleet (flat bedded) from the old part of the city where the roads and the lanes are narrow to the dumping sites. Every vehicle has got specified areas and route through which they move to collect wastes. The number of solid waste transporting vehicles in NCC is 22, where the number of garbage truck (03 ton) = 19 and the number of garbage truck (05 ton) = 03. Every day dirt or garbage clear time at NCC is between 06.00 am to 10.00 am.

4.1.5 Disposal

Garbage trucks then bring the collected solid wastes to the selected dumping sites. City wastes are only being used for filling low-lying lands. Currently there are five sites to dispose the daily generated solid wastes. In Narayanganj waste is dumped at Alamin Nogor dumping site.

Figure 4.7: Alamin Nogor temporary disposal site

Among them four are used by the communities of the municipality and the remaining one is used only by the municipality authority that is located outside the Paruvashava boundary. Out of the four, two sites, namely Khanpur and Shahid Nagar, are affected by flooding. Community based household wastes, commercial, and medical wastes are disposed of daily in these sites.

The only disposal site used by the Paruvashava is located at Ponchhaboti, about 2.5 km from the Narayanganj Paruvashava area. The Narayanganj- Muktarpur road passes alongside the site. The greater part of the site is flat and free from flooding. The municipality authority deposits wastes generating from the municipality as well as coming from the Ponchhaboti residential area, Fatulla, Enayetnagar and other surrounding areas. There are also few numbers of minor sites which are operated in an uncontrolled manner without any proper earth cover and compaction. These are located at Chashara (near rail station), Khanpur (near ice making factory), near Kalir Bazar and Shahid Nagar. All the sites are located in low land areas. The uncollected wastes are dumped in open spaces and streets clogging drainage systems and creating serious environmental degradation and health risks.

4.1.6 Existing Recycling/Compost Plant in NCC

Narayanganj Paruvashava does not yet have any solid wastes recycling projects. However, wastes which have market value are being reclaimed or salvaged for recycling. Recycling contributes to resource conservation as well as environmental protection. Papers, broken glass, metals, plastic are purchased on a house to house basis by a class of mobile purchasers. A section of the poor people collects re-useable and recyclable waste materials from the dustbins/containers as well as from the streets and dumping sites. In 2006, the Department of Environment established a compost plant at Ponchhaboti. Mega Ltd is responsible for this compost plant. At present, they are producing 22 tons'/day organic fertilizer from the compost plant. Narayanganj City Corporation has also 23 acres' land in Jhalkuri Dashpai area (Ward 09). From which, 10 acres' land will be used to prepare an electric power plant (Waste to Energy) of 5MW. The whole system will need 500 tons' waste per day to run this power plant project. 2 acres' land will be used for Fecal Sludge Management by WSUP (Water and Sanitation for Urban Poor). And the rest of the land will be used for sanitary dumping site.

Figure 4.8: Mega Compost Plant at Ponchhaboti in NCC

4.1.7 Current Industrial Waste Management of NCC

Narayanganj City is predominantly an industrial area. The extensive amount of industrial waste such as, polyethylene, cloth and papers are generated here daily.

Figure 4.9: Locally dumped industrial waste

Narayanganj Paruvashava authority is the only responsible organization for waste management in this area. Everyday 140 to 150 tons' waste are generated in this area. Out of which about 50% is disposed in the landfills and the rest left unattended and locally dumped.

Figure 4.10: Industrial waste dumped at road side

4.1.8 Current Commercial Waste Management of NCC

Commercial waste of Narayanganj city corporation is dumped along the road way. Basically, this type of waste is dumped at the open dumping points. Narayanganj City Corporation has designated 80 dumping points where commercial waste is dumped every day. Following pictures show the open dumping points along the road side in Narayanganj City Corporation.

Figure 4.11: Commercial dump yard along the road side in NCC

From our open dumping survey, it is found that more than 300 tons solid waste goes to Alamin Nogor dump yard. City corporation trucks are used to transport this waste from open dumping points to Alamin Nogor Dump yard.

Figure 4.12: Picture of open dumping yard along the road side at market area in NCC

Most of this waste comes from market area and small-scale industries and to some extent medicals and clinic. Street sweep also include in the commercial waste. Conservancy officers of Narayanganj City Corporation checks this type of waste management and they are always connected with the trucks and SWM related workers. NCC does not charge to clear this type of waste.

Figure 4.13: Open dumping points at Narayanganj Paruvashava

4.1.9 Existing Medical Waste Management of NCC

A good number of hospitals in Narayanganj city keep dumping medical wastes in the open ignoring their consequences on the environment and human health. Locals alleged the situation has come this far as there is no regulation for proper medical waste management. Although the Ministry of Environment and Forests formulated a draft regulation in 2008, it has not been finalized yet.

Figure 4.14: Picture of Medical waste dumped at bucket at Hospital

According to Narayanganj City Corporation (NCC), a total of 101 hospitals, clinics and diagnostic centers are operating in the city. Clinic and Diagnostics center waste quantity (Per day) is about 100 tons in total. NCC sources said City Corporation and Prism Bangladesh Foundation signed an agreement for proper management of medical wastes. Besides, the NCC directed all the hospitals and clinics to sign contracts with Prism for proper disposal of medical wastes. However, only 86 hospitals and clinics have signed agreements with Prism for disposing of medical wastes while the rest are dumping the wastes in their own old fashion.

Figure 4.15: Hazardous Medical Waste at Hospital

The two government hospitals in the city, 300-bed Hospital and Narayanganj General Hospital are yet to sign contracts with Prism. Visiting the 300-bed Hospital, the UNB correspondent found that medical wastes are being thrown in open places surrounded by brick walls in front of its outdoor department. These wastes contain various chemicals, including syringes, stitches, blood, pooled cotton, tumors, bandage-gauze, hand-gloves, drugs, drug-bottles, blood bags and saline bags. The malpractice has put the public health at risk of various infectious diseases, including hepatitis B, hepatitis C, tuberculosis and various skin diseases.

Figure 4.16: Hazardous Medical waste dumped yard

The situation of medical waste management at Narayanganj General Hospital was found even worse as it does not even have any specific spot for dumping wastes. All the medical wastes from Narayanganj General Hospital are being dumped on the approach road of the hospital, used by patients and locals regularly.

4.1.10 Waste to Energy Plan of Narayanganj City Corporation

Bangladesh government has plans to generate electricity using garbage or solid waste. Bangladesh Power Development Board (BPDB) signed a memorandum of understanding (MoU) with Narayanganj City Corporation (NCC) in this regard. NCC Mayor Selina Hayat Ivy, power secretary Dr Ahmad Kaikaus, PDB chairman Khaled Mahmood and other concerned senior officials attended the signing function. Financial Express covered a news report on energy production from garbage in March, 2018. According to that news the PDB will implement the 3MW-5MW waste based IPP power project at Jalkuri in Narayanganj. Addressing the contract signing ceremony, state minister for power and energy Nasrul Hamid said the government has a plan to implement more similar waste-to-energy project once this one succeeds. He noted that Dhaka city is now producing over 9000 tons of waste daily. Nasrul Hamid informed that the country has already generated highest 10,084 MW of electricity on March 19. "So, we have no problem to supply electricity in the Boro season and hot summer," he said. NCC Mayor Selina Hayat Ivy said most of the city corporations are facing trouble to manage city corporation garbage. She requested power ministry to ensure dumping stations in every city corporations so that they can produce electricity from it in coming days. "Industrial units get land quickly if they apply for it. But city corporations are waiting long times to get the lands for making cities clean and healthy," she said. Power secretary Dr Ahmad Kaikaus said the government is hopeful to generate maximum electricity to meet 12000 MW electricity demand in the summer season. BPDB secretary Mina Masud Uzzaman and NCC chief executive officer AFM Ehtashamul Haque signed the deal on behalf of their organizations. Now NCC has designated 10 acres at Jhulkuri for waste to energy program. PDB will run this project (waste to energy project) with NCC authority.

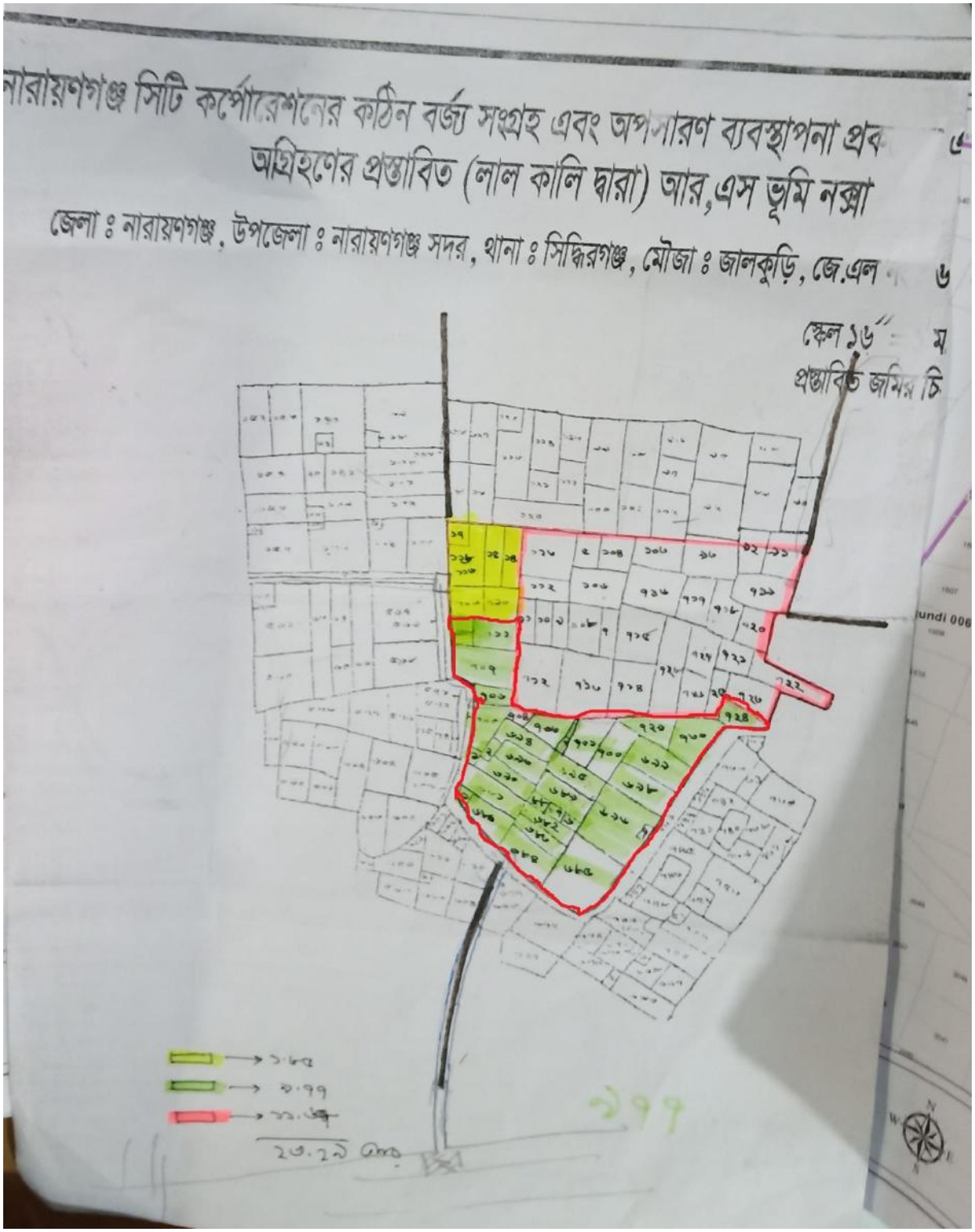

Figure 4.17: Muza map of designated land for waste to energy plan marked with red color (Source: NCC survey department)

4.1.11 Public Involvement

In NCC, decision makers such as Mayor, Ward Councilor, high ranking officers and other community leaders have important roles in solid waste management. It is indispensable that decision makers are familiar with the issues of solid waste management as the priority policy. Waste Management Division NCC should coordinate and implement the following events in order to keep them more closely to SWM:

Table 6: Events for SWM of NCC

Method	Useful for	Considerations
Open House	▪ Providing information on project and options (often through information boards and short videos) ▪ One-to-one conversations with people as they view the boards ▪ Accommodating large numbers of people	▪ Can provide additional detailed information on proposals in handouts ▪ Can seek feedback through online or written surveys ▪ Display boards should be visual for people with lower literacy skills, staffed by someone who can help to explain the content ▪ Requires people to travel to your event and to be available at a specific time
Public meetings	▪ Providing a presentation, with opportunity for question and answer session ▪ Explaining concepts in more detail than can be obtained from information boards ▪ Accommodating large numbers of people	▪ Can provide additional detailed information on proposals in handouts ▪ Can seek feedback through online or written surveys ▪ Hard for shy people to stand up and get their questions answered ▪ Needs good moderator to prevent grandstanding or individuals who monopolize the conversation ▪ Requires people to travel to your event and to be available at a specific time
Workshops	▪ More engaged discussion with small groups on specific questions ▪ Can be combined with presentation(s)	▪ Needs a venue where people can sit around small tables ▪ Need to have a good moderator and a good recorder at each table (could be paid person or volunteer from the group) ▪ Better at engaging quiet people, more opportunity for every participant to provide comment

Method	Useful for	Considerations
		▪ Requires people to travel to your event and to be available at a specific time
By-invitation meeting	▪ Opportunity for specific in-depth discussion with selected groups and individuals, e.g., ▪ sector-specific discussions	▪ Good for consultation with a specific group or sector but is not open "public" engagement ▪ Requires people to travel to your event and to be available at a specific time
Kitchen table talks	▪ Meeting with small groups of individuals at their house, house of friend, local coffee shop—host does the invitations ▪ Opportunity for in-depth discussion with participants	▪ A familiar and friendly venue, will encourage some participants who would not otherwise show up ▪ Useful for individuals with a specific interest or concern (e.g., residents close to a waste facility) ▪ Needs to be offered widely to avoid perception of favoritism to some groups or individuals
Events	▪ A display or other information at a public event or location (e.g., farmers market, festival), staffed by knowledgeable individual(s)	▪ Reaches people who might otherwise not participate, but are already at that event ▪ Needs to be engaging format to encourage passers-by to stop and find out more ▪ Usually more limited space than a full open house display
Website	▪ Providing information and regular updates on website to public and interested parties	▪ Can provide an opt-in to an email newsletter for updates ▪ Needs to be kept up to date
App (mobile application)	▪ Providing information and regular updates on mobile app on collection time & the bill payment of waste collection ▪ Maintain the information and regular updates of sold recycling material	▪ Can provide an opt-in to relavent waste managment information ▪ Needs to be kept up to date with user friendly features

4.1.12 Legal Aspect

The master plan aims at cleaning Narayanganj city as a whole, the implementation of the plan makes those areas surrounding a water body and voluntary or official dump sites cleaner and more hygienic by reducing illegal dumping and conducting sanitary landfill. Those people around such areas presently suffer from adverse environmental conditions caused by the current incomplete waste management. However, the situation will be definitely improved by the implementation of the master plan. In this sense, the master plan is evaluated as environmentally viable.

4.1.13 Organization

The waste management activity of NCC shall be strengthened through (both in short & long term):

- Provision of vehicles for source separated waste collection
- On-going training on solid waste management for waste collection staff and supervisory staff and
- Private sector participation for street sweeping, primary and secondary waste collection and recycling activity.

4.2 Findings from structured questionnaire Household and Commercial Survey

4.2.1 Study Approach

A single survey is made out of the full population, a method of data collection (e.g., a questionnaire) and individual questions or items that become data that can be analyzed statistically. Since survey research is almost always based on a sample of the population, the success of the research is dependent on the representativeness of the sample with respect to a target population of interest to the researcher. The persons replying to a survey are called respondents, and depending on the questions asked their answers may represent themselves as individuals, their households, employers, or other organization they represent.

ODK Survey Findings:

A four (4) days field visit was conducted by the survey team to find out the existing scenarios of the project area in aspects of solid waste management. The total number of surveyed data is 400 comprising of 366 households and 34 commercial entities.

Household Status:

Household surveys are questionnaires that are given to a sample of households in a population. Their primary advantage was to provide considerable discretion to the interviewer about the information requested of respondents. A properly managed effective Solid waste management program increases the health and environmental quality of the country. This survey examines the status of Solid Waste Management household level in an urban area (Narayanganj City Corporation) in relation to the willingness of the people for the participation of an upgraded program and the level of awareness of the people about the environmental and health hazards associated with disorganized management of solid waste.

Waste Related Information:

Waste production of the households was in the range of 0.8 kg to 2 kg per household per day, depending on the sort of area in which the households are located and a number of other factors, such as income and family size.

Field Activities:

- ✓ Four supervisors and twelve surveyors were engaged for data collection. They had been recruited from the respective professional sectors.
- ✓ Supervisors and surveyors were given an orientation and training on the survey methodology and how to collect and compile field data.
- ✓ The prepared questionnaire was discussed thoroughly during the training and orientation session.
- ✓ **A four (4) days of field visits** were conducted by the survey team to find out the existing scenarios of the project area in aspects of solid waste management.
- ✓ The total number of surveyed data is **400 (366 households and 34 commercial)**.

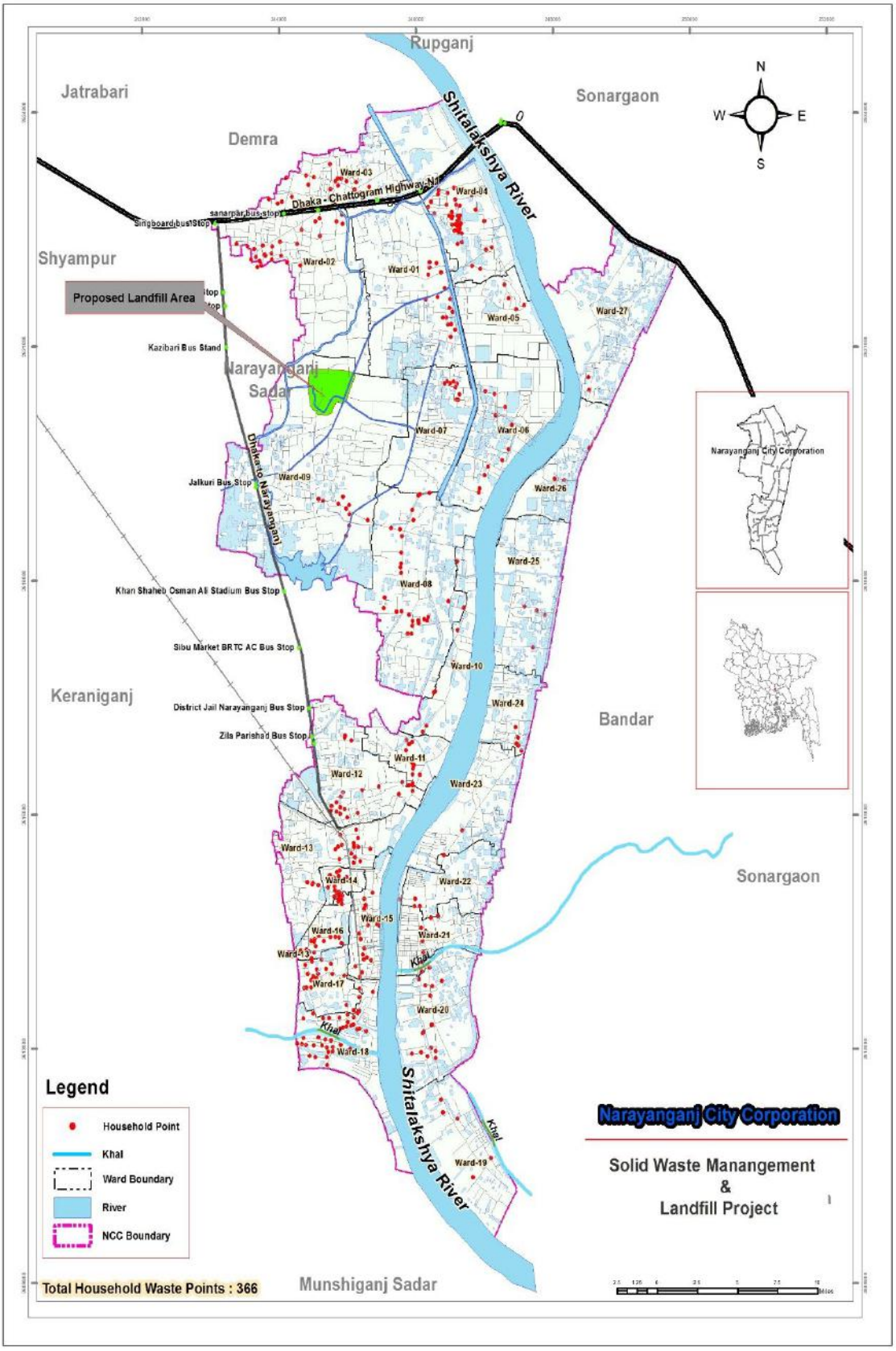

Figure 4.18: Household data (total of 366 respondents) collection point at NCC

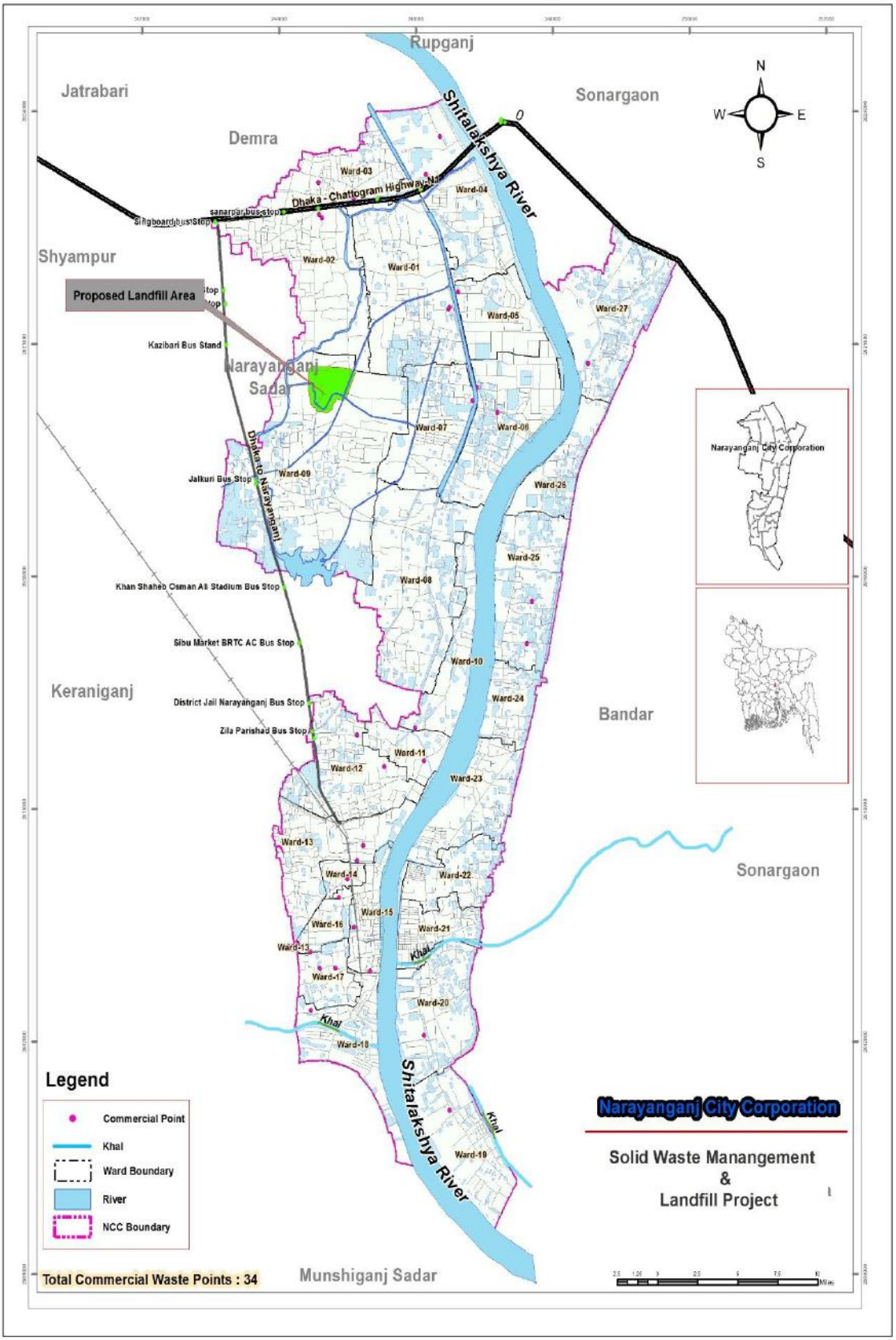

Figure 4.19: Commercial data (total of 34 respondents) collection point at NCC

Figure 4.20: Both household and commercial data (total of 400 respondents) collection point at NCC

4.2.2 Data Analysis and Issues Identification

4.2.2.1 Household Survey Data Analysis

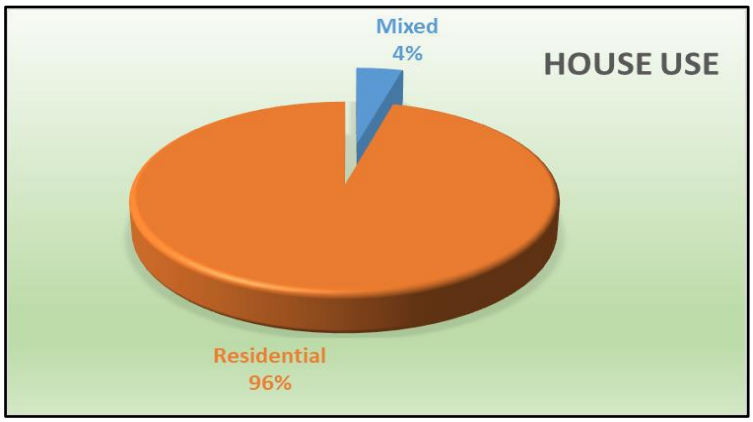

Figure 4.21: House use of the respondents

- Most of the houses (96%), those were surveyed, were in the residential area apart from only (4%) of them were in the mixed zone

Waste related information:

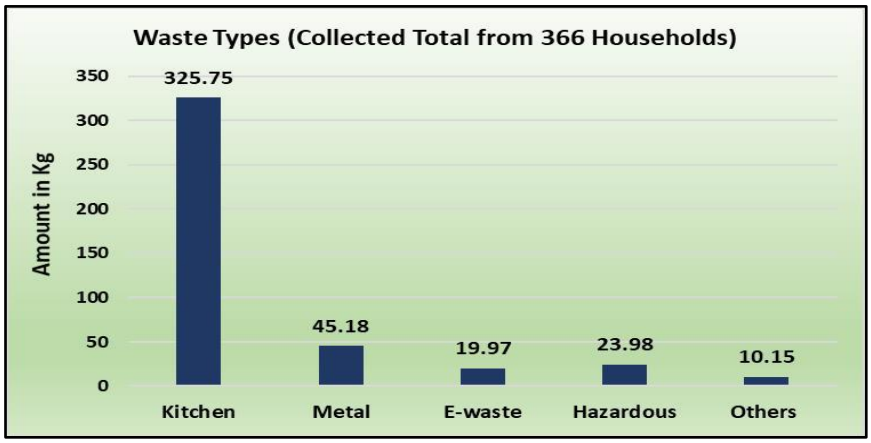

Figure 4.22: Total waste generated at the household level among the respondents

The major types of waste generated at the household level and other domestic usages in the survey area were from Kitchen waste, a total of 325.75 kg from 366 households. Therefore, on average there were 0.9 kg kitchen waste generated from each household as well as 0.1 kg (metal), 0.05 kg (e-waste), 0.07 kg (hazardous), and 0.03 kg (others) were generated, respectively.

- Issues: These data are generated from a small proportion of the total population, therefore the number we came up with might be misleading. An appropriate safety factor will have to be considered while designing the SWM plan.

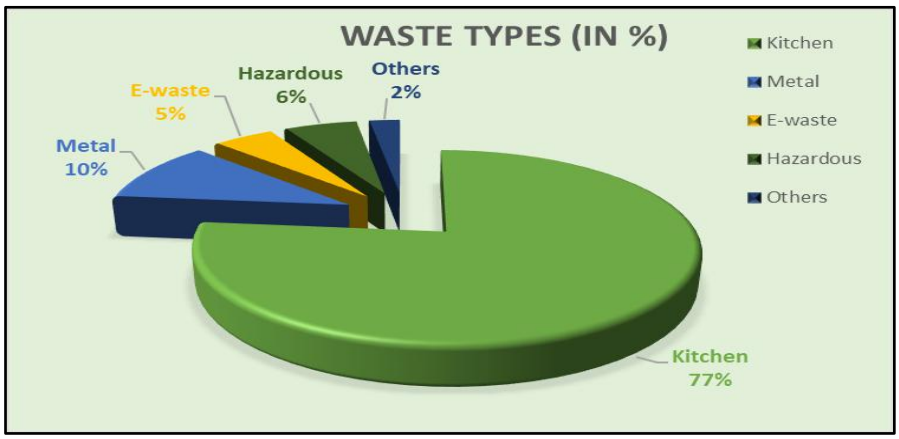

Figure 4.23: Types of waste generated at the household level among the respondents

- The average composition of the household waste that was measured by weight is as follows: Kitchen waste (77 percent), E-waste (5 percent), Metal (10 percent), hazardous (6 percent) and others (2 percent).

Figure 0.24: Household waste storage system (in %)

- Most of them around 75% of household use bins/buckets to store their daily waste
- 24% of the household use plastic bags to store their daily waste
- Issues: There were still, about 24% of the respondents relying on plastic bags which is incredibly significant. It will be a tough job to change this behavior.

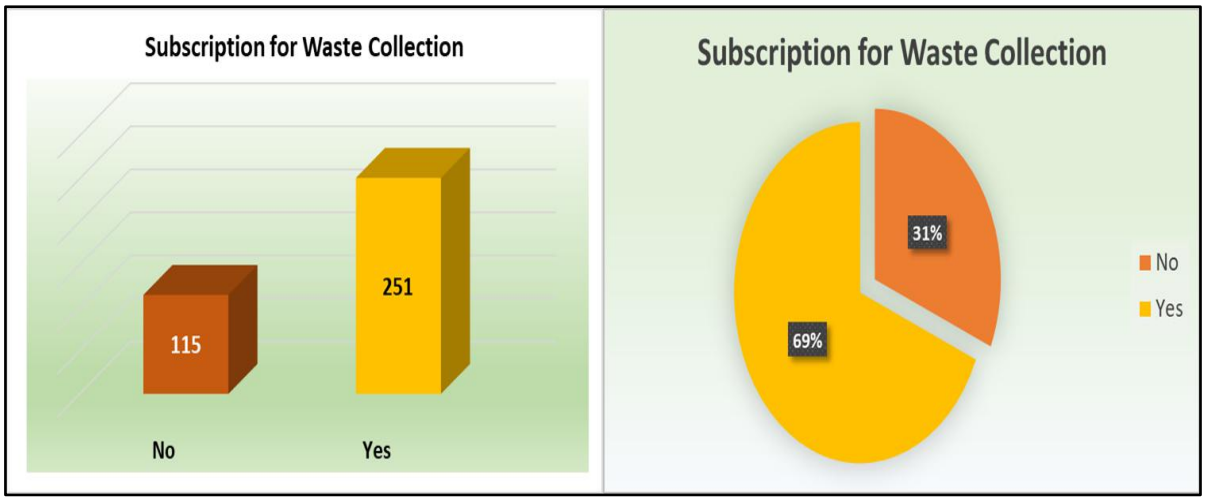

Figure 0.25: Subscription rate for waste collection

- About 69% of the respondents were subscribed to the local waste collector.
- And the rest 31% of respondents did not have any waste collection subscription
- Issues: There were still, about 31% of the respondents relying on themselves to dispose of the daily waste which is incredibly significant considering Narayanganj is a City Corporation. It will be a tough job to change their mind and convince them to subscribe to waste collection.

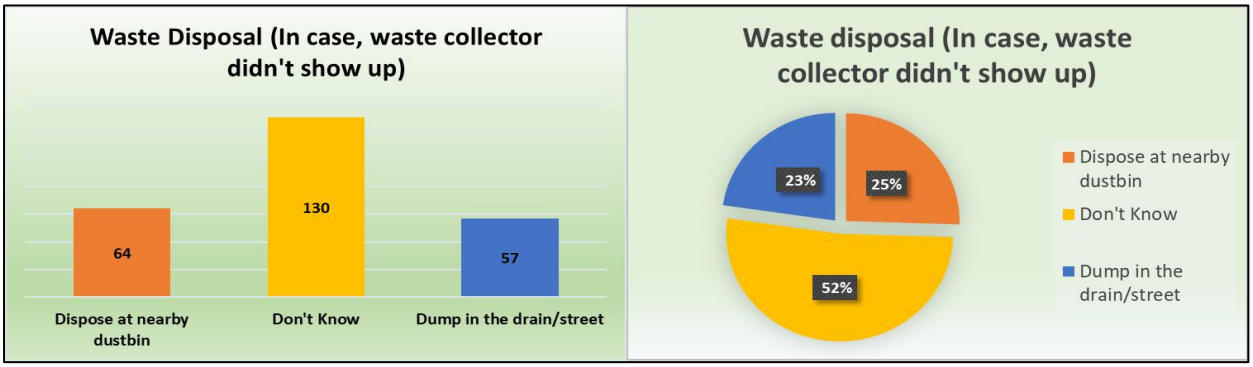

Figure 4.26: Waste disposal (In case, the waste collector did not show up)

- **Issues:** Only 25% responded that they are disposing of their waste to the nearby dustbin. The rest of it ends up in either drains or streets.

115 Non-subscribers Information:

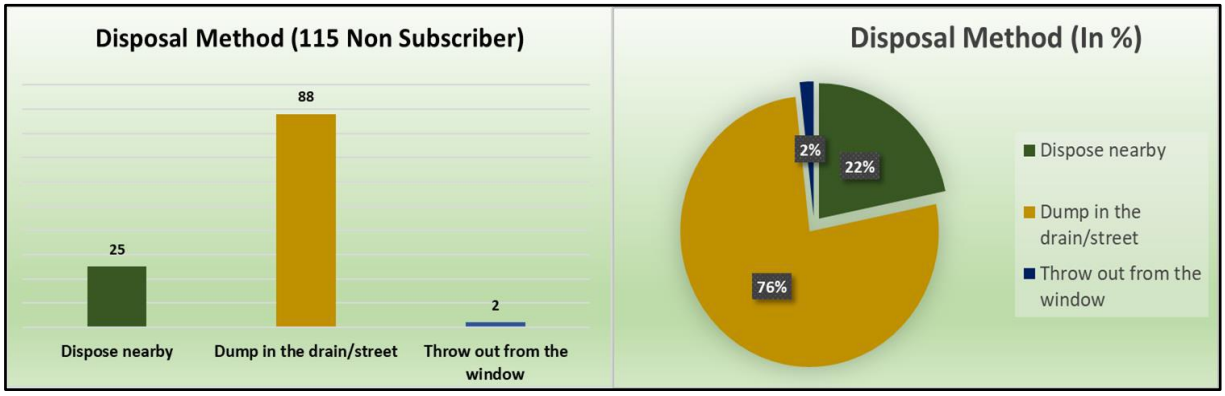

Figure 0.27: Disposal method

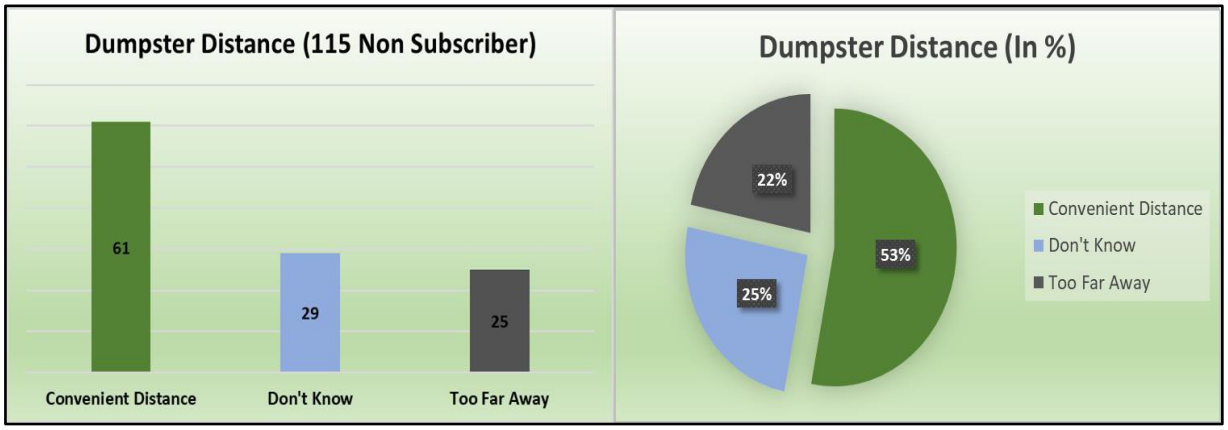

Figure 0.28: Dumpster distance from household

- Issues: Although, 53% of the respondents had responded that the dumpster is located at a convenient distance but still most of the respondents had chosen to dump everything in the nearby streets/drains or throwing out of the window. Therefore, substantial changes in behavior are needed to overcome this situation.

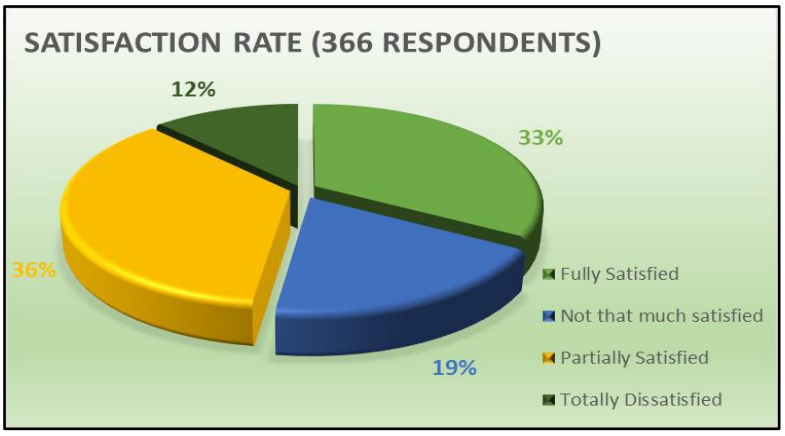

Figure 4.29: Satisfaction rate among all 366 respondents

- About 33% of the respondents were fully satisfied and about 36% of the respondents were partially satisfied with the current waste management situation.
- And the rest 19% & 12% of respondents were no that satisfied and totally dissatisfied, respectively.
- **Issues:** Altogether, there were about 67% of the respondents were not fully satisfied with their present waste management situation which will need further intervention.

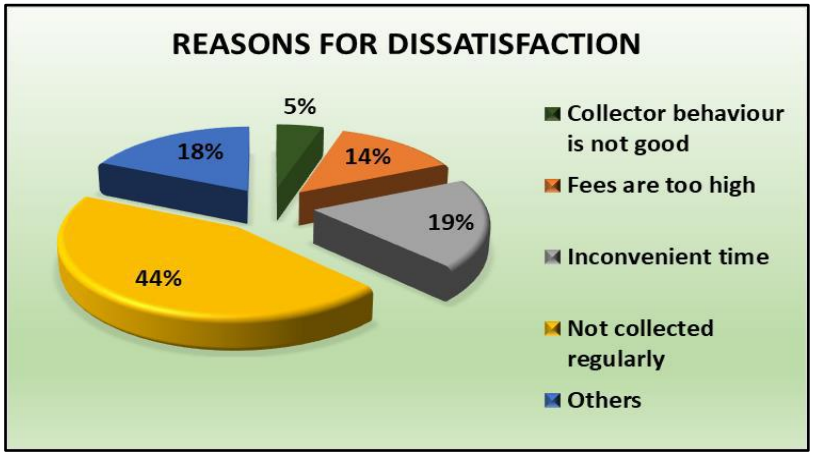

Figure 4.30: Reasons for dissatisfaction (among 366 respondents)

- About 33% of the respondents were fully satisfied and about 36% of the respondents were partially satisfied with the current waste management situation.
- And the rest 19% & 12% of respondents were no that satisfied and totally dissatisfied, respectively.

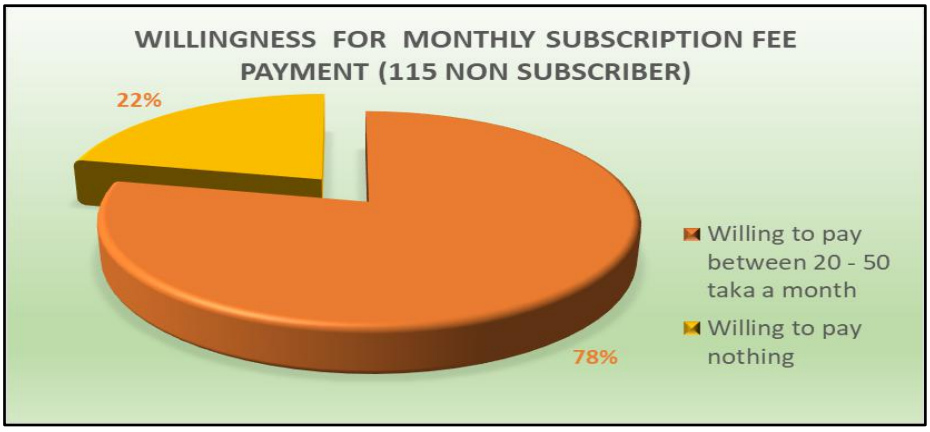

Figure 4.31: Willingness for monthly subscription fee payment (115 non-subscribers)

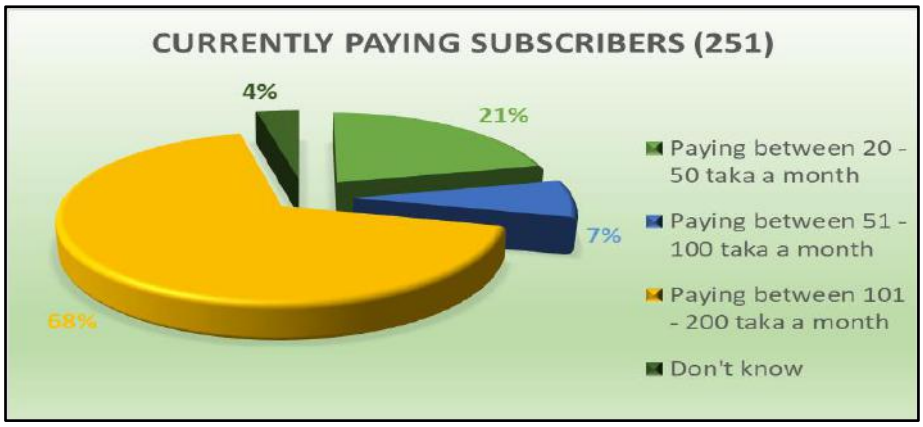

Figure 4.32: Currently paying subscribers (251 subscribers)

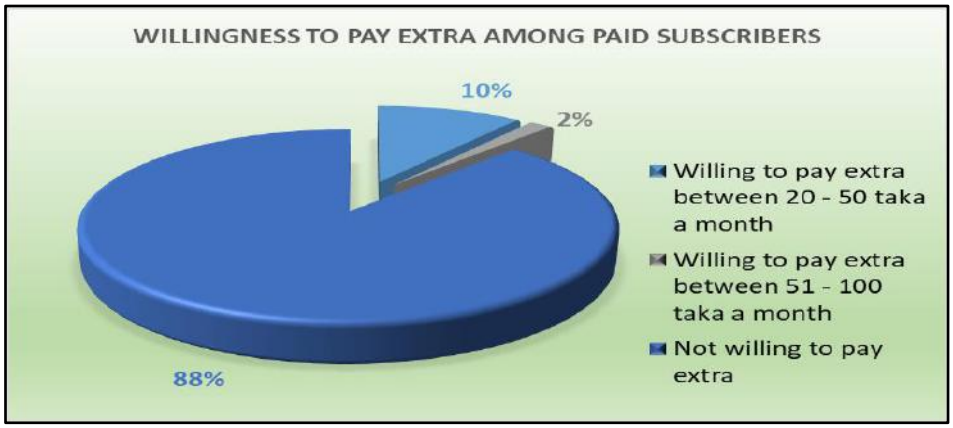

Figure 4.33: Willingness to pay extra among paid subscribers (251 subscribers)

- **Issues:** Altogether, most of the respondents are willing to pay 20 – 50 taka a month for waste collection service. Only 25 out of 366 (6.8%) respondents are not willing to pay any money for the service but if the situation improves then they will be thinking of paying for the monthly subscription.

Information on Segregation:

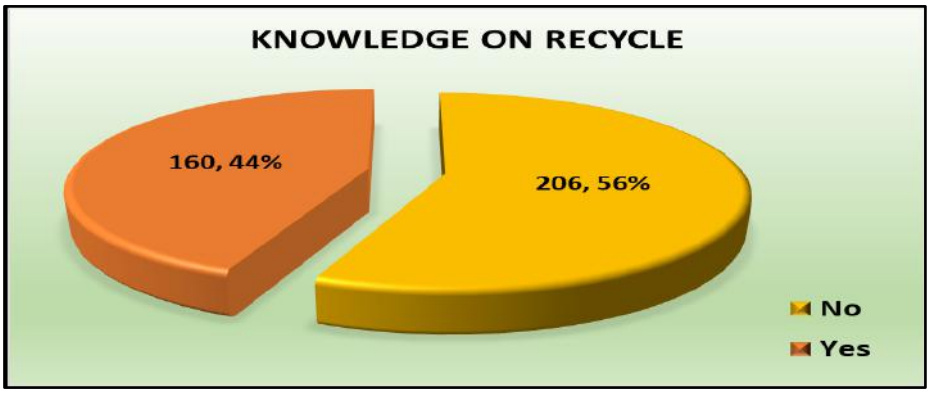

Figure 4.34: Knowledge of recycling among 366 respondents

- Only 44% (160 out of 366 respondents) had knowledge of recycling which is surprising and shocking at the same time considering Narayanganj is a city corporation.
- **Issues:** It will take a long time to let people aware of recycling.

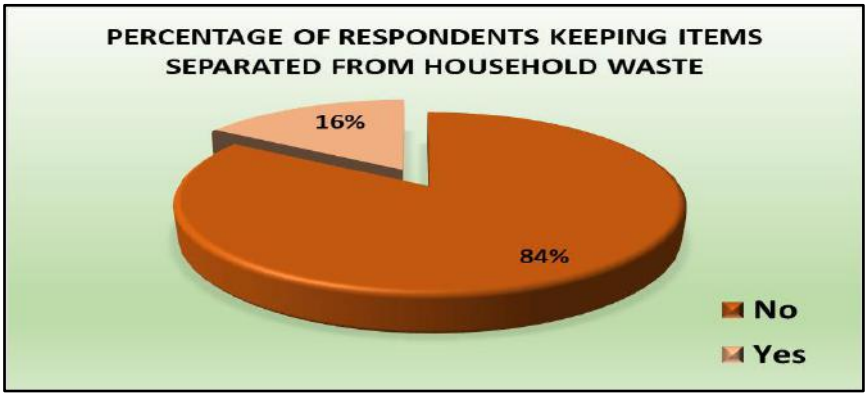

Figure 4.35: Percentage of respondents keeping items separated from household waste

Figure 4.36: Willingness rate of separating kitchen waste for compost and make compost from kitchen waste

- About 59.3% (217 out of 366 respondents) showed the willingness to separating kitchen waste for compost, which also aligns with a willingness to make compost from kitchen waste chart.

4.2.2.2 Commercial Survey Data Analysis

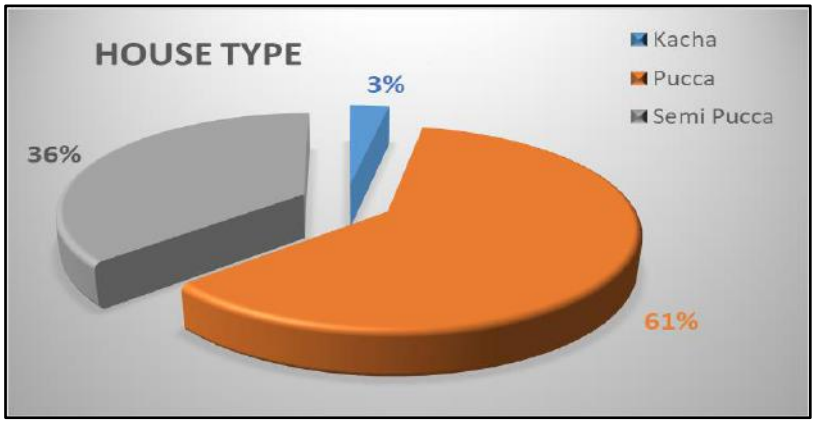

Figure 4.37: House type of commercial respondents

- Most of them around 61% house type of the respondents were pucca
- 36% of the house type was semi pucca
- Only 3% of them were kacha

Waste related information:

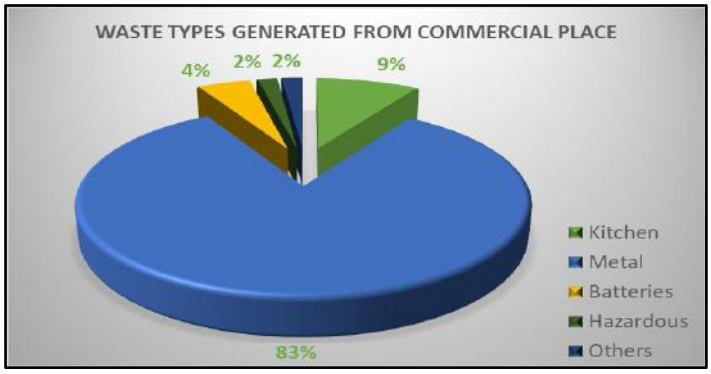

Figure 4.38: Generated waste types from the commercial place

- The average composition of the commercial waste that was measured by weight is as follows: **Kitchen waste (9 percent), E-waste (4 percent), Metal (83 percent), hazardous (2 percent) and others (2 percent).**

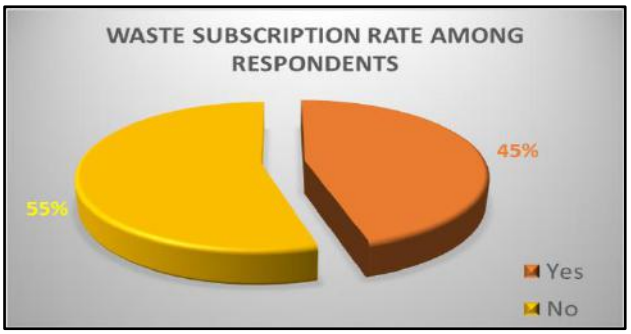

Figure 4.39: Total waste generated at the household level among the respondents

- About 45% of the respondents were subscribed to the local waste collector.
- And the rest 55% of respondents did not have any waste collection subscription
- **Issues:** There were still, about 55% of the respondents relying on themselves to dispose of the daily waste which is incredibly significant considering Narayanganj is a City Corporation. Thus, it is really difficult for the city corporation to manage the waste properly as a substantial percentage of commercial entities are disposing of the daily waste everywhere with no proper protocol.

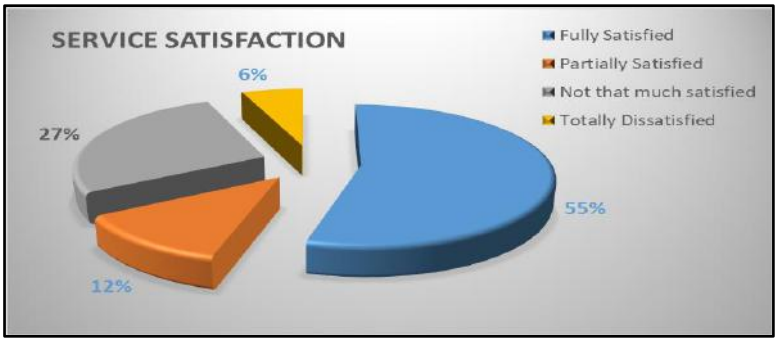

Figure 0.40: Satisfaction rate among all 34 respondents

- About 55% of the respondents were fully satisfied and about 12% of the respondents were partially satisfied with the current waste management situation.
- And the rest 27% & 6% of respondents were no that satisfied and totally dissatisfied, respectively.
- **Issues:** Altogether, there were about 45% of the respondents were not fully satisfied with their present waste management situation which will need further intervention.

Figure 4.41: Currently paying subscribers (15 subscribers)

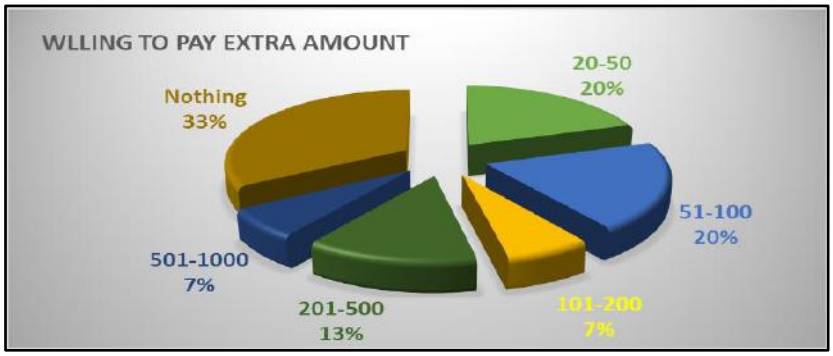

Figure 4.42: Willingness to pay extra among paid subscribers (15 subscribers)

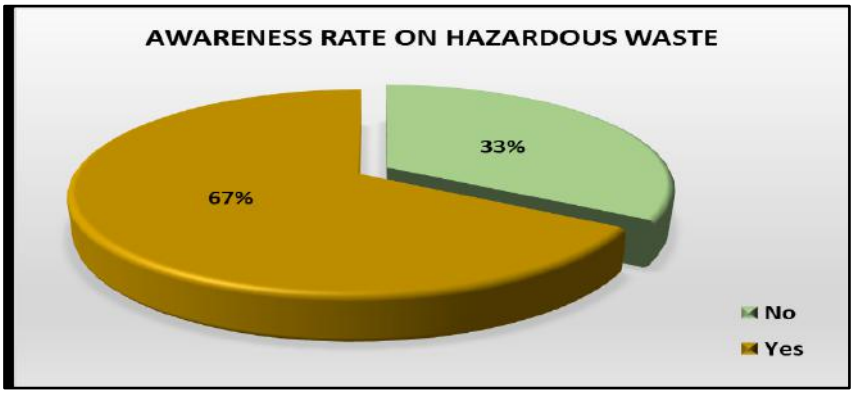

Figure 4.43: Awareness rate on hazardous waste

- About 67% of the respondents were well aware of the hazardous waste and about 33% of the respondents had no idea about hazardous waste.

4.3 Existing limitations

Despite the efforts of the municipal authority there are some problems associated with the current management system of solid wastes of the city. Narayanganj municipal authority has no scientific or engineered planning approach on solid waste management. It has no solid waste management specialist (with an engineering background). The City planning department is yet to allocate any specific space for storage of waste bins or placing of containers. Placing of dustbins on the road, near any house, creates social problems because of improper use, irregular cleaning, and road blockage by collection vehicles, bad smell, rodents, vermin's, flies and unhygienic conditions. Open truck collection systems need an average of 2 to 3 h for loading and unloading the waste to and from the trucks. Municipal authority normally spends only about 0.75 million takas for providing the service and that is not sufficient. Inefficient management of existing manpower, equipment and other resources, unscientific and inefficient collection practices, inefficient management of landfill make the management system more vulnerable.

4.4 Findings from Open Dumping Points Survey

According to Waste Management Department of Narayanganj City Corporation, there are lots of open duping point (designated and undesignated) in NCC. But Narayanganj city corporation is responsible for only 85 open dumping points which were designated and operating by the waste management department of Narayanganj City Corporation. Most of the open dumping points are along the main road and in market place of NCC. Not only the household waste but also the commercial and industrial waste is also thrown in these open dumping points. Waste from roadside commercial, industrial, household even hospital comes at open dumping points through individuals, hand trolley or rickshaw van.

Figure 4.44: Open dumping point beside popular clinic in NCC

Every day city corporation truck comes and takes out the waste of those open dumping points at morning and sometimes evening. There are more than 20 open dumping points from where city corporation vehicle (Trucks) come twice (Morning and evening) to collect waste from those open dumping points. We can have a picture of existing amount and type of generated waste from this open dumping point visit. Acumen Architects and Planners Ltd. (The Consultant) with waste management department of NCC has visited several open dumping points and collected detail information about all of the open dumping points.

Figure 4.45: Open dumping point beside Jimkhana Road in NCC

This experience helps us to estimate the current amount of generated waste in NCC area. Following table shows the visited open dumping points of NCC.

Carrier size of Truck: 20'/8'/4'

Table 7: List of visited open dumping points with calculation of amount of waste

Location Name of open dumping point	Wand Number	Type of Area	Approx. Area (sq. feet)	Amount of waste	
				Unit: Number of Loaded Truck (3 ton)	Amount of Waste (Unit: Ton)
Nitaiganj Mor	18	Commercial	12'/6'	1	3
Nulua Road (Bongobondu extension Road, Motin Shaber Bari, beside Kamarer Shop	18	Commercial	5'/5'	1	3
Nitaigang Mor, boldeb Temple	15	Commercial	8'/6'	1/2	1.5
Nitaiganj, in front of Somrat Garments	15	Commercial	8'/5'	4	12
DIT, Jonota Super Market	15	Commercial	5'/6'	1	3
In front of F Rahman Super Market	15	Commercial	5'/7'	1	3
Ukil Para Mor	14	Commercial	8'/10'	2.5	7.5
Flower Bazar Mor	14	Commercial	8'/6'	3	9
Beside Popular Clinic	13	Commercial	8'/10'	2.5 (Evening ½ Truck)	7.5
Beside Hokers Market	13	Commercial	5'/7'	2.5 (Evening ½ Truck)	7.5
Children Park Sport	12	Residential	5'/6'	1	3
Officer's Quarter, Khanpur	12	Commercial	10'/8'	1.5 (Evening ½ Truck)	4.5

Beside Borofcall Field	11	Commercial	5'/6'	1	3
Beside Fire Service Mor	11	Residential	10'/8'	1/2	1.5
M. Sarkas Mor	11	Industrial and Commercial	12'/10'	1	3
Beside Pathantoli Bazar Mosjod	10	Residential, Industrial and Commercial	20'/6'	1	3
Beside Metro Cinema Hall	13	Commercial	5'/6'	1/2	1.5
Beside Jahaj Office	13	Residential and Commercial	10'/12'	2	6
Beside 1 no. rail gate	15	Commercial	5'/6'	1	3
Beside Chamber Road	15	Commercial	5'/7'	2	6
Beside Amina Monjil	17	Residential	12'/8'	1	3
Beside Akhrar Mor	16	Commercial	15'/5'	1/2	1.5
Beside Jim Khana Road	17	Residential	15'/12'	1	1.5
Total Visited ODP(23)				32 (Approx.)	97.5 (Approx.)
Grant Total in NCC (85)				118 (Approx.)	340 (Approx.)

Figure 4.46: Map of the visited open dumping site

4.5 Findings from Polythene Beg Distribution and Collection Survey

The consultant has conducted a special survey to find out the existing generated waste from the households of Narayanganj City Corporation. They have distributed 100 begs in Narayanganj City Corporation among the high (10), middle (50) and low income (40) group households. They have also hired an expert member from Waste Concern to conduct this survey. The waste management department of Narayanganj city Corporation also helped by supporting their man power to conduct this survey.

Figure 4.47: Picture of Polythene Beg Distribution and Collection Survey at NCC

We have conducted this survey for three consecutive days where 1st day was Friday, 2nd day was Saturday and 3rd day was Sunday. We distributed 3 begs with different color for each family where 1st one was for perishable waste (like kitchen waste, food waste etc.), 2nd one was for nonperishable waste (like plastic, rubber, leather, paper etc.) and 3rd one was for hazardous waste (like containing chemical ingredients). We had distributed all types of begs among the different income group households at morning in NCC area and collected them at the next day morning and it was continued for 3 consecutive days. The findings of this survey helped us to calculate the total amount of daily generated waste from the households of NCC area. The overall summery of that survey is shown below tables and figures.

Figure 4.48: Picture of polythene beg survey in NCC area

Average Waste Generation rate per Person per day in NCC

Table 8: Per capita waste generation rate per day in NCC

Income Group	Average Family Size	Average Waste Generation rate per Person	Average Waste Generation Rate (gm)
High Income Group	5.44	601.272	462.534 gm 0.463 kg
Middle Income Group	4.964	421.224	
Low Income Group	4.416	365.206	
Total Population of Narayanganj City Corporation at 2020	1063576 (Based on BBS, 2011 data: Projected with exponential growth methods)		
Total Amount of Household Solid Waste Generation per Day at 2020	491975.514 kg or 491.975 tons		

Bucket Information: Volume Calculation/Density Calculation/ Waste Composition

Table 9: Volume Calculation/Density Calculation/ Waste Composition

	Amount of Perishable Waste (gm.)	**Amount of Plastic/Polythene/ Nonperishable Waste (gm.)**	**Amount of Hazardous Waste (gm.)**
Bucket 1	3425	1285	1425
Bucket 2	4855	1335	
Bucket 3	2825	1030	
Bucket 4	3775		
Total amount for 15 beg	14880	3650	1425
Total amount for 100	99200	24333.33	9500
Volume of the Bucket	0.0122 m^3		
Density (kg/m^3)	8131.148	1994.536	778.6885

Waste Composition (%)	74.56778	18.29116	7.141067

4.6 Findings from the Warehouse of Broken Material Survey

Good management of solid waste is one of the most important ways of protecting our health. Before we can design a waste, management service and monitor its effectiveness, we need detailed information on the waste itself. For each type of waste produced we need to know the quantities generated, where the waste is generated and its composition. Broken materials, cloth or textile, wood, leather, rubber, plastic, paper and other wastage substances (miscellaneous items) are basically come from households and commercial area. These wastages are not only come from the Narayanganj City Corporation area but also from the outside of the city corporation area. The consultant has visited several warehouses of broken materials, cloth, wood, rubber, leather, plastic, paper and others wastage substances. The wastage of those warehouses can be recycled and reused and disposal waste also can be used in waste to energy production. We are going to present in brief the current scenario of those warehouses.

Figure 4.49: Picture of warehouses of NCC area beside Narayanganj Rail Station and Nim Chasra

Types of Wastages come to those warehouses:

1. Broken Materials (Iron, Glass, Silver, Steel, Tin etc.)
2. Cloth
3. Wood
4. Leather
5. Rubber
6. Plastic

7. Paper

8. Hazardous Waste (Bottle of Medicine, Acid and other hazardous substances)

9. Others Wastage Substances

Detail about of some wastage type of the warehouse:

Broken Materials: Most of the broken materials are come from households, construction site and commercial area. The wastage of these broken materials can be recycled and reused because they have high market value. All of the broken materials go to Nawab Bazar and Islambagh, Dhaka and recycle there. They use truck to carry all type of broken materials.

Figure 4.50: Picture of Broken materials beside Narayanganj Rail Station

Cloth: The wastage of cloth comes from garments industries and households. The market value of wastage of garments industries is also high. Garments industries have fixed customers to sell their wastages. Local buyers told that they use those garment's cloth wastages to produce cotton and raw material of cloth production.

Figure 4.51: Textile or Cloth wastage

Wood: Most of this type of wastage come from household and commercial area. They use wood waste as a material of fuel in many industries (Brick kiln) even in the household of low-income group.

Plastic: Plastic is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be molded into solid objects. Due to their low cost, ease of manufacture, versatility, and imperviousness to water, plastics are used in a multitude of products of different scale, including paper clips and spacecraft. They have prevailed over traditional materials, such as wood, stone, horn and bone, leather, metal, glass, and ceramic, in some products previously left to natural materials. Plastic waste is main raw material of waste to energy production.

Leather: This type of wastage mainly come from household waste like shoe, leather beg, money beg, belts etc. It's also come from small local leather industries.

Figure 4.53: Ware house of Leather waste beside Narayanganj Rail Station

Hazardous Waste: Wastages like bottle which contain medicine, acid, paints ingredients and other hazardous substances are also come in those warehouses. They are dealing with those wastages without any safety management.

Figure 4.54: Picture of Hazardous Waste

Details of warehouse of broken materials, cloth or textile, wood, leather, rubber, plastic, paper and others substances of Wastages of Narayanganj City Corporation:

Total approx. number of warehouses: 250-300

Average number of rickshaw van come per warehouses per day: 2-3

The amount of waste each van contains: 80-90 kg

Average amount of waste come at each warehouse: 200-250 kg

Percentage of useful/recyclable waste: (70-80) %

Percentage of disposal waste from the warehouses: (20-30) %

Frequency of wastages loaded truck from each warehouse which go to Islambagh/Nawabbazar: Twice or more in a month

Amount of taka, NCC charge to management their disposal wastage: 0 taka

Local retail prices of warehouse wastage

Table 10: Local price of all type of wastages which come at warehouse

Type of Waste	Buying Price (per kg) BDT	Selling Price (per kg) BDT
Broken Material	15-25	30-35
Paper	8-10	10-12
Cloth or Textile	10-15	15-20
Plastic	12-15	15-20
Leather/ Rubber	6-8	10-12
Cooking Container	60-80	90-120
Bottle of Hazardous waste	6-8	10-12
Woods	1-1.5	2

Table 11: Total amount of solid waste from the warehouses of broken materials

Total approx. number of warehouses	**250-300**
Average number of rickshaw van come per warehouses per day	**2-3**
The amount of waste each van contains	**80-90 kg.**
The amount of waste comes at each warehouse per day by waste collector (Tokai)	**30-40 kg.**
Frequency of wastages loaded truck from each warehouse which go to Islambagh/Nawabbazar	**Twice or more in a month**
Percentage of useful/recyclable waste	**70-80 %**
Total amount of solid waste comes at each warehouse per day	**250-300 kg**
Total amount of solid waste comes at all warehouses of NCC	**(300* 300) = 90000 kg. or 90 tons**

Expectation of the owners, workers and wastage collectors of the warehouses:

Narayanganj city corporation do not give any kinds of facilities to the owners, workers and waste collectors. They need safety equipment like hand gloves, special shoes, masks etc. They demand that they are working to make Narayanganj City Corporation clean but they are deprived in many ways. There is no proper management system to dispose their wastages. They suggest that Narayanganj City Corporation should come up with a plan to collect, transport and dispose the wastages which come to them. They also demand for a recycling market in Narayanganj.

4.7 General Information about NCC's Waste Management Department

4.7.1 Waste Management Data/2019-2020 (Source: Waste Management department and City Corporation Website)

Narayanganj City Corporation belongs Narayanganj, Kadamrsul and Shiddirgonj area.

Amount of daily generated waste (Including household waste): 500 tons

The amount of daily disposed waste: 450 tons

The amount of daily disposed household waste by **NGO/CDC**: 40 tons

Percentage of disposed waste in NCC: 94 %

Temporary open waste dumping points in NCC: 80-85

Number of total garbage truck in NCC: 22

Number of garbage truck (03 ton): 19 and number of garbage truck (05 ton): 03

Total number of sweepers: 867

Every day dirt or garbage clearing time: 06.00 am to 10.00 am

Table 12: Sweeper's payment scale per day

Serial no.	Position Name	Regular salary
01	Sweep, Dom and Latrine man	135/-
02	Sweep and Trolley man	175/-
03	Drain man	175/-
04	Trolley man	175/-
05	Truck leaver	250/-

4.7.2 Clinical/Hospital Waste Management

Total number of hospitals: 02

Total number of clinic and diagnostics center: 55

Amount of waste from Clinic and Diagnostics center (Per day): 100 kg from 3 ton of total waste

B: N: The solid waste from clinic and diagnostics center transports by "Prijom Bangladesh" and also dispose by "Prijom Bangladesh".

Total Number of NGO/CDC to manage household waste: 18

- 18 wards out of 27 are covered by Waste Management Department of NCC and rest of them (9 Wards of Kadamrsul) are in the process of SWM.
- In 2006, the Department of Environment established a compost plant at Ponchhoboti. Mega Ltd is responsible for this compost plant. They are producing 22 tons/day organic fertilizer from the compost plant.
- Narayanganj City Corporation has 23 acres land in Jhalkuri Dashpai area (Ward 09). 10 acres land will be used to prepare an electric power plant (Waste to Energy) of 5MW. There needs 500 tons waste per day to run this power plant project. 2 acres land will be used for Fecal Sludge Management by WSUP (Water and Sanitation for Urban Poor). Rest of the land will be used for sanitary dumping site.

4.7.3 Data from Waste Management Department of NCC

Table 13: Waste Management Department of NCC

Sl. No	Subject	Data
01	City Corporation area (square km)	72.43 sq. km
02	Total Population of Narayanganj City Corporation area	20 Million
03	Total number of Ward	27

04	Total amount of daily generated waste (Metric Ton)	400
05	Percentage of area covered by Waste Management Department NCC	94%
06	**Waste collection/management method**	
	a) Do they collect waste from household or institutions or others?	Yes
	b) Do they collect waste by using dustbin?	Yes
	c) Above both methods are running or not?	Yes
	d) Clinical/medical waste management method	
	e) Households/ organization septic tanker dirt removed method	
07	Are perishable and nonperishable waste collected separately or not?	No
08	a) Is there any Land fill site in NCC? b) If have, is it enough or not?	No
09	Method to produce organic fertilizer from perishable waste and their daily production and usability	Daily 22-ton organic fertilizer is produced
10	Waste treatment plant management	No
11	a) Is there any project taken for WM? If yes, what is the current situation of that project? b) Budget of that project? c) Is there any possibility for coming up new project? If yes, what is the amount of project budget? What are the major components of that Project?	Running 5-megawatt electricity production plant Jalkuri ,Dospie area ward no 09
12	Is there any separate unit for waste management in NCC? If you have, describe it in brief?	No
13	**Manpower/population and vehicles/machinery engaged in WM**	
	a) Number of employees?	02
	b) Number of assistant employees?	20

	c) Number of cleaning staff?	900
	d) Number of garbage truck?	21
	e) Number of waste collection van?	12
	f) Number of excavators?	5
	g) Other vehicles - machinery?	1. Vacuum tank 03 2. Pay – loader 10 3. Wheel douser 03

Table 14: Short Term and Long-Term Plans for Waste Management of NCC

Serial No	Subject	Information
01	short-term work plan of waste management for the next 3 years	* Sanitary Landfill Site development * 3- R (Reduce, Reuse, Recycle) polices development and implementation * Purchase modern waste transport vehicle * Development of Secondary Transfer Station * Implementation of separately waste collection scheme from source
02	Long -term work plan of waste management for the next 3 years	* Sanitary Landfill Site development * 3- R (Reduce, Reuse, Recycle) polices development and implementation

		* Purchase modern waste transport vehicle * Development of Secondary Transfer Station * Implementation of separately waste collection scheme from source * Ensure technical and adequate manpower for Waste Management Department
03	Miscellaneous issues related to waste management	* Provide regular training on WM * Increase in institutional and professional capacity

4.7.4 Challenges and Recommendations of Waste Management Department of NCC

Challenges in Waste Management:

01) Inadequate manpower structure

02) Inadequate vehicles and machinery

03) Secondary stations and sanitary landfill no longer available

04) Problems in household waste management and clinical waste removal

05) Inefficiency of the WM workers

06) The job of the lower performers is at risk

07) Inadequate technology and advanced technology

08) Running waste management activities in a simple and unplanned way

09) Budget shortages in waste management

10) Lack of social awareness on waste management

11) The institutional legal framework on waste management is insufficient

12) FSM (No drainage).

4.7.5 Initiatives to tackle waste management challenges

01) Adequate manpower must be increased

02) Secondary stations and sanitary land fill should be constructed

03) Awareness and incentive program should be adopted for public awareness of waste management.

04) The institutional legal framework for the management of waste must be developed

05) 3-R policies need to be implemented

06) FSM (Sewage system) and a sound implementation

07) Waste management should increase the budget allocation

08) The number of modern vehicles and equipment employed for waste management should be increased

09) Sweepers or lower ranked workers need to ensure about their jobs.

Recommendation: A well organized and modern WM master plan should be formulated on waste management and implementation of the plan accordingly to improve the current WM system.

4.7.6 List of Waste Management NGOs and CDCs of NCC

Table 15: List of Waste Management NGOs and CDCs of NCC

Sl. No	NGOs and CDC	Working area	Number of Van	Expiration Date	Comment
01	Sahebpara Development Committee (01712634311) MD. Mobaruk Hossan Khan Shahabpara, Sidhergonj, Narayangonj	02 no ward	10	30/08/2018	Applying for renewal and 25,000 taka pay-order was submitted
02	Harun ar rosid, Treasurer of Bangladesh Freedom Fighter Welfare and Rehabilitation Society Shanerpar, Siddhigonj, Narayongonj	03 no ward (Partly)	05	31/08/2017	
03	MD. Shohel Rana President, "Rasulbagh Udayan Youth Association" Rosulbagh, Sanerpara Siddhigonj, Narayangonj	03 no ward (Rasulbagh and Mukte Nogor)	04	31/07/2018	Sonali Bank Limited: Nitaigonj branch, Narayangonj. Pay Oder NO-POC-8661150 Date-31/07/2017 25,000 taka pay-order was submitted
04	MD. Ounce Ali Shojib	07 no ward	06	31/05/2018	01724573970

	In Conductive consciousness Kodomtoli, Admoji Nogor, Siddhigonj, Narayangonj				
05	MD. Roni and MD. Mosthofa Service Association Jalkuri West para, Siddhigonj, Narayangonj.	08 no ward (Partly)	07	31/10/2017	
06	Rima Akter Madder tax Army Store Jalkuri West Para, Weaving, Siddhigonj, Narayangonj	08 no ward (Partly)	02	31/03/2018	
07	Ahsan Habib (President) Sirajul Islam (Secretary) A co-operative society, Narayangonj	09 no ward	06	30/11/2018	Agrani Bank Ltd. Bongobondhu Road C. R. R. P branch, Narayangonj Pay Oder NO-POA-0750798 Date-09/08/2017 25,000 taka pay-order was submitted
08	MD. Imran Hassan (Emon) Social Welfare Development Forum 260, Godnail, Arambagh Narayangonj	10 no ward	06		Counselor sir's oral instructions
09	Abdul Jabber	11 no ward	08	31/12/2015	AL-Amin

	Director of Public Service 29, Bongobondhu Rode Narayangonj				01685035496 He works
10	Sahida Hossain Sweety Secretary-General, Aid Bangladesh Chanmari, Narayangonj. (01673419933)	12 no ward	13	31/08/2017	
11	MD. Habibur Rahaman Mamun, Executive Director Ankur Health and Education Development Society, 126/6 Chanmare, Narayangonj	13 no ward	23	09/08/2017	
12	Kanchon Sen Vice-president (01919403507) C.D.C No-01-04-03 South Rally Gardens, Narayangonj	14 no ward	11		Related ward Councilor renowned at the behest of Mahomed
13	C. G. Committee (Tran Bazar from Bongsal)	15 no ward (Partly)	06	01/07/2019	
14	Achia Khanam Sumi Buriganga Cluster Committee (CDC Town Federation) 316 West Devogh, Narayangonj	16 no ward	09	31/10/2018	Jonota Bank Limited: Syed Ali Chamber Branch Narayangonj Pay Oder NO-POB-0810451 Date-15/10/2017 25,000 taka

					pay-order was submitted
15	Salma Runa Magna cluster Community Development committee C.D.C. No-1108037 U.P.P.R. P	17 no ward	05		
16	MD. Joinal Abadin Sitolokkha Cluster Committee-03 Narayangonj. (01818703053)	18 no ward	05		
17	MD. Al- amin, President of the Port Public Service Association Welfare Service Company, Narayagonj	21 no ward	02	31/06/2017	
18	MD. Niamot Ullha President Sirajuldoilla Club, Bondr, Narayangonj	22 no ward	09	09/04/2018	Applying for renewal 25000 Taka Pay Oder Submitted
19	Selina Mahamuda Masuma Bandar Upazila Women's Cooperative Society Ltd. 128/1 Wilson Road, Nobigonj, Narayangonj.	23 no ward	06	31/08/2016	

4.7.7 Name of current designated driver and their working area of waste management department of NCC

Siddhirganj Area

Serial No	Driver Name	Diver phone Number	Ward No
O1	MD. Nijamuddin	01684556353	01, 02, and 03 no ward
02	MD. Ridoy	01939853188	04, 05, and 06 no ward
03	MD. Noion	01992420772	07, 08, and 09 no ward

Kadamrsul Area

Serial No	Driver Name	Diver phone Number	Ward No
01	Nur MD. Bokul		21and 22 no ward (Partly)
02	MD. Abbul Bashar	01681262381 01921064596	19,20 no ward 21 no ward (Partly)
03	MD. Feroz		23 no ward
04	MD. Ibrahim		24, 25, 26, and 27 no ward

Comment: There are 1 payload in the area. All the garbage is removed with the combination of pay loaders and track workers.

Pay loader Driver: 01) MD. Masud (19 no ward – 27 no ward).

Narayanganj Area

Serial No	Driver Name	Diver phone Number	Area of Action	Ward No
O1	MD. IQBAL	01835537417	AM Circus, The whole Godainaiel Ward	10
02	MD. Melon	01621755229	Iceberg, Children Park, Magistrate's Quarter, The face of the DC street and the street in front of the street, Floor Area	11 12
03	MD. Monju	01621381950	Duck bungalow bend, Jamtola, Eidgaho mat, Metro Cinema Hall, Dustbin adjacent to Kumudini Gate, Chara gope, SP Bungalow, Police line	13

04	MD. Salem Gare No-New Track-03	01987030226	B.I.W.T. Ship office, Jute office space adjacent to the old Alam cabin, The front subdivision of the city subdivision, Hawkers Market & Front	13
05	MD. Faruk Hossan Khondokar	01715588640	Ukilparar mor, Grindlays bank adjacent flower market bend, Freedom fighters in front of Parliament	14 15
06	MD. Sobuj lal Gare No- s-11-0042	01828100767	Nimtala Thousand Cottage, Turn Market is in front of Park Pursuit Pharmacy, Sweeper colony at the southern corner, Number 1 railway gate	15
07	MD. Mahabub Hossan Montu Gare No-New Track-10	01720261955	Chamber Road with Toilet Mass, Dhoivog nogor Mattresonod, Dhoivog water tank Adjacent field, One day at seven o'clock Karim Market and the other on the north side of the Mathematics School	15
08	MD. Samshul Hok Gare No-New Track-03	01720261955	DIT Gulmal Cinema Hall, Digubabur Bazar Mirjumla Road	15
09	MD. Shaiful	0199108562	DIT Rizeia clinic, Digubabur Bazar Mirjumla Road, In front of the old court reb's office	15
10	Onil Chondro da	01954056075	Shaheed Bappi Road New Road, Netaigonj Twist, Rishipara dustbin, Amena Monjil Twist, The Emperor is in front of the garment, Victoria Hospital's inner dustbin	18
11	MD. Noion	01775717943	Frog gatola, Amena Monjil, Joy Gobindo schoolar back Road, Jimkhana new road twist	16 17
12	MD. Monju	01621381950	After noon all the sports on the main road of the city	
13	MD. Imran	016388810819	Dahovog Hakim Ali Market (2nd Floor), Mogen School, Lack par spot	16
14	MD. Akas\Bossier		B.I.W.T. Ship Office	13

Comment: There are 2 payloads in the area. All the garbage is removed with the combination of Pay Loaders and Track Workers.

Pay loader Driver: 01) MD. Monir (10 no ward – 14 no ward).

02) MD. Delaware (15 no ward – 18 no ward)

4.7.8 List of Vehicles and Vehicle Driver Engaged with SWM of Narayangonj City Corporation

Serial No.	Car No.	Driver name
1	Long boom excavator	MD. Johir
2	Skid steer loader - 3	MD. Masud
3	Skid steer loader -1	MD. Monir
4	Skid steer loader -5	MD. Delowar
5	18 No. dump truck **(EICHER)**	Suboj das
6	2 No. dump truck **(EICHER)**	Anil
7	3 No. dump truck **(EICHER)**	MD. Nijam
8	4 No. dump truck **(EICHER)**	Not driver
9	5 No. dump truck **(EICHER)**	MD. Mahdub
10	6 No. dump truck **(EICHER)**	Not driver
11	7 No. dump truck **(EICHER)**	MD. Noyon (2)
12	9 No. dump truck **(EICHER)**	MD. Shamsul huq khandokar
13	10 No. dump truck **(EICHER)**	MD. Noyon (1)
14	11 No. dump truck **(EICHER)**	MD. Ibrahim
15	13 No. dump truck **(EICHER)**	MD. Khandokar faruq ahmed
16	14 No. dump truck **(EICHER)**	MD. selim
17	16 No. dump truck	Not driver
18	17 No. dump truck	MD. Munju ahmed
19	19 No. dump truck	Nur hossen boqul

20	20 No. dump truck	MD.Ridoy
21	21 No. dump truck	Not driver
22	22 No. dump truck	MD. Milon
23	23 No. dump truck	MD. Abul basar
24	Chain type bulldozer - 1	MD. Shakib
25	24 No. dump truck	MD. Iqbal
26	25 No. dump truck	MD. Saiful
27	26 No. dump truck	MD.Firoz
28	Narayangonj -Sa – 11- 0002 Water car	Not driver
29	Track type hydraulic boom excavator	Not driver
30	Mini excavator - 1	Not driver
31	Mini excavator -2	Not driver
32	Skid steer loader -2	Not driver
33	Skid steer loader -4	Not driver
34	8 No. dump truck **(EICHER)**	Not driver
35	15 No. dump truck **(ISUZU)**	Not driver
36	3 Ton dump truck (china)	Not driver
37	2 No. truck (709 TATA)	Not driver
38	3 No. truck (709 TATA)	Not driver
39	6 No. truck (709 TATA)	Not driver
40	Truck (407 TATA)	Not driver
41	1 No. dump truck	Not driver
42	3 NO. dump truck (china)	Not driver
43	4 No. truck (709 TATA)	Not driver
44	27 No. dump truck	MD. Akash
45	28 No. dump truck	Not driver
46	29 No. dump truck	Not driver
47	30 No. dump truck	Not driver

48	31 No. dump truck	Not driver
49	Chain type bulldozer - 2	Not driver
50	West collect truck (box) - 1	Not driver
51	West collect truck (box) - 2	Not driver
52	West collect truck (box) - 3	Not driver
53	West collect truck (box) - 4	Not driver

4.7.9 Total Number of Holdings in NCC

Kadamrsul Area

Serial No.	Ward No.	Holding number 2017-2018 (Kadamrsul)
1	19	1587
2	20	1602
3	21	1608
4	22	2218
5	23	2172
6	24	1964
7	25	1264
8	26	716
9	27	1443
Non-government	-	14,574
Government	-	62
Total	-	14,636

Siddirganj Area

Serial No.	Ward No.	Year	Holding number 2017-2018 (Siddirganj)
1	01	2017-2018	3904
2	02	2017-2018	3846
3	03	2017-2018	2724
4	04	2017-2018	1194
5	05	2017-2018	1538
6	06	2017-2018	1276
7	07	2017-2018	1826
8	08	2017-2018	3725
9	09	2017-2018	3436
10	Non-government	Total	23,469
11	Government	Total	58
12		Total	23,527

Narayanganj Area

Serial No.	Ward No.	Year	Holding number 2017-2018 (Narayanganj)
1	10	2017-2018	1169
2	11	2017-2018	1568
3	12	2017-2018	1940
4	13	2017-2018	2767
5	14	2017-2018	1624
6	15	2017-2018	1694
7	16	2017-2018	2108
8	17	2017-2018	1426
9	18	2017-2018	2552

10	Non-government	Total	16,884
11	Government	Total	306
12		Total	17,190

4.7.10 Budget Information of Waste Management of Narayanganj City Corporation

Budget Information of Narayangonj City Corporation (Budget Year 2016-2019)

Income sector	Previous year's budget 2016-2017	Revised this year 2017 -2018	Next year's budget 2018 -2019
Dirt Drainage Tax	63884615.00	79231000.00	94113000.00
Narayangonj City Corporation Road, Drain Construction and Reconstruction			
GoB	50000000.00	900000000.00	339200000.00
NCC	0.00	9600000.00	150000000.00
Narayangonj City Corporation sweeper worker housing project			
GoB	0.00	31200000.00	257440000.00
NCC	0.00	8700000.00	64360000.00
Narayangonj City Corporation Solid waste collection and disposal management project			
Gabi	0.00	1620500000.00	237370000.00
NCC	0.00	0.00	0.00
CRDP			
Road drainage and construction	364780.00	11806000.00	0.00
Others	407447.00	20940.00	0.00

Expense sector	Previous year's budget 2016-2017	Revised this year 2017 -2018	Next year's budget 2018 -2019
Jip van, Garbage truck, Microbus, pi cup van, power tiller, Motor cycle, speed board, chain drogue, Long excavator, Hydraulic Lipter.	17529750.00	19756000.00	40000000.00

Waste Management and Fecal sludge Disposal			
Drainage and Cleaning of Garbage	4416644.00	5000000.00	15000000.00
Purchase of equipment's for daily drainage and cleaning garbage	952100.00	1000000.00	2000000.00
Conservancy vehicles fuel	0.00	8000000.00	20000000.00
Land Purchase/Acquisition of Land for dumping site	0.00	0.00	15000000.00
Waste Management Modernization	0.00	0.00	5000000.00
Trolly, van purchase and Repairing	0.00	1200000.00	5000000.00
Sweeper's remuneration	24987380.00	30000000.00	50000000.00
Implementation of sanitation activities	253620.00	50000.00	2000000.00
Electrical Equipment Purchase and Repairing	4510605.00	3500000.00	5000000.00
Total	35120349.00	48750000.00	119000000.00
Drain Construction	100737224.00	28030000.00	5000000.00
Drain Repair and Maintenance	33579075.00	12013000.00	20000000.00
Narayangonj City Corporation road and drain construction and reconstruction			
GoB	49991347.00	800000000.00	439200000.00
NCC	0.00	9600000.00	15000000.00
Subtotal	49991347.00	809600000.00	589200000.00

Budged Information of Narayangonj City Corporation (Budged Year 2013-2016)

Income sector		Previous year's budget 2013-2014 (BDT)	Revised this year's budget 2014-2015 (BDT)	Next year's budget 2015-2016 (BDT)
1.	Dirt tax	6135589.00	54733063.00	106752166.00
2.	Road and drain construction		151617000.00	121000000.00
3.	Jip van, garbage truck, microbus, pic up van, power tiller, motor cycle, speed board purchase, chain dodger, long excavator, hydraulic elevator	6582900.00	0.00	30000000.00
4.	Dumping land acquisition/purchase	0.00	0.00	50000000.00
5.	Waste management modernization	0.00	0.00	5000000.00
6.	Trolley, van purchase and repair	1274450.00	50000.00	2000000.00
7.	Sweeper's fee	16543420.00	18738500.00	28000000.00
8.	Drain construction	177542188.00	154552000.00	60000000.00
9.	Dumping center, land development and boundary wall construction	0.00	0.00	20000000.00
10.	Drain repair and maintenance	95599640.00	86550000.00	40000000.00
11.	Road and drain construction		151617000.00	121000000.00

Budget Information of Narayanganj city Corporation (Budget year 2011-2014)

Expense sector	Previous year's budget 2011 -2012	Revised this year 2012 -2013	Next year's budget 2013 -2014
Dirt Tex	18899237.00	46821100.00	63275700.00
Drain Construction	31403158.00	400000000.00	100000000.00
Dumping Site and Land Development and Boundary Wall Construction	0.00		200000000.00
Drain Repair and Maintenance	10467710.00		400000000.00
Public Toilet/ slaughterhouse	335383.00		100000000.00

Road and Drain Construction			160000000.00
Purchase of waste management development and equipment	0.00		250000000.00

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