Sustainable Solid Waste Management Through 3R Strategy in Gazipur City Corporation

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APPROVAL

The thesis titled "Sustainable solid waste management through 3R strategy in Gazipur city corporation" submitted by Abdullah Rumi Shishir (Student ID 125423), Promi Islam (Student ID 125447) of Academic Year 2012-16 has been found as satisfactory and accepted as partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering.

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DECLARATION

We hereby declare that the undergraduate project work reported in this thesis has been performed by us and this work has not been submitted elsewhere for the award of any degree or diploma.

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DEDICATED
TO
OUR BELOVED PARENTS

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Abstract

Generation of huge amount of solid waste and its mismanagement has become one of the major concerned social and environmental issues in both urban and rural areas. Although municipal authorities are concerned about the importance of solid waste collection and disposal and recycling but it is difficult to deal effectively with the growing amount of solid waste generated with the increase of population. Therefore, solid waste is dumped on roads and into open drains which leading to serious health risk and degradation of living environment for millions of urban people. With the advance of time special consideration for municipal solid waste is being required.

In urban areas, the most adverse impact of solid waste is incidence and prevalence of various diseases. In Dhaka, malaria, respiratory problems, eye and skin diseases are the worst impacts. Moreover, contamination of ground water and air also leads to such adverse health impacts. On the other hand, solid waste blocks the drainage system and creates flooding in the streets leading towards mosquitoes, bad odor, and inconvenience. Dhaka with its geographical and climatic conditions is prone to flooding; hence, solid waste in the streets and drains multiplies the health impacts and miseries. Most of the child mortality could be related with this problem, as contaminated ground water and malaria are the major causes for this mortality.

Gazipur is the largest city corporation of Bangladesh. The area of this city corporation is about 329.53 square kilometer and its population is about 2500000. To conduct our study Gazipur was divided into 5 zones. Wastes were collected from each zone for two seasons- dry and wet to determine seasonal comparisons. From each zone sample wastes were collected thrice. Household wastes are primary sample source. Then from a secondary and final dumping site sample wastes were collected.

The main objectives of this study were to determine waste generation rate (per capita per day) and to determine the composition waste composition in houses, secondary dumping site and final dumping site, amount of the waste that can be reduced and the possible amount of economic benefits that can be achieved through adopting 3R policy. Then suggestion for some environmental management initiatives so that a sustainable waste management system can be achieved.

A questionnaire survey was done during the collection of household wastes. From the survey information gathered from the people were about socio economic level, existing and preferable waste collection system, generation rate. After the survey was done wastes from all sources were collected and dried in sun for 24 hours separately after drying for 24-hours wastes was sorted into various components according to physical properties. Then percentages of mass of each component were determined. From the dry sample moisture content of waste and composition analysis were prepared.

From our study it has been determined that waste generation rate for the Gazipur City Corporation was 0.323 kg/capita/day depending on season and socio economic level whereas the national waste generation rate for the urban area is 0.41 kg/capita/day (**Source: Waste Survey 2005**) . In dry season waste generation rate is little lesser than wet season due to production of more food in wet season. Again high socio economic people generate more wastes than low

socio economic people. Another major finding from our study is that Food and vegetable waste i.e. organic waste is the predominant component in each sampling source. Non organic recyclable components are mainly paper and plastic and others include wood, leather, glass, metal, polythene, bricks and their range by mass varies between 25% and 35% in each source.

Our study recommends that mass and volume of recyclable components are key factor in developing a healthy and economical waste management system. Recyclable wastes should be separated and only organic and non-recyclable inorganic wastes should be brought to final dumping site. Recycling at the same time can reduce landfill required to dump and produce resource. Only non-recyclable inorganic components should be dumped in earth and other organic wastes should be used for compost manufacturing.

As Gazipur is a large and densely populated city corporation, feasible and healthy management system is an obvious to employ as soon as possible. During our study another fact that was revealed is that administrational and financial framework for managing wastes in this area is inadequate and inconsistence due to new establishment of this city corporation.

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Chapter 1

INTRODUCTION

1.1 General

Solid wastes are all the solid materials which are discarded as useless or unwanted generated from human and animal activities. Municipal Solid Waste (MSW)—more commonly known as trash or garbage—consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses. Composition of municipal waste varies from municipality to municipality and changes with time.

Maximum waste is not collected and all are throw on open air. This result is uncollected waste on roads, canals, river and other public places. This human practice is making our urban life truly vulnerable. At this moment we are concerned and have to make sure the proper utilization of waste and we have to recycle all types of waste. Recycle is the intellectual salutation of urban waste problem. Because of, if we can recycle our waste we will also financially get benefits. Maximum people are not concerned about waste management. This is an important cause of mismanagement of waste. In Dhaka city household waste are thrown in the roadside and open areas. Clinical wastes also are thrown in the open dustbin. These types of human practice create huge environmental pollution. The sources of solid wastages are garbage, refuse, sludge and discarded material and the wastages are produce by industry, hospital, or household community activities. (DU Journal, Office of land quality-2000). Waste management is a tactic used to waste collection largely from different sources, including recycling and re-use of materials.

Wastes are not avoidable. Human activities Economic development, urbanization and improving living standards in city life have led to an increase in the quantity and complexity of waste generation rapid growth of population and the development of civilization, urbanization are degrading the urban environment and creating serious stress on natural resources. We live in a world of increasing scarcity. Raw materials from natural resources are limited financial resources are often insufficient, and securing land for final disposal is getting more difficult. So it is essential to set policy directions aiming for resource efficient, recycle-based management system to provide a clean, healthy and pleasant living environment to the citizens of the city and for current and future generations.

Rapid urbanization has made solid waste management a serious problem today. The urban area of Bangladesh generates approximately 16,015 tons of waste per day, which adds up to over 5.84 million tons annually. It is projected that this amount will grow up to 47,000tons/ tons/day and close to 17.16 million tons per year by 2025, due to growth both in population and the increase in per capita waste generation. Based on the present total urban population, per capita waste generation rate is found at 0.41 kg/capita/day in urban area of Bangladesh. Existing infrastructure for waste management showed that waste collection efficiency in different urban areas varies from 37% to 77% with an average of 55%. The overall waste collection situation is

not very satisfactory.

With the increase in population, economic activities and the income the municipal solid waste quantity and composition including the non- biodegradable and hazardous waste is bound to increase. The evolutionary waste quantity and characteristics accordingly challenge the municipal authorities in management, demanding more and more resources and technological capability. In developing countries where resources and capacity is constrained, the challenges thus become serious (Penjor, 2007)

Gazipur City Corporation is the largest city of Bangladesh having an area of 329.53sq.km and a population of 2500000.Population is increasing rapidly for the industrialization of Gazipur City. Generation of solid waste is also increasing with the rapid growth of population. Many studies have been done previously on the management process and system of solid waste of different major cities but none on Gazipur city.

1.2 Objectives of the Study

The study includes the following objectives

1) To study the solid waste generation rate and composition of wastes at different stages.

2) To estimate per capita generation of solid waste generation rate in Gazipur city corporation area and also the total generation rate.

3) To assess economic benefit by adopting 3R policy in Gazipur City Corporation area.

1.3 Description of the Study Area

The research work is carried out in Gazipur city. Gazipur is the largest city corporation in Bangladesh. This is also the most recently formed city corporation in Bangladesh. It was formed in the year of 2013. In Gazipur City Corporation, no segregation of waste has been done for reusing or recycling purpose. The existing practice is to collect waste from a secondary dumping site and then dispose of the waste at in open dumping site (usually at roadside).

1.4 Thesis Layout

I. Introduction: a. General: Some basic ideas about solid waste management.

b. Objective of the study: The aim of the study is described.

c. Description of the study area: Some brief description about the study area is given.

II. Literature review: a. Introduction: Some ideas about the previous studies.

b. Solid waste management in Asian countries.

c. Solid waste management in Developing countries.

d. Solid waste management in Bangladesh.

e. 3R policy in Bangladesh: main features and institutional responsibilities.

III. Methodology: a. Introduction: Some basic ideas about how the work is done.

b. Study area: Details description about the study area.

c. Data collection: Method of collecting data is described.

d. Waste sampling: Shows how different elements of waste is sorted.

e. Analysis: Finally the analysis procedure is given.

IV. Results and discussions: a. Introduction: Brief about the obtained results.

b. Zonal data representation

c. Volume and weight reduction

d. Economic analysis.

V. Conclusion and Recommendation: a. Steps those are necessary to adopt the 3R policy.

b. Conclusive comment.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Waste is an unavoidable byproduct of human activities Economic development, urbanization and improving living standards in cities, have led to an increase in the quantity and complexity of generated waste. Rapid growth of population and industrialization degrades the urban environment and places serious stress on natural resources, which undermines equitable and sustainable development [1]. Inefficient management and disposal of solid waste is an obvious cause of degradation of the environment in most cities of the world. Dhaka, the Capital City of Bangladesh, is expanding rapidly turning it into a mega city with an enormous growth of population at a rate of around 6 percent a year [1]. Dhaka City Corporation (DCC) has an area of 131 km2 and population of 120 million and population density exceeds 92,000 per km2 [2]. Rapid growth of industries, lack of financial resources, inadequate trained manpower, inappropriate technology and lack of awareness of the community are the major constraints of solid waste management for the fast growing metropolis of Dhaka [1].

Solid waste disposal poses a greater problem because it leads to land pollution if openly dumped, water pollution if dumped in low lands and air pollution if burnt. Dhaka city is facing serious environmental degradation and public-health risk due to uncollected disposal of waste on streets and other public areas, clogged drainage system by indiscriminately dumped wastes and by contamination of water resources near uncontrolled dumping sites [3]. The Dhaka City Corporation (DCC) is responsible for solid waste management. DCC is facing serious problems in providing a satisfactory service to the city dwellers with its limited resources and a poor management plan. An inadequate information base (regarding quantity, type and characteristics of wastes), poor operation and maintenance of service facilities and above all lack of civic awareness on the part of a section of the population are adding up to the deteriorating environmental situation [3]. 2 Municipal corporations of the developing countries are not able to handle increasing quantities of waste and a significant portion of wastes are not properly stored, collected or disposed in the proper places for ultimate disposal due to lack of enthusiasm, consciousness, loyalty, as well as money. There is a need to work towards a sustainable waste management system, which requires environmental, institutional, financial, economic and social sustainability. In less developed Asian countries integrated management and safe disposal of solid waste can be found in reference. Most appropriate systems for collection, storage and transportation and choice of a suitable method for disposal, sustainable management programs and proper planning is entirely depends on the characteristics of municipal solid waste .

The approach for SWM varies and should be compatible with the nature of a given society. Many studies on SWM management in developing countries have revealed that waste quantities and composition vary according to the characteristics of a place, and the management must be adapted to certain limitations common to these settings. Some of these limitations are attributed to the immaturity of SWM management discipline in developing countries on the one hand and new laws to regulate solid waste not systematically enforced because of a lack of clarity in the duties and

liabilities of the parties involved. On the other hand, indigenes depend on the capability of municipal authorities for municipal solid waste collection and disposal [4] the fundamental environmental issue in industrial and developing countries throughout the world is how to best identify and manage waste streams [5]. As urbanization continues to take place, the management of solid waste poses major public health and environmental problems in urban areas of many developing countries. Thus development must be sustainable such that it is based on an integrated approach and interaction between social, cultural, economic and ecological. Sustainability therefore means reducing the ecological footprint while simultaneously improving the quality of life – for ours and future generations – within the capacity limits of the globe [6]. SWM has been an integral part of every human society and policies vary both within and between developing countries. The characteristics and 3 quantity of SWM arising from domestic, commercial, and industrial activities in a region is not only the result of growing population, rising standards of living and technology development, but also due to the abundance and type of the region's natural resources [7]. Waste generation dates back as far as man started roaming the earth. The abandonment of the nomadic life in later years led to the creation of permanent communities. Until recently, waste was given a low priority in most municipalities, conference rooms and government offices responsible for public health and safety. [8]. It was only way into the 19th century that the idea of collecting and disposing of garbage in a systematic fashion became part of the general drive to improve public health [9]. In today's cities solid waste is removed and is either sent to disposal or is reprocessed for subsequent use.

2.2 Solid Waste Management in Asian Countries

The urban areas of Asia now spend about US$25 billion on solid waste management per year; this figure will increase to at least US$50 billion in 2025. Today's daily waste generation rate is about 760,000 tons. By 2025, this rate will be increased to about 1.8 million tons per day. Japan spends about ten times more for waste disposal than collection costs (mostly incineration costs). Total waste management costs in low income countries are usually more than 80 percent for collection costs. Lower cost landfilling is usually a more practical waste disposal option than incineration. Municipal governments are usually the responsible agency for solid waste collection and disposal, but the magnitude of the problem is well beyond the ability of any municipal government. They need help. In addition to other levels of government, businesses and the general community need to be more involved in waste management. Generally, solid waste planners place too much emphasis on residential waste; this waste represents only about 30 percent of the overall municipal waste stream but often receives the lion's share of attention. The waste components requiring priority attention in Asia are organics and paper.

2.3 Solid Waste Management in Developing Countries

In Europe, the growth has been in recycling more than in energy recovery, but in the United States, both have grown at the expense of landfill. The U.S. EPA projects that material recovery was more than double again in the 1990s, accounting for 30% of total waste management in the 2000. Energy recovery grow to 21%, leaving only 49% of municipal waste for land disposal [10]. The approach to waste management in North America has evolved over the years from disposal in open dumps until the 60‟s, the emergence of sanitary landfills as the preferred method of waste management in the 70‟s to integrated waste management. This waste management philosophy is to ensure the

treatment of all wastes as resource material, some suitable for recycling, others for conversion to compost [11].

In Japan, only 10% of the land is suitable for residential purposes. The shortage of land in accessible areas limiting the availability of suitable landfill sites is the driving force behind Japan's waste management policy3.Some 52 million tons of municipal waste is generated each year in Japan, 77.4% of which is incinerated, 5.9% land filled and 16.7% recycled [12]. Source separation of waste by households is well established with separation into either combustible or non-combustible material or recyclable materials such as glass, metal cans, newspapers etc.

MSWM is a major responsibility of local governments. The requirement of appropriate organizational capacity and cooperation between numerous stakeholders 19 in the private and public sectors make the task complex. With the importance of waste management to public health and environmental protection, solid waste management in most cities of developing countries is highly unsatisfactory [13]. African countries were given the opportunity by the WHO to prioritize their environment health concerns, the results revealed that while solid waste was identified as the second most important problem(after water quality), but less than 30% of urban populations have access to " proper and regular garbage removal [14].

Asian developing countries have increased their population, urbanization and industrialization which contribute to solid waste (SW) generation. For example, in India it was between 0.2 kg/capita/day and 0.5 kg/capita/day with 217 million people [15, 16]. Asian developing countries are experiencing in increasing population, income and urban growth. This situation contributes to the increase of SW volume and type. Most of municipal solid waste comes from residential areas, commerce and other sources [14]

2.4 Solid Waste Management in Bangladesh

Current waste generation in Bangladesh is around 22.4 million tons per year or 150 kg/cap/year. There is an increasing rate of waste generation in Bangladesh and it is projected to reach 47, 064 tons per day by 2025 (**Wikipedia).** The Waste Generation Rate (kg/cap/day) is expected to increase to 0.6 in 2025. A significant percentage of the population has zero access to proper waste disposal services, which will in effect lead to the problem of waste mismanagement.

The total waste collection rate in major cities of Bangladesh such as Dhaka is only 37%. When waste is not properly collected, it will be illegally disposed of and this will pose serious environmental and health hazards to the Bangladeshis.

Solid waste disposal poses a greater problem because it leads to land pollution if openly dumped, water pollution if dumped in low lands and air pollution if burnt. Dhaka city is facing serious environmental degradation and public-health risk due to uncollected disposal of waste on streets and other public areas, clogged drainage system by indiscriminately dumped wastes and by contamination of water resources near uncontrolled dumping sites.

Bangladesh has minimal waste collection coverage which forces majority of the waste to be dumped in open lands. These wastes are not disposed of properly, where general wastes are often mixed with hazardous waste such as hospital waste. In a report on solid waste management in Asia,

the data showed that, in Dhaka, only about 42% of generated waste is collected and dumped at landfill sites, and the rest are left uncollected. As much as 400 tons are dumped on the roadside and in open space. As such, these improperly disposed wastes poses serious health implications to the people where it may have the potential of transmitting diseases.

Due to the lack of funding, there are also insufficient subsidies put in place for the issue of waste management in Bangladesh. Hence, there are essentially no proper disposal facilities to cater to the rapid creation of waste.

Normally residents bring their refuse to nearby communal bins/container located in the street, whilst in some specific areas communities have arranged house-to-house collection of garbage by their own initiatives and efforts. Household, commercial, institutional and medical wastes are deposited in the same waste collection bins located beside the streets. Street sweeping is done manually and debris is loaded from the side into handcarts and delivered to the street storage facilities. In the down town areas, where the roads and lanes are narrow, the wastes are transported by two types of trucks i.e. either flat-bedded open vehicles or trucks with closed bodies (with shutters that slide vertically on both sides). In the new part of the City, a container system where containers are lifted hydraulically is working. Every vehicle has its own designated areas and routes for collecting wastes. The wastes, which remain uncollected, are dumped in open spaces, street and drains, clogging the drainage system, which create serious environmental degradation and health risks. The collected waste is presently being disposed of mainly in a low-lying area about 3 kilometers from the corporation area. There are few number of minor sites also which, are operated in an uncontrolled manner without any proper earth cover or compaction. In Dhaka, wastes, which have market value, are being reclaimed or salvaged for recycling. Recycling contributes to resource conservation as well as environmental protection. Recycling of paper, plastic, glass, metal etc. plays a very important role in the economic sphere and a large number of poor people are dependent on it for their livelihood. The major component of municipal waste i.e. organic food waste-is totally ignored even though it has potential value and can be converted into organic fertilizer.

Due to some reasons solid waste management system is not satisfactory in our country. Some reasons are Technical Constraints, Financial Constraints, Institutional Constraints, Economic Constraints, Social Constraints, and Social Constraints.

There have been recent developments in Bangladesh to improve waste management, especially in urban cities. In Dhaka, Dhaka City Corporation with support from the Japan International Corporation Agency (JICA) has a master plan underway to better handle the solid waste management in Dhaka. For instance, Social Business Enterprise Waste Concern has sprung up to tackle the municipal waste accumulation problem through working with the households. UNICEF has also initiated recycling programs and waste control with the city corporations and municipalities. However, currently, there are still insufficient incentives to improve the standard of waste management across all relevant sectors, especially for industrial waste and medical waste.

Gazipur City Corporation is the largest city corporation of Bangladesh. It is considered as one of the most important industrial zone of our country. Because of rapid population growth and increase of industrialization the amount of waste generation in this area is increasing at an alarming rate.

As the city corporation is formed newly, corporation authority is struggling to cope with the existing situation. Inadequate management practices and unrolled waste dumping are creating numerous environment problems. This study revealed that the existing waste management practices in Gazipur city is behind the satisfactory level due to poor infrastructural facilities in waste management ,lack of trained workers, lack of technologies and lack of proper planning's and monitoring activities.

2.5 3R Policy in Bangladesh

2.5.1 Main Features of 3R Policy

The principle of reducing waste, reusing and recycling resources and products is often called the "3Rs." They are: **Reduce**, **recycle** and **re-use**.

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Waste minimization can be achieved in an efficient way by focusing primarily on the first of the 3Rs,"reduce," followed by "reuse" and then "recycle." The waste hierarchy refers to the "3Rs" i.e., reduce, reuse and recycle, which classify waste management strategies according to their desirability. The 3Rs are meant to be a hierarchy, in order of importance. The waste hierarchy has taken many forms over the past decade, but the basic concept has remained the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

Approximately 120000 people are involved with the recycling occupation in Dhaka city. Similar recycling activities are also prevailing in other cities and towns of the country. The poor socially disadvantaged people informal sector are primarily involved with waste recovery and recycling practice in the country. Their recycling activity is reducing a significant volume of waste which otherwise would have to be collected by the local authorities.

2.5.2 Institutional Responsibility for 3R policy

1. Improving access to information and other resources

Providing easy access to online resources and information on events and training courses is essential for equipping all staff involved in animal research with contemporary and comprehensive information on the 3Rs. Most institutions will have an intranet for project and personal license holders and animal care staff, setting out internal policies and standard operating procedures. Internal online resources could be strengthened by providing a direct and visible link to the NC3Rs, including its Procedures with Care website, newsletters, free events and funding schemes.

2. Championing the 3Rs

There is a need to move the 3Rs 'out of the animal facility'. Responsibility for the 3Rs should not just be considered to be the domain of the vets and animal care staff. While these staff have a significant role to play on refinement and improving animal welfare, wide scientific engagement is

required for the full adoption of the 3Rs. This is particularly the case for replacement and reduction where detailed knowledge of the scientific objectives and experimental design are required. Divisions (Departments or Schools as appropriate) should be encouraged to have scientific 3Rs champions who can help identify relevant 3Rs opportunities from the NC3Rs website, the scientific literature and conferences to share with colleagues. A program of regular seminars or journal clubs focusing on the 3Rs should be instigated. The 3Rs should be a regular item on lab meeting agendas.

3. Involving the wider institutional community

Advances in the 3Rs are dependent on challenging existing models and procedures, and scientific and technological innovation. A multi-disciplinary approach is often required, including those not normally involved with animal research. Many institutions have expertise in a wide range of disciplines from mathematics to material sciences. Providing a framework where biologists and those not directly involved in animal research come together to focus on 3Rs issues can be difficult. Nevertheless, providing opportunities for networking and knowledge exchange can accelerate the development of the 3Rs.

4. Rewarding 3Rs developments

An annual 3Rs prize for individuals who have made a significant personal or scientific contribution to the 3Rs is an effective way of raising the profile of the 3Rs within the institution, and encouraging the collation and dissemination of ideas and techniques. Rewards do not have to be huge or even monetary. For many the recognition is enough, particularly if the prize is sponsored by senior management. Providing additional funds to attend a conference is one option for reward.

5. Supporting 3Rs training

Opportunities should be provided for regular training that is relevant to the 3Rs. This could be attendance at an NC3Rs event or workshop for example. Training for PhD students in the life sciences should include a good understanding and appreciation of the scientific as well as ethical aspects of the 3Rs. Ensuring staff are aware of training opportunities and resources, for example, on experimental design is critical.

6. Disseminating 3Rs advances

All staff should be encouraged to include information on the 3Rs in papers, posters and presentations as standard practice. It should be an institutional requirement to comply with the ARRIVE guidelines when reporting animal research. The guidelines also provide a useful checklist to consider when designing or reviewing experiments.

7. Taking a strategic approach

Ultimately institutions should take a strategic approach to the 3Rs, additional to project license assessment - focusing on areas of particular concern, for example in terms of animal numbers, severity or utility of the models used within the institution. The approach taken should tap into local expertise, and foster wide scientific engagement at all levels. The Animal Welfare and Ethical Review Body (AWERB) is well placed to lead this if an organization-wide approach is considered most appropriate. For some institutions, it may be more appropriate for individual Departments to take the lead.

Chapter 3

METHODOLOGY

3.1 Introduction

This study is a combined study of waste character and generation analysis as well as developing a management system for future. For this some steps are followed serially. General hierarchy is likely as following:

1. Study area selection.
2. Questionnaire survey.
3. Data collection; from houses and dumping sites.
4. Waste sampling; includes collection, drying, sorting by components.
5. Analysis of result by taking weights, making charts and discussions.

3.2 Study area

The research work is carried out in Gazipur City. To conduct this study firstly the entire Gazipur city was divided into five zones to facilitate and to ease the work.

These zones are:

- Board bazar zone
- Kaliakair zone
- Kaliganj zone
- Sripur zone
- Kapasia zone

Figure 3.1 shows the map of Gazipur City Corporation with five zones.

3.3 Zone description

1. Boardbazar

This is known as Gazipur upazila. It occupies an area of 457.67 sq. km. including 0.31 sq. km. river area and 54.52 sq. km. forest area. It is located between 23°53' and 24°11' north latitudes and between 90°20' and 92°30' east longitudes. The upazila is bounded on the north by Sreepur upazila, on the east by Sreepur and kaliganj upazila and Rupganj of Narayanganj, on the south by Uttara thana and Mirpur thana of dhaka megacity and on the west by kaliakair and Savar upazilas.

2. Kaliakair

This zone occupies an area of 314.13 sq. km. including 1.22 sq. km. river area and 79.72 sq. km. forest area. It is located between 24°00' and 24°15' north latitudes and between 90°09' and 90°22' east longitudes. The upazila is bounded on the north by Sreepur upazila, on the east by Gazipur Sadar, on the south by Savar and Dhamrai upazila of Dhaka and on the wset by Mirzapur upazila of Tangail zila.

3. Kaliganj

This upazila occupies an area of 214.63 sq. km. including 2.15 sq. km. river area and 0.34 sq. km. forest area. It is located between 23°54' and 24°02' north latitudes and between 90°26' and 92°39' east longitudes. The upazila is bounded on the north by Sreepur and Kapasia upazila, on the east by palash and Shibpur upazila, on the south by Rupganj of narayanganj and on the west by Gazipur Sadar Upazila.

4. Sreepur

The upazila occupies an area of 462.94 sq. km. including 3.16 sq. km. river and 121.44 sq. km. forest area. It is located between 24°01' and 24°21' north latitudes and between 90°18' and 90°33' east longitudes. This upazila is bounded on the north by Bhaluka and gafforgaon of Mymensingh zila, on the east by kapasia upazila, on the soth by Kaliganj and Gazipur Sadar Upazila and on the west by Kaliakair upazila.

5. Kapasia

The upazila occupies an area of 356.98 sq. km. including 10.69 sq. km. river and 17.40 sq. km. forest area. It is located between 24°02' and 24°16' north latitudes and between 90°30' and 90°42' east longitudes. It is bounded on the north by Goffargaon upazila of Mymensingh zila and Pakuakandi upazil of Kishorgonj zila, on the east by Monpohardi upazila of Narsingdi zila, on

the south by Kaliganj upazila and on the west by Sreepur upazila.

This zones are selected to divide our whole study into five steps. Wastes are collected from household and dumping sites of each zones.

3.4 Data Collection

To carry out the study, both primary and secondary data sources were used. Primary data were collected through practical observation and field based data collection of generation, collection, transportation of solid waste. Data is collected through questionnaire survey through interviews city dwellers Secondary data was collected from published and non-published sources. Secondary data were collected from GCC (Gazipur City Corporation), Rajuk (Rajhdhani Unnayan Kartipokkha, Dhaka) and BBS (Bangladesh bureau of Statistics, Agargaon, dhaka)

This data are used for evaluation of generation behaviour, future projection with the increasing of population in order to develop a future healthy waste management system for Gazipur city.

3.5 Waste Sampling

Sampling is one of the most important parts of our study. The accuracy of results mostly depends on it.

Collection of wastes is the first task to do. Wastes have been taken from houses, secondary dumping site from each zone and from the final dumping site where all of the city wastes are disposed. Wastes are collected in polythene bag.

Polythene bags are given to the families. After 24 hours bags are collected back from them with full of household wastes generated by the family members over 1 day. Wastes from dumping sites are also collected in separate polythene bags.

After that samples are brought to our experiment site. Initial weights of the bags are measured. The next task is **drying** the sample waste. Wastes are kept open to sunlight for 24 hours. After drying the weights are measured again and from the differences of weights moisture content of the sample waste is calculated.

After that **sorting** the samples by different components is done. It is easier to sort the dry components than wet. Wastes are classified in components as following

Food & veg. waste, paper & paper products, plastic, rubber, leather, wood, glass/ceramic, metal/tin, bricks-concrete (demolition), garden trimming and hazardous waste like battery, aerosol bottles, hospital residues (if any).

After sorting **Weight** of each components are measured and charts of different comparisons are

prepared.

3.6 Analysis

I. Generation rates: For the generation rates, 10 household surveys were done at each zone. From the survey data, the information about household members is obtained. And, from the measurement of the sample waste collected from the household, the information about the amount of waste is obtained. From this two data, the generation rate is obtained.

Generation rate = Total waste generated/total number of household

II. Moisture content: After the samples were collected, at first their weight was taken, and then they were 24 hour dried under the sunlight. After the sun drying, again their weight was measured. From this two measured weight, the moisture content was calculated.

Moisture content = (Weight before 24 hour sun dry-weight after 24 hour sun dry)*100/weight before 24 hour sundry

III. Composition: After the 24 hour sun dry, the different type of elements from the waste samples are separated. Then the weight of separated samples are measured and from that the composition of different type of waste in the waste sample is measured.

IV. Economic analysis: The economic analysis can be divided into two sections.

a. Benefits from recycling: For the recycling benefits, the local markets were surveyed to assess the price of the second hand recyclable products. From that value, the benefits from the recycling is calculated.

b. Benefits from composting: For this, a composting organization named “Prodipon” which is situated at Dhaka is made in consideration. They has a capacity of 1 ton per day. They usually use food wastes and other vegetable rags, garden trims as raw materials. And they produce 0.18 kg of compost per 1 kg raw material.

Chapter 4

Results and Discussions

4.1 Introduction

Solid waste management is one of the main responsibilities of both urban and rural communities and the fundamental objective of solid waste management programs is to minimize the pollution of the environment as well as utilizing the waste as a resource. Even though per capita waste generation rates in developing countries is less than in higher-income countries, the capacity of the responsible local authorities to manage waste from collection, to recycling or reuse and disposal, is limited. Targets can be achieved using methods that can be afforded by the community over the long term and with less risk to the persons involved. An input of universally valid skills or techniques, or a set of similar culture- neutral attitudes defines management itself, while management of waste requires particular kind of intellectual insight, which would be expected to yield value specific solutions to local problems

Collection of solid waste in an urban area is difficult and complex because the generation of residential and commercial-industrial solid waste takes place in every home, every apartment building, and every commercial and industrial facility as well as on the streets, parks, event vacant areas.

Open dumping still remains the cheapest and most effective solution to get rid of rising heaps of garbage. The present disposal site is distantly located from source of waste generation. This has led to increase transfer costs due to longer collection and hauling time. When a place filled up then local authority try to find new place for dumping the waste.

Increasing population, urbanization, industrialization, faced by developing countries in Africa, Asia, South America, are all pointing out to further increases of refuse. Urbanization induces a consumer based society whereby an increase in concentration of people and industrial/commercial development implies an accumulation of waste which needs to be properly managed and safely disposed of. The genesis of the problem with the disposal of waste dates back to the time when humans first began to congregate in tribes, villages and communities and the accumulation of waste became a consequence of life. Thus the littering of food and 10 other solid wastes in medieval towns led to the breeding of rats and the outbreak of the plague

epidemic which killed half of the Europeans in the 14th century and caused many subsequent epidemics and high death tolls.

The solid waste data of different stations which were surveyed is described below one by one.

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4.2 Boardbazar Zone

Table 4.1: Average waste generation rate of Boardbazar zone (2016)

Family No	Number of family members	Dry season 2016		Wet season 2016	
		Amount of waste (kg/day)	Generation rate (kg/capita/day)	Amount of waste (kg/day)	Generation rate (kg/capita/day)
1	7	2.8	0.4	2.9	0.41
2	5	1.01	0.202	1.1	0.22
3	6	2.6	0.433	2.5	0.42
4	4	1.03	0.26	1.04	0.26
5	8	3.09	0.39	3.08	0.385
6	7	2.01	0.29	2.00	0.28
7	5	1.03	0.206	1.02	0.204
8	7	1.05	0.15	1.06	0.15
9	3	1.01	0.34	1.2	0.4
10	5	2.67	0.534	3.765	0.753
Total	57	18.297	Average generation rate= **0.321**	19.665	Average generation rate= **0.345**
		At **2015**	**0.316**		**0.426**

Table 4.2: Waste composition at primary station (household level) at Boardbazar Zone

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	58.2	63.2	69.32	65.89
Paper	18.47	16.5	4.03	21.74
Plastic/polythene/pet bottle	10.87	10	6.77	6.18
Garden trimming	1.3	2.1	2.88	0.43
Bones	0	0.32	4.90	0.78
Brick chips	1.3	0.9	6.27	0
Glass/bottle	2.56	0.32	0.72	3.81
Metal/tin/can	1.92	1.9	3.24	2.22
Hazardous waste	0	0	1.87	0

Table 4.3: Waste Composition at secondary dumping site for Boardbazar zone

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	72.1	75.1	61.41	51.75
Paper	3.25	2.9	7.31	8.25
Plastic/PET bottle	10.1	8.2	4.28	9.52
Garden/trimming	1.1	3.2	1.43	0
Rubber	2.88	1.6	1.71	0.32
Leather	1.44	1.3	0	0
Wood	1.8	2.1	3.51	4.76
Bone	0	0	2	0.95
Brick chips	0.72	0.6	0	0
Glass/ceramic	2.5	1.9	3.43	3.81
Tin/can	0.36	0.8	3.43	2.22
Hazardous waste	0.36	0.15	2.06	0
Others	0.36	0.68	9.43	18.41

4.2 Kaliakoir Zone

Table 4.4: Wastes generation rates

Family No	Number of family members	Dry season 2016		Wet season 2016	
		Amount of waste (kg/day)	Generation rate (kg/capita/day)	Amount of waste (kg/day)	Generation rate (kg/capita/day)
1	5	2.04	0.408	2.59	0.518
2	12	2.58	0.215	3.16	0.26
3	10	1.35	0.135	2.39	0.239
4	7	4.87	0.695	5.62	0.8
5	6	1.40	0.23	4.52	0.75
6	6	1.5	0.25	3.2	0.53
7	7	2.97	0.42	4.56	0.65
8	9	3.02	0.33	4.58	0.50
9	8	2.1	0.2625	4.28	0.535
10	7	2.04	0.291	3.6	0.514
Total	77	23.87	Average waste generation rate=0.31	38.5	Average generation rate=0.50
		At **2015**	**0.31**		**0.37**

Table 4.5: Waste composition at primary station (household level)

Waste type	2015		2016	
	Dry season	**Wet season**	**Dry season**	**Wet season**
Food waste	67.70	70.98	76.28	86.06
Paper	20	17.24	6.88	6.30
Plastic/polythene/pet bottle	9.4	4.28	6.96	0.63
Garden trimming	0.3	4.28	0.09	0
Bones	0	0	3.68	0
Brick chips	0	0.43	0	0
Glass/bottle	0.13	1.93	2.19	4.40
Metal/tin/can	0	0.86	3.13	2.61
Hazardous waste	0	0	0.78	0

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	60.86	61.41	42.44	58.28
Paper	2.51	12.28	8.90	9.2
Plastic/PET bottle	5.17	8.90	5.69	3.07
Garden/trimming	2.74	6.50	3.36	0
Rubber	0	0.54	0	0
Leather	1.83	0.48	2.64	0
Wood	4.57	2.53	0	0
Bone	0	0.42	4.29	4.60
Brick chips	1.37	0.48	14.84	18.71
Glass/ceramic	1.37	2.1	3.30	3.07
Tin/can	0.91	0.84	0.99	1.84
Hazardous waste	10.5	0.84	2.67	0
Others	1.83	0.30	10.88	1.23

Table 4.6: Waste composition at secondary dumping site

4.3 Kaliganje Zone

Table 4.7: Wastes generation rates

Family No	Number of family members	Dry season 2016		Wet season 2016	
		Amount of waste (kg/day)	Generation rate (kg/capita/day)	Amount of waste (kg/day)	Generation rate (kg/capita/day)
1	8	2.8	0.35	2.5	0.31
2	7	1.2	0.17	5.74	0.82
3	8	2.5	0.31	1	0.125
4	6	1.02	0.17	1	0.17
5	4	3.08	0.77	1.05	0.375
6	12	2	0.17	3.08	0.32
7	3	1.04	0.35	2.6	0.87
8	9	1.04	0.116	1.02	0.113
9	7	1.02	0.15	1.56	0.22
10	8	3.02	0.385	2.05	0.26
Total	72	18.72	Average generation rate=**0.26**	21.6	Average generation rate=**0.30**
		At **2015**	**0.27**		**0.36**

Table 4.8: Waste composition at primary station (household level)

Waste type	2015		2016	
	Dry season	Wet season	Dry season	Wet season
Food waste	63.92	64.94	70.86	73.18
Paper	20.03	12.77	10.76	17.08
Plastic/polythene/pet bottle	8.12	7.095	5.33	2.08
Garden trimming	2.03	2.92	4.51	0
Bones	3.38	0.83	0	0
Brick chips	0	0.292	0	0
4.1Glass/bottle	0.87	0.6677	6.25	4.10
Metal/tin/can	1.28	0.459	2.18	3.55
Hazardous waste	8.12	9.59	0	0

Table 4.9: Waste composition at secondary dumping site

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	52.89	73.1	55.23	64.02
Paper	1.96	2.1	2.62	5.68
Plastic/PET bottle	5.18	8.3	0.77	2.79
Garden/trimming	2.30	4.3	0.98	0
Rubber	1.90	1.8	0.33	0
Leather	0.69	1.7	2.95	0
Wood	1.50	2.7	17.38	15.93
Bone	0	0	7.87	3.83
Brick chips	1.08	0.8	0	6.13
Glass/ceramic	3.28	2.1	0	1.63
Tin/can	0.79	0.59	0.19	0
Hazardous waste	20	1.4	4.92	0
Others	5.90	0.68	6.95	0

4.5 Kapasia Zone

Table 4.10: Wastes generation rates

Family No	Number of family members	Dry season 2016		Wet season 2016	
		Amount of waste (kg/day)	Generation rate (kg/capita/day)	Amount of waste (kg/day)	Generation rate (kg/capita/day)
1	4	0.85	0.2125	1.58	0.395
2	7	3	0.4285	2.3	0.33
3	8	1	0.125	2.9	0.36
4	5	1.02	0.204	1.4	0.28
5	6	1.03	0.172	1.8	0.3
6	4	0.78	0.195	1.3	0.325
7	9	1.04	0.116	2.59	0.29
8	12	4	0.33	4.29	0.36
9	12	1.39	0.116	4.64	0.39
10	8	0.89	0.111	0.45	0.056
Total	75	15	Average generation rate=**0.20**	23.25	Average generation rate=**0.31**
		At **2015**	**0.2026**		**0.36**

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Table 4.11: Waste composition for primary station (household level)

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	50.75	50.71	79.90	81.67
Paper	20.4	19.33	7.54	7.80
Plastic/PET bottle	10.45	8.98	4.91	3.73
Garden/trimming	5.47	7.10	0	0
Rubber	1.99	2.70	1.75	0
Leather	0.99	0.90	0	0
Wood	1.49	3.10	0	0
Bone	0	0	0	0
Brick chips	3.98	1.16	0	0
Glass/ceramic	1.49	1.31	5.32	3.83
Tin/can	1.49	1.80	1.17	2.97
Hazardous waste	0	0	0	0

Table 4.12: Waste composition for secondary dumping site

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	61.6	61.81	61.41	58.18
Paper	3.3	5.09	7.31	8.25
Plastic/PET bottle	6.1	5.81	4.28	3.18
Garden/trimming	8.8	4.36	1.43	0
Rubber	1.43	1.52	1.71	0
Leather	1.76	2.4	0	0
Wood	1.54	1.09	3.51	11.22
Bone	0	0	2	0
Brick chips	3.3	3.12	0	0
Glass/ceramic	1.43	2.32	3.43	0.86
Tin/can	1.1	1.89	3.43	14.68
Hazardous waste	4.95	6.6	0	0
Others	1.1	2.4	15.79	14.68

4.6 Sreepur Zone

Table 4.13: Wastes generation rates

Family No	Number of family members	Dry season 2016		Wet season 2016	
		Amount of waste (kg/day)	Generation rate (kg/capita/day)	Amount of waste (kg/day)	Generation rate (kg/capita/day)
1	6	2.01	0.335	2.5	0.42
2	6	1.00	0.17	1.5	0.25
3	5	1	0.2	1.02	0.204
4	4	1	0.25	1.03	0.2575
5	7	2.06	0.29	2.3	0.33
6	6	1.05	0.175	1.4	0.23
7	4	1.5	0.375	1.8	0.45
8	5	1.6	0.32	2.3	0.46
9	3	1.01	0.337	1	0.33
10	8	3.97	0.49	2.97	0.37
Total	54	16.2	Average generation rate=**0.3**	17.82	Average generation rate=**0.33**
		At **2015**	**0.289**		**0.377**

Waste type	2015		2016	
	Dry season (%)	Wet season (%)	Dry season (%)	Wet season (%)
Food waste	61.65	63.1	77.25	83.86
Paper	20.32	13.7	10.94	2.45
Plastic/PET bottle	6.98	7.1	1	3.88
Garden/trimming	2.54	3.5	7.33	0
Rubber	1.91	0.2	0	0
Leather	1.27	0.62	0	0
Wood	0.64	0	0	0
Bone	0	0	0	0
Brick chips	0.63	0.3	0	0
Glass/ceramic	1.05	1.72	3.48	6.76
Tin/can	1.33	1.21	0	3.04
Hazardous waste	0	4	0	0

Table 4.14: Waste composition at primary station (household level)

Waste type	2015	2016

Table 4.15: Waste composition at secondary dumping site

	Wet season (%)	Dry season (%)	Dry season (%)	Wet season (%)
Food waste	71.7	69.82	53.45	64.37
Paper	2.5	3.1	6.12	7.67
Plastic/PET bottle	7.6	8.3	2.95	5.83
Garden/trimming	4.4	0	5.48	0
Rubber	2.4	1.5	0.10	1.63
Leather	1.6	3	0	0
Wood	1.1	1.5	0	0
Bone	0	0	8.06	0
Brick chips	2.1	3	0	0
Glass/ceramic	0.8	2.25	1.83	4.65
Tin/can	0.6	1.5	0.83	4.65
Hazardous waste	0.96	3.75	0	1.72
Others	0.6	0.75	21.18	9.48

Name of the zones	2015		2016	
	Wet	Dry season	Wet	Dry Season

4.7 Moisture content data

	season (%)	(%)	Season (%)	(%)
Boardbazar	37.7	30.5	23.2	38.31
Kapasia	37.97	35.16	37	35.16
Kaliakoir	33.6	36.10	36.5	36.1
Sreepur	29.17	28.4	33	31.81
Kaliganje	31.9	29.62	38	36.71

Table 4.16: Moisture content data

4.8 Final Dumping Site

Table 4.17: Final Dumping Site

Waste type	Amount (Kg/day)	Percentage (%)
Food	17.538	58.46
Paper	1.503	5.01
Plastic	1.224	4.08
Garden trimming	1.074	3.58
Rubber	0.345	1.15
Leather	0.3	1.00
Wood	1.371	4.57
Bone	0.318	1.06
Brick	0.9	3.00
Glass	0.657	2.19
Metal/tin/can	0.555	1.85
Hazardous waste	1.134	3.78
Others	3.054	10.18
Total	30	100

4.9 Average Waste Generation Rate:

Table 4.18: Average waste generation rates

Zone	Generation rate (kg/capita/day)
Boardbazar	0.352
Kaliakoir	0.3725
Kaliganje	0.2975
Kapasia	0.2638
Sreepur	0.3238
Total average	**0.323**

4.10 Composition comparison

Table 4.19: Composition comparison

Waste Type	Primary station (%)	Secondary station (%)	Final Dumping site (%)	Difference between primary and secondary station	National waste composition (%)
Food	64.85	57.87	58.46	**-6.98**	***67.65***
Paper	13.04	5.57	5.01	**-7.47**	***9.73***
Plastic	5.82	5.59	4.08	**-1.04**	***5.10***
Garden trimming	2.22	4.34	3.58	**+2.12**	***4.20***
Rubber	1.57	1.05	1.15	**-0.05**	***N/A***
Leather	0.37	0.99	1.00	**+0.62**	***N/A***
Wood	0.57	4.34	4.57	**+3.77**	***4.2***
Bone	2.32	2.5	1.06	**+0.18**	***N/A***
Brick	0.65	2.98	3.00	**+1.76**	***8.79***
Glass	2.47	2.07	2.19	**-0.4**	***1.13***
Tin	3.22	1.78	1.85	**-1.44**	***4.20***
Hazardous waste	0.6	3.22	3.78	**+2.62**	***2.5***
Others	2.32	7.7	10.18	**+5.38**	***N/A***

4.11 Volume Reduction

Table 4.20: Volume reduction at household level

Waste type	Density (kg/m3)	Dry season		Wet season	
		Percentage (%)	Volume reduced (m3/100 kg)	Percentage (%)	Volume reduced (m3/100 kg)
Paper	85	14.5	0.17	12.15	0.143
Plastic	65	7.21	0.11	5	0.076
Glass	195	2.48	0.013	2.43	0.012
Metal/tin/can	90	1.55	0.017	4.25	0.047
		Total =	**0.31**	**Total =**	**0.278**
		=	**3.1 (m3/ton)**	**=**	**2.78 (m3/ton)**

Table 4.21: Volume reduction at secondary dumping site

Waste type	Density (kg/m3)	Dry season		Wet season	
		Percentage (%)	Volume reduced (m3/100 kg)	Percentage (%)	Volume reduced (m3/100 kg)
Paper	**85**	**4.71**	**0.055**	**6.84**	**0.08**
Plastic	**65**	**5.42**	**0.084**	**6.02**	**0.093**
Glass	**195**	**2.02**	**0.01**	**2.27**	**0.012**
Metal/tin/can	**90**	**1.77**	**0.02**	**1.85**	**0.021**
		Total =	**0.169**	**Total =**	**0.206**
		=	**1.69 (m3/ton)**	**=**	**2.06 (m3/ton)**

4.12 Weight Reduction

Table 4.22: Weight reduction at house

Waste Type	Dry season		Wet season	
	Percentage (%)	Possible weight to be reduced (kg/ton)	Percentage (%)	Possible weight to be reduced (kg/ton)
Recyclable(paper, metal/tin/can, glass)	18.53	185.3	18.83	183.3
Reusable (plastic)	7.21	72.1	5	50
	Total =	257.4	Total =	238.3

Table 4.23: Weight reduction at secondary dumping site

Waste Type	Dry season		Wet season	
	Percentage (%)	Possible weight to be reduced (kg/ton)	Percentage (%)	Possible weight to be reduced (kg/ton)
Recyclable(paper, metal/tin/can, glass)	8.5	85	10.6	106
Reusable (plastic)	5.42	54.2	6.02	60.2
	Total =	139.2	Total =	166.2

4.13 Economic Benefits

4.13.1 Benefit through recycling

Table 4.24: Economic benefits through recycling at household level

Waste type	Second hand market value (BDT/kg)	Dry season		Wet season	
		Weight (kg/ton)	Possible benefit (BDT/ton)	Weight (kg/ton)	Possible benefit (BDT/ton)
Paper	8	145	1160	121.5	972
Plastic	11	72.1	793.1	50	550
Metal/tin/can	10	15.5	155	42.5	425
		Total =	**2108.1**	**Total =**	**1947**

Table 4.25: Economic benefits through recycling at secondary dumping sites

Waste type	Second hand market value (BDT/kg)	Dry season		Wet season	
		Weight (kg/ton)	Possible benefit (BDT/ton)	Weight (kg/ton)	Possible benefit (BDT/ton)
Paper	**8**	**47.1**	**376.8**	**68.4**	**547.2**
Plastic	**11**	**54.2**	**596.2**	**60.2**	**662.2**
Metal/tin/can	**10**	**17.7**	**177**	**18.5**	**185**
		Total =	**990.7**	**Total =**	**1394.4**

4.13.2 Benefit through composting

Table 4.26: Benefits from composting at household level

Season	Weight of organic weight (kg/ton)	Amount of compost (kg/ton)	Retail price (BDT/Kg)	Possible benefits (BDT/ton)
Dry	701.3	126.23	2.5	**315.58**
Season	652.4	117.43	2.5	**293.58**

Table 4.27: Benefits from composting at secondary dumping site.

Waste type	Second hand market value (BDT/kg)	Dry season		Wet season	
		Weight (kg/ton)	Possible benefit (BDT/ton)	Weight (kg/ton)	Possible benefit (BDT/ton)
Paper	**8**	**47.1**	**376.8**	**68.4**	**547.2**
Plastic	**11**	**54.2**	**596.2**	**60.2**	**662.2**

Chapter 5

RECOMMENDATIONS AND CONCLUSIONS

6.1 Steps to Be Undertaken to Adopt 3R Policy

1. Source separation at household level.
2. Community based urban solid waste management.
3. Composting of waste in slums.
4. Composting program at schools and educational establishment.
5. Medium scale commercial composting.
6. Plastic waste recycling by informal sector.
7. Battery buy back for recycling.
8. Biomass use for commercial power generation.
9. Environmental management system (EMS) practices in several industries.
10. Recycling training center.
11. Raising public awareness through information, education and demonstration projects.
12. Engaging an affordable mix of appropriate technical options to reduce, reuse and recycle waste.
13. Establishing National 3R Focal Point

6.2 Conclusions

A healthy life, cleaner city and a better environment are the logical demand for the city dwellers. In area Gazipur City Corporation is the largest city corporation of Bangladesh. It is considered as one of the most important industrial zone of our country. Because of rapid population growth and increase of industrialization the amount of waste generation in this area is increasing at an alarming rate.

As the city corporation is formed newly, corporation authority is struggling to cope with the existing situation. Inadequate management practices and unrolled waste dumping are creating numerous environment problems. This study revealed that the existing waste management practices in Gazipur city is behind the satisfactory level due to poor infrastructural facilities in waste management ,lack of trained workers, lack of technologies and lack of proper planning's and monitoring activities.

However as an individual body it becomes difficult for GCC to ensure proper waste management system. They should upgrade the concept of solid waste management and improve the system of entire management. They also need proper implementation of laws and regulations in proper ways

The following recommendations need to be fulfilled for the improvement of the collaborative program-

1. Public awareness of health education should be raised through public campaigns.

2. Monitoring facilities have to improve

3. Proper implementation of rules and regulations

4. Have to improve collection and transportation equipment

5. Modification of municipal ordinance is needed to accommodate the inclusion of NGO'S, CBO'S and micro enterprise into the main stream of solid waste management

6. Public awareness of waste segregation, recycling and re use should be raised through public campaigning and media demonstration through NGO's rather than capital-intensive projects

6. This study recommends that to implement a well-organized and proper waste management system in Gazipur city there needs a conjunctive initiatives of government and private sectors whereas community based waste management practices also could play a vital role.

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Appendix

Questionnaire Survey on Solid Waste Management of Gazipur City

Date:

Time:

Name:	
Age:	
Address:	
Family Member:	
Earning Member:	
Average monthly income:	

1. What are the main types of wastes generated in your house?
   i) Kitchen waste ii) Paper iii) Glass iv) Plastic v)others:

2. Do you separate different types of wastes that are generated in your house?
   i) Yes ii) No

3. If yes, then what types of materials are separated?
   i) Plastic/Bottles ii) Rubber iii) Glass iv) Paper v) Dry cell

4. If no, then how the wastes are stored in your house?
   i) Plastic bin ii) Polythene iii) Others

5. How the waste from your house is disposed?
   i) Waste collected by the people managed by community ii) City corporation van collects from house
   iii) waste bag/bin taken to the dustbin iv) Others:

6. In what frequency the wastes are collected from your house?
   i) Once a week ii) Twice a week iii) Thrice a week Iv) Daily

7. In case of Community/City corporation based management system, How much do you pay for waste collection?
   i) Tk. 50
   ii) Tk. 100
   iii) Tk. 300
   Iv) More

8. How do you manage the clothing wastes?
   Ans.

9. How do you manage the organic part of wastes?
   Ans.

10. How do you manage the hazardous wastes(especially dry cell)?
    Ans.

11. How you use the inorganic separated item?
    i) Sell them(at which rate :)
    ii) Reuse them
    iii) Dumping

12. In case you dump them, then how do you do it?
    Ans.

13. If different bins are supplied for different type of wastes, will you separate them?
    i) Yes ii) No

14. If no, then what is the main reason behind that?
    Ans.

15. Are you aware of the 3R policy?
    i) Yes ii) No

16. If wastes are separated at household level, what do you think about the benefit of

it?
Ans.