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Study On 4 R's (Rethink, Reduce, Reuse And Recycle) Strategy For Waste Management In Dhaka City

Dr. Engr. Md. Mofazzal Hossain
Ph.D
M.S in Environmental Science
B.sc. Engineering (Civil), Member IEB (M-31634)
LL.B and Post Graduation Diploma in Computer Science

ABSTRACT: Waste generation and its management are being widely debated across the globe and in recent years, it has become a niche spot. Both the developed and developing countries are trying to find out new ways for climate change mitigation and adoption options respectively. Global climate change is a burning issue and presently Bangladesh is facing grave situations. A large proportion of the waste is not properly managed and dumped in unplanned sites that are creating severe environmental hazards. Gradually, it can be replicated in each urban and rural center and growth points of Bangladesh can play a vital role in climate change mitigation. Implementation of the 4Rs will have a profound socioeconomic impact, also modern 4Rs (Rethink, Reduce, Reuse and Recycle) strategy acts as a sustainable and socioeconomic option for climate change mitigation by reducing green house gas (GHG) emission from the municipal solid waste.

Keywords: Dhaka City Corporation, Green House Gas (GHG), Municipal Solid Waste (MSW), Waste management, 4R's

INTRODUCTION

The metropolitan city of Dhaka has an area of 305.23 km2and population of 12.4million. Because of the scarcity of flood free land, the population density exceeds 40,000 per km2onone hand, and the rest of flood prone area is commonly used as voluntary dump site. The conspicuous intensity of building causes difficulty in waste collection from the city particularly from the old Dhaka area. The collection rate is estimated in this study at 44% of generated volume. This means almost half of waste is not properly collected and disposed at official dump sites. Uncollected waste has been recognized as the root of inferior environment such as scattered garbage, offensive odor; drain clogging, water pollution and mosquitoes. In present day's problems regarding with the waste management have become one of the top concerning issues, basically in developing countries because of their rapid and imbalanced urbanization and industrialization. Though the municipal and industrial waste produced in developed countries are enormous in compared to that of developing countries but advanced management and recycling system keep the problem in tolerable limit. In developing countries due to their less budget and many other sensitive problems waste management system is left neglected causing serious environmental and health hazard. Bangladesh a third world country, situated in south east area is facing its greatest threat of environmental pollution because of its poor waste management system. This country is solely trying to attain economic stability but in the trail of development it is undertaking uncontrolled and unplanned urbanization. Peoples are migrating to the cities tremendously for unimproved life style. In these situation to save the city dwellers as well as live in green environment it is urgently required to manage the waste in applying 4 R`S (Rethink, Reduce, Reuse and Recycling) which are also called the Non-structural Management and only the Recycling is the Structural Management of waste.

DEFINITION OF 4 R'S

Rethink: RETHINK

We know that most items we purchase will be thrown away eventually, so why not design for the "end of life" of the product? Engineers and product Designers need to address-

Packaging: Materials Comprise 65% of our waste

Toxic Substance: Substitute with less toxic or benign Materials (Lead-free solder) that can be harmlessly disposed of or recycled.

Rethink Example:

Building a Greener Computer

1. Engineer recycling into the design of the computer.

Create Components which are easily interchangeable for updating or removed for recycling

2. Solder with lead free materials.
3. Select wire insulation that is free of PBC.
4. Used non- toxic silicon-based flame retardant instead of non-recyclable and toxic brominated fire retardants.
5. Replace chromium corrosion inhibitors with non-toxic forms.

Reduce: Reduce means to use less and NOT waste. Reduce the use of harmful, wasteful, and non-recyclable products. Reduction of single-use products can result in less waste materials ending up in landfill. Use the minimum amount required.

Reuse: Checking, cleaning, repairing, refurbishing, whole items or spare parts, preferably avoiding any other pre-processing. Reuse here means using a substance, product or material again before it becomes waste.

RECYCLE

-This term often misused, or used too broadly. Proper definition of recycling is "the separation and collection of materials for processing and manufacturing into new products and use of these new products to complete the cycle"

-Should be the final step, after rethinking product design and reducing waste production through wise purchasing and reuse.

-We are "closing the cycle" when we purchase items made up recycled material.

- "Down cycling" occurs when the new product is of mixed materials and cannot be recycling again (i.e. carpeting and boards made of a mixture plastic bottles and sawdust).

When as an individual

-We/I/you have purchasing power:

- Will select more greenly designed items?

-Will buy less and reuse more?

- Can choose a greener lifestyle:

-Will take advantage of existing recycling programs in community?

-Will pass along your usable goods to thrift stores, online pages like Craig`s list, Free cycle?

Today`s happening

What is changing?

- Climate.
- Energy prices.
- Resource depletion.
- Public awareness.
- Political support.

S-M-A-R-T
S=Save.
M=Money.
A=and.
R= Reduce.
T= Trash.

Residents can save when they reduce the amount of trash they produce.
Paying for Waste Disposal.
What are the choices?
Tax Base
General Fund
Flat Fee
User Fee
(Pay-as-you-Throw)

Pricing Systems.
-Proportional.
-Variable

Figure 1: 4 R's For Solid Waste Management

Figure 2: Three E (3 E's) Benefits

Lessons Learned from Payment.
-Economic incentives encourage behavioral changes
- Treating SWM services as a utility- You pay for what you use.
-Win-win: High recycling rate and economic stability

Contribution of Tokai for Managing Solid Waste. (Traditional system)

Homeless children are called tokai. A Large number of (15000 Nos.) child are contributing to managing solid waste an informal initiatives in Dhaka City. They collect 300 tons of waste per day and sale the same to the (Bhangari) petty traders and ultimate goal is recycling.
Those who are related to the activities-
- Tokai
- Feriwallas
- Gariwallas
- Bhangari (Petty traders)
- Mohajans /Paikar(Wholesalers)
Who are also Tokai?

Children/ Slum dwellers/ homeless children/street children are also called tokai. There are 4,00,000 Nos. homeless children in Bangladesh. Out of which 15000 Nos lives in Dhaka City. They have No identity like as-
-Have-not proper accommodation.
-No bed room.
-No bed
-No Kitchen
-No washroom
-No holding Number
-No postal code
-No Telephone number, e-mail address etc
-No Education
-No Treatment
-No Food Security
-No TIN

Figure 3: Tokai are collecting solid waste from different areas in Dhaka city.

They are also Sleep-

-Under open sky
-Side walks
-Park benches
-Railway Stations
- launch Terminals
-Bus stands etc.
But their earning-
They earn for them as well as for the Nation and Ultimate contribution goes to GDP with risking their life.
Value of their devoting life-
-Reduce waste

-Reduced air pollution
-Ground water leach ate
-Create employments
-Income generation
-Contribution to recycling in a largest scale.

Recommendation for their betterment.
- Make them formal
- Bring them to the main stream
- Create WGB (works for green Bangladesh)
- Patronize them
- To reduce children labor

Even though they are not affected diseases like corona/dengue etc
- Conclusion. (Slogan)
- In favor of their activities.
- Pollution-
- If you Don`t kill it
- It will kill you.
- Don`t trash our
- Future.
- To Convert
- WASTE as WEALTH
- Don`t Convert
- WEALTH as WASTE

OBJECTIVES OF THE STUDY

The main objective of this 4R's strategy is to delineate ways and means of achieving national 4R's goals through providing a uniform guideline for all stakeholders. Specific objectives of this strategy are to:

1. Address the key issues and challenges of waste management acting as a barrier for promotion of 4R's in the country;
2. Define the roles of various actors to promote 4 R's in the country; and
3. Guide the creation of enabling conditions for success regarding implementation of 4R's all over the country.

Overview of Municipal Waste Management and 4R's

Numerous studies discussed about the waste management system of Bangladesh and different models for sustainable waste management and marketing. Municipal solid waste (MSW) generation and its management are being widely debated across the globe at various events, from local forums to international conferences and summits. On a global scale, we currently are facing three major environmental crises: global warming, depletion of resources, and destruction of our ecosystem. These crises are interrelated and connected to waste and waste management.

A rising quality of life and high rates resources consumption patterns have had a unintended and negative impact on the urban environment generation of waste far beyond the handling capacities urban government and agencies. Dhaka city, with almost 15 million inhabitants is experience particularly serious difficulties in dealing with ever increasing waste disposition burden. There are more than 522 towns and cities in Bangladesh which accumulate 13,332 tons of waste per day or 4.86 million tons annually. It is projected that this amount will grow up to 47,000 tons/ day and close to 17.2 million tons per year by 2025. The Dhaka City Corporation alone generates approximately 1.6 million tomes of municipal waste per year which emits approximately 1 million tons GHG annually.

Waste generation is closely linked to population, urbanization and affluence. Waste-generation rates can be correlated to gross domestic product (GDP) capita, energy consumption capita, and private final consumption capita. In developed countries seeking to reduce waste generation, a current goal is to decouple waste generation from economic driving forces such as GDP found that total waste generated in the urban areas of Bangladesh per day is 13,332.89 tons. Based on the total estimated urban population of the year

2005, per capita waste generation rate is computed as 0.41 kg/capita/day. Per capita waste generation would obviously depend on a number of socio-economic parameters affecting consumption and other behavioral factors also.

In most developed and developing countries with increasing population, prosperity and urbanization, it remains a major challenge for municipalities to collect, recycle, treat and dispose of increasing quantities of solid waste and wastewater. It is important to emphasize that post-consumer waste is a significant renewable energy resource through thermal processes (incineration and industrial co-combustion), landfill gas utilization and the use of anaerobic digester biogas. Waste has an economic advantage in comparison with many biomass resources because it is regularly collected at public expense. The energy content of waste can be more efficiently exploited using thermal processes than with the production of biogas: during combustion, energy is directly derived both from biomass (paper products, wood, natural textiles, food) and fossil carbon sources (plastics, synthetic textiles). For the many countries that continue to rely on land filling, increased utilization of landfill CH_4 can provide a cost-effective mitigation strategy. The combination of gas utilization for energy with bio covers to increase CH_4 oxidation can largely mitigate site-specific CH_4 emissions. These technologies are simple ("low technology") and can be readily deployed at any site. Moreover, R&D to improve gas collection efficiency, design biogas engines and turbines with higher efficiency, and develop more cost-effective gas purification technologies are underway. These improvements will be largely incremental but will increase options, decrease costs, and remove existing barriers for expanded applications of these technologies.

Another study found that the composition of the entire waste stream was about 74.4% organic matter, 9.1%paper, 3.5% plastic, 1.9% textile and wood, 0.8% leather and rubber, 1.5% metal, 0.8% glass and 8% other waste in six major cities. The per capita generation of municipal solid waste was ranged from 0.325 to 0.485kg/cap/day while the average rate was 0.387 kg/cap/day. PREGA made a feasibility study report in Khulna and found major portion of solid waste consists of green vegetables and fruit residues.

One of the environmentally harmful consequences of unsanitary waste disposal is the emission of greenhouse gases (methane, carbon dioxide etc.). Since the final disposal of urban solid waste in Bangladesh is yet to be sanitized, it has been coupled with the unutilized high organic content of waste, which contributes to increased GHG emission potential. In six cities of Bangladesh, pourashava and other urban center and found that about 2.19 million ton CO_2e is emitted per year from the total generated urban waste. This high GHGemission potential indicates the necessity of proper waste management and disposal system along with the prospect of trading the reduction of GHG emission with developed countries.

Recently, the importance of recycling activities in reducing waste volume, recovering resources and its economic benefits is being acknowledged. Many NGOs and CBOs are actively working on 4R related issues, often in a decentralized manner failing to fit in the bigger picture due to lack of communication, networking andother factors. As of today, a long-standing practice and a complex networking of informal source separation and recycling of materials exists. In most cases, they were compelled to focus more on reusing and recycling of waste than on source reduction. Prioritizing the 4Rs among themselves may not promise a drastic change within a short period, but will reap a significant reward in the long run.

The 4R's can be a vital and sustainable option for reducing waste at a minimum level. 4R Initiative" was officially launched at the 4R Ministerial Conference hosted by the Government of Japan in April 2005, with an aim to promote global action on 4R. In March 2006, a Senior Officials Meeting on 4Rwas organized in Japan resulting in strong commitment of governments and other stakeholders to implement 4R at local, national, and regional level.

For most of the developing countries of Asia, MSW management has become a difficult task. The existing system is to collect and dump to the land fill. For promoting 4Rs in developing countries the participants of 4R South Asia Expert Workshop identified some priority issues which are: a) establishing 4Rsrelated policies along with environmentally sound recycling industries b) supporting improving informal waste recycling and c) utilizing financial incentives and market forces. The popular and well known concept of "4Rs"refers to reduce, reuse and recycle particularly in the context of production and consumption. It calls for an increase in the ratio of recyclable materials further reusing of raw materials and manufacturing wastes and overall reduction in resources and energy used. The ideas are applied to the entire lifecycles of products

and services, this theory can be applicable in the agricultural sector also. The Global 4Rs initiative aims to promote the 4Rs (reduce, reuse and recycle) globally so as to build a sound material cycle society through effective use of resources and materials. Waste Concern an NGO working with waste management proposed a decentralized waste collection and composting scheme to manage the MSW in a sustainable manner. But under the present conditions this would not be feasible, as the availability and price of land in and around Dhaka city for composting would not be financially viable.

Solid Waste Management

Solid Waste means any garbage, refuge, sludge, or other discarded material, including solid, liquid, semisolid or contained gaseous material resulting from industrial, commercial mining or agriculture operations of from community activities. One study found that in some countries the solid waste management system also handles human wastes such as night soil ashes from incinerators, septic tank sludge and sludge from sewerage treatment plants. If these wastes manifest hazardous characteristics they should be treated as hazardous wastes. Waste management means collection of resources from different sources including recycling and re-uses of materials.

Characteristics of Solid Waste

In Bangladesh solid waste are mostly generated from residential, industrial and commercial sources. These includes dust, ash, vegetable and animal bones, paper and packing of all kinds, rags and other torn fabrics, garment materials (wastes) glass and many other non-combustible trash. Approximate composition of Solid Waste (% by weight) in Bangladesh compared with India and Europe are laid down below:

Table 1: Composition of Solid Waste

Waste Components	Bangladesh	India	Europe
Food and vegetables	70	75	30
Paper products	4	2	27
Plastics	5	1	3
Rags	-	3	3
Metals	0.13	0.1	7
Glass and Ceramics	0.25	0.2	11
Wood	0.16	-	-
Garden waste	11	-	4-5
Others (Stones, dirt etc)	5	7	3
Medicine and Chemical	-	-	-
Moisture content	65	22-32	15-35

The composition of solid waste in Bangladesh although vary with the location and season of the year includes organic food waste, paper and paper products, wood, metal, glass, plastics including hospital waste, construction waste, industrial; waste, dust, firewood and others.

Solid Waste Generation

It is very important to estimate the waste generation in Bangladesh in the planning for proper solid waste management. The waste stream is more than 80% organic matter and contains a wide variety of substances such as waste, paper, cloth, agricultural waste, etc. In Dhaka city, the waste generation rate is approximately 1.65 million metric tons of solid waste annually per capital waste generation estimates between 0.29 and 0.60 kilograms per person per day depending on the individual level of income (higher income individuals tend to generate more waste).

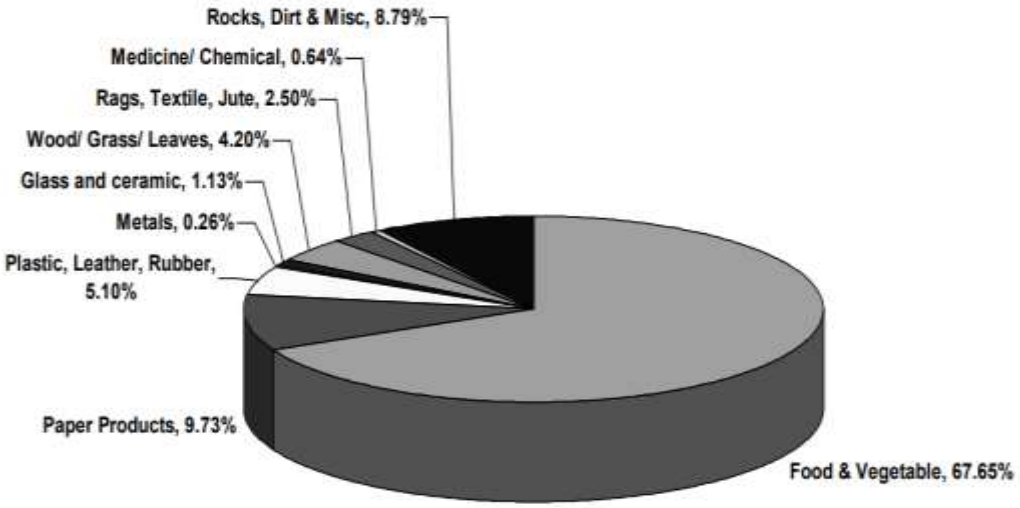

Figure 4: Average Composition of the waste generation in Bangladesh (compiled from different sources)

The above figure 1, shows the average composition of the waste generated in Bangladesh, where 68% is biodegradable waste or food & vegetable waste, 8% is paper, 6.1% plastic, leather and rubber, while 2% is metal and glass waste.

Ultimate disposal of all types of waste is done crudely in open dumps, lowlands or water bodies in an unsanitary manner. As a result, the surroundings of the dumpsites are barely hygienic. The increasing demand for landfill is also a big problem for the authorities to find suitable lands for dumping wastes. At current waste generation rate the total land required for municipal solid waste per year with the existing collection efficiency and 100% collection efficiency will be 141 acres and 273 acres respectively having a depth of 4 meters.

Managing MSW cannot be single-handedly managed by the smallest administrative unit of a town or even by the federal government. It has to be a concerted effort of all stakeholders; from waste generator, municipal administrator to community based waste management committee, informal sector involved in waste management and technology providers. The following table shows the urban areas of Bangladesh:

Table 2: *WGR= Waste Generation Rate, **TWG= Total Waste Generation

City/Town	*WGR(kg/cap/day)	No of City/Town	Population	Average **TWG (ton/day)
Dhaka	0.56	1	6,728,404	4,634.52
Chittagong	0.48	1	2,622,098	1,548.09
Rajshahi	0.30	1	468,378	172.83
Khulna	0.27	1	967,365	321.46
Barisal	0.25	1	437,009	134.38
Sylhet	0.30	1	386,896	142.76
Pouroshovas	0.25	298	15,215,306	4,678.40
Other urban areas	0.15	218	9,217,612	1,700.65
Total		**522**	**36,042,067**	**13,332.89**

Waste Collection in Dhaka City

For administrative purposes, Dhaka is divided into two distinct units Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC). These units are responsible for solid waste collection and disposal in their respective areas. In the DNCC, it is estimated that only 40–60% of waste is collected; a 2007 study estimated that approximately 42% of the entire city's (DNCC and DSCC) waste is collected. Uncollected waste is deposited in open spaces, where its accumulation contributes to foul odors, rodents, and clogged storm water and sewer drains. It is often burned deliberately to reduce its volume and by accident, which contributes to a range of health and environmental impacts. Waste collection is particularly insufficient in the slum areas, which are home to approximately half of the city's poor and where government services are minimal. Dhaka is making improvements under its 2005 Solid Waste Master Plan, which led to a new system for regularly collecting household waste from a network of collection bins

throughout the city. However, that plan is due to expire in 2015, and it is not certain that a new plan will replace it. Volume and by accident, which contributes to a range of health and environmental impacts. Most of the cities in Bangladesh, waste collection consists of two parts, namely primary collection and secondary collection. City authorities are responsible for secondary waste collection to remove the waste from the dustbins/containers and transport the waste to final disposal sites. Residents are responsible to bring their waste collection points where dustbins/containers are located. Rickshaw cans are used to collect the waste from each house. For this, residents have to pay specific fees at the end of each month. This covers the salary of the van drivers, waste collectors and maintenance costs.

Waste Disposal

Collected waste is first transported on hand trolleys (often by private micro-enterprises) from dense neighborhoods to consolidation locations, where it is loaded onto city owned trucks. Before 2007, these trucks transported the waste to two open dumps outside the city. In 2007, one of the dumps was converted to a controlled landfill (in DSCC), but access is limited by traffic congestion and a large portion of the waste generated in the DSCC is consequently transported to the DNCC. The DNCC is planning upgrades to its dump, including adding a leach ate management system and a waste to energy facility.

Organic Diversion

Only a small portion of Dhaka's organic waste is diverted before being transported to the city's landfills or deposited in open spaces. However, one small-scale, private composting company is currently collecting (for a fee) and processing approximately 100 metric tons of organic waste per day, and selling the compost to local farmers. Dhaka has preliminary plans to develop a larger Integrated Resource Recovery Center at one of the city's landfills to process waste into compost and to generate electricity using landfill gas.

Recycling

Dhaka has historically relied on the informal recycling sector (e.g., waste pickers, of whom there are an estimated 120,000) for the recovery of non-organic materials. In an effort to recover more recyclable materials, the city launched a source separation pilot program in 2012.

Existing system of waste collection in Dhaka City Corporation

In most cities in Bangladesh, waste collection consists of two parts, primary and secondary collection (see Figure 2). City authorities are responsible for secondary waste collection to remove waste from the dustbins/containers, and transport the waste to final disposal sites. Residents are responsible to bring their waste to the waste collection points where dustbins/containers are located. NGOs/ CBOs/ private sector provide primary collection services to collect waste from door-to-door and transport the waste to dustbins/containers, or sometimes to vacant lands, by rickshaw vans. At present, NGOs/CBOs/private initiative primary collection services are prevalent in most cities.

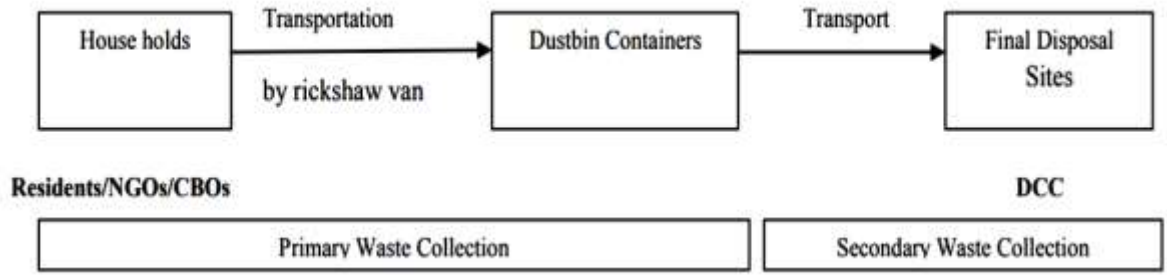

Figure 5: Existing Waste Collection System in Bangladesh

Problems of Existing Systems

Solid waste management is growing environmental and financial problem in developing countries. The majority of municipalities in the developing countries cannot manage the growing volume of waste gradually. The inability for waste management is poor institutional structure, lack of sanitation, inadequate financing, lack of manpower, inadequate waste collection, and lack of awareness among citizens, shortage of land for waste disposal. Also the green house gas emission is increasing day by day. Meanwhile, in many cities in developing countries, collection rates remain low and the quality of collection services are poor. Waste collection services are generally non-existent in poorer neighborhoods such as slums. While there are some successful examples where the private sector and communities are involved in waste management

services, in many cities of developing countries, involvement of these segments of society is still very limited. The wastes collected typically end up in open dumps, where they may be burnt, and in some cases are deposited in illegal dumping sites.

Climate Change in Bangladesh

Climate change is a critical issue in Bangladesh as the country is one of the most vulnerable to the effects of climate change. In the 2020 edition of German watch's Climate Risk Index, it ranked seventh in the list of countries most affected by climate calamities during the period 1999–2018. Bangladesh's vulnerability to the effects of climate change is due to a combination of geographical factors, such as its flat, low-lying, and delta-exposed topography, and socio-economic factors, including its high population density, levels of poverty, and dependence on agriculture. The impacts and potential threats include sea level rise, temperature rise, food crises, droughts, floods, and cyclones.

Medical Waste

The wastes that are being generated from hospitals, clinics or institutions that provide healthcare services are commonly known as hospital waste or medical waste. The hospitals produces a wide variety of medical wastes ranging from general waste (like food waste, paper waste) to hazardous biological, chemical and radiological wastes. In a broad term medical wastes can be of two types shown in the following figure 2:

Waste Management during COVID-19 (Source: Internet)

Undoubtedly the most searched and spoken world of last year is corona virus disease 2019 (Covid-19), which initially originated in Wuhan, China near the end of 2019. COVID-19 is a disease caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). Albeit almost all countries shut down their borders to prevent rapid spread of the virus. However, the number of cases continues to increase in developing countries at a faster rate due to community and cluster transmission. The severity of the epidemic made it a pandemic as it progressed to over 200 countries including Bangladesh. The world health Organization (WHO), government of Bangladesh, National disease control and prevention units worked together to break down the chain as well as the catastrophic impact of COVID-19.Government formulated various guidelines like social distancing, Frequent hand washing, social distancing to inhabit the spread of the virus**. Government also advised that the general population and medical personnel wear face masks, face shields, gloves and aprons. As a result, this waste category has substantially increased**. Sustainable Solid waste management is a critical parameter for the health, wellbeing, and development of society. Near about 28000 peoples Died during Covid-19 in Bangladesh.

Consequence of Dengue (Source: Internet)

In Bangladesh, dengue fever was first reported in 1964 but became a disease of public health significance from 2000 onwards. Bangladesh has lower dengue prevalence than most Southeast Asian states, but recently has sustained an upsurge in dengue outbreaks; from 2769 cases in 2017 to 10148 cases in 2018. In 2019, the Directorate General of Health Services (DGHS) recorded 87953 cases with 81 deaths, a 9-fold increase in the incidence rate of dengue from the previous year. Porcelain, plastic, rubbers, Glass & polythene materials constitute bulk of household wastes. Owing to resistibility and slow degradability that accounts for higher residence time, these materials qualify as potential hazardous wastes. Retention of water permits these wastes to form a congenial biotope for the breeding of different vector mosquitoes. Thus porcelain and plastic wastes pose a risk from public health viewpoint. This proposition was validated through the study on the porcelain and plastic household wastes as larval habitats of Dengue vectors (*Aedes* spp.) in rural and urban areas around Dhaka city. Huge Quantity of waste generates and the wastes were characterized in terms of larval productivity.

Figure 6: Medical waste

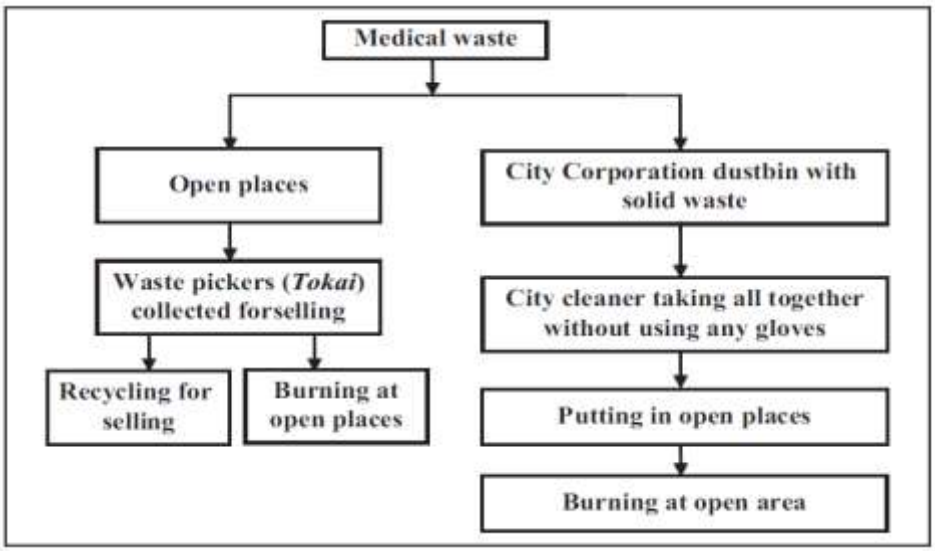

Figure 7: Common steps of medical waste collection in Bangladesh

Table 3: Different Categories of Hospital Wastes Products with Examples

Waste Category	Description with Examples
Infectious waste	Pathogens may be present. E.g. excreta, laboratory cultures, tissues, materials or equipment that have been in contact with infected patient.
Pathological waste	Human tissues or fluids. E.g. blood and other body fluids, foetuses.
Pharmaceutical waste	Wastes containing pharmaceuticals. E.g. pharmaceuticals that are no longer needed or expired
Genotoxic waste	Waste containing substances with genotoxic properties e.g. waste containing cytotoxic drugs (often used in cancer therapy); genotoxic chemicals.
Chemical waste	Chemical substances present in a waste. E.g. laboratory reagents, film developer; disinfectants that are expired or no longer needed; solvent.
Wastes with high content of heavy metals	Batteries, broken thermometers, blood-pressure gauges.
Pressurized containers	Gas cylinders, aerosol cans
Radioactive waste	Radioactive substances present in a waste e.g. unused liquids from radiotherapy or laboratory research, contaminate glassware, packages or absorbent paper.
Sharps	Sharp wastes. E.g. needles, knives, blades, broken glass infusion sets.

The composition of medical wastes varies from country to country even within a country as it depends on the type of health services they are providing to the people. The following table 3 shows the wastes that are commonly found in all the hospitals all over the world.

QURBANI /EIDAL-ADHA WASTE MANAGEMENT

One of the major activities of WMD is to organize the synchronization of the management of generated waste of sacrificial animals during this festival. Over the past few years' government has been taking the initiative to aware citizens to slaughter at designated spots to ensure a smooth conduct of cleaning to bring back livable environment immediately after the religious ritual. DSCC has been improving consistently since government imposed new regulations for the Eidul Adha. In 2019-2020 Approximately 223,677 animals were sacrificed, and 21,400-ton waste was transported to Landfill.

Year	Sacrificial Animal	Waste Generation and Collection
2018- 2019	267,105	25,000 tons
2019 -2020	223,677	21,400 tons

Figure 8: Qurbani/Eidal- adhawaste management

Figure 9: E-waste

E-waste

Now-a-days electronic and electrical e-waste (e-waste) is increasing in a significant rate. Which are the important parts of the solid waste for modernization as well as technological advancement all over the world including Bangladesh (Mainly Dhaka City)

METHODOLOGY OF THE STUDY

The implementation of 4Rs can begin from our homes. Internationally recognized waste management hierarchy prescribes that the first priority should be given to waste minimization. Recycling, reusing, recovering, treatment and disposal in these orders may follow the minimization of all kind of waste. The 4Rs 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.

Figure 10: Waste Hierarchy

The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. The impression of minimizing waste impacts in terms of extent or environmental effects, by reducing quantity of wastes, reusing the waste products with a simple treatments and recycling the wastes by using it as resources to produce products is usually referred to as "4Rs"

Implementation of 4Rs involves a number of steps:

- **Demarcation of the project area:** First step is the design of facility management, which will also include Planning and management for field survey, the second will be the identification or demarcation of project area. Using GIS is the modern and best possible method.

- **Stakeholder Analysis:** The project will conduct a vigorous stakeholder analysis to identify and assess the importance of key people, groups of people, or institutions that may significantly influence the success of the project to develop strategies, get maximum possible for the project and reduce any obstacles to successful implementation

- **Stakeholder Consultations:** Stakeholder consultation is a multi-step process. Initial consultations will need to be formal or informal one-to-one meetings with representatives of individual stakeholder groups and in groups. This is required to introduce stakeholders to the project objectives.

- **Baseline Survey:** A baseline study for 4Rs plan will be used to assess achievement of the outcomes and impact expressed in the program's logical framework. When compared with the condition of the same indicators at some point during implementation (mid-term evaluation) and post-operation implementation (final evaluation). The baseline study forms the basis for before and after assessment or a change over time. Below figure-4, is the explanation of how to do the baseline survey and last point the Impact assessment explain the exiting waste management practice son natural environment, occupational and public health.

- **Emission calculation:** 4Rs approach can reduce the emission from municipal solid waste up to 90%. So we can calculate the emission with and without project scenario. This calculation will also help us to predict whether this 4Rs project is feasible for CDM (Clean Development Mechanism) claim or not.

- **Impact on occupational and environmental health:** Inadequate collection and disposal of waste poses a serious health risk to the population. This causes environmental degradation in most cities of the developing countries like Bangladesh. The informal labors, which are working in collection, transportation and processing sectors never use any protective measure and are very vulnerable to infectious diseases.

Location of Study Area

Dhaka city is located at the center of Bangladesh. The city is between 23° 43' 23" North latitude and 90° 24' 31" East latitude. The city is located along the river's the Buriganga and the Shitalakhha. Figure 8 represents the location of the study area.

FACTS ATA GLANCE /2019-20 (DSCC) SOURCE: INTERNET.

Total Area	= 109 sq. km
Population	=6.3 million
Average Population density	=57,798 per sq. km
Total Number of Zone	= 10
Total Number of Ward	= 75
Total Amount of Waste Generation	=3,256 Ton/day
Waste Collection Growth	= 7.7 %
Waste Collection Total amount	=927,100 Ton
Percentage	=78%*
Total Trip Generation	= 232,940 nos.
Waste Collection Highest in a month	=89,235 Ton (August 2019)
Lowest in a month	=55,927 Ton (February 2020)
DSCC Cleaners	=5,168 nos.
Number of Sanitary Landfill	= 1 (Matuail Landfill Site)

Load per Trip = 3.98 Ton/trip
Waste Generation during Eid-ul-Adha =19,200 Ton
Number of Waste Collection Vehicles 307 (Arm Roller: 12; Compactor: 58; Container Carrier: 74; Dump Truck: 112, Open Truck: 10, Heavy Equipment: 41) Container Box 360 nos.
Average Waste Disposal in Landfill =2,540 Ton/day
Landfill Operation Cost = 426 Taka/Ton *

Mostly uncollected from drain, water bodies, canals, and newly extended area.

WASTE FACTS AT A GLANCE /2019-20 (DNCC) SOURCE: INTERNET.

Total Area	= 196.23 sq. km
Population	= 6.10 million
Average Population density	=31.488 per sq. km
Total Number of Zone	= 10
Total Number of Ward	= 54
Amount of Waste Generation	=3,433 Tons/day
Waste Collection Total amount in FY 2019-20	=1002.561 Tons
Percentage	= 80%*
Total Number of Trips	=208,808 nos.
Waste Collection Highest in a month	=100630 Ton (August 2019)
Lowest in a month	= 60710 Ton (April, 2020)
DNCC Cleaners	= 2479 nos.
Private company cleaner	=1435 Nos
Number of Sanitary Landfill	= 1 (Amin bazar Landfill Site)
Load per Trip	=4.80 Ton/trip
Waste Generation during Eid-ul-Adha	=12700 Ton
Number of Waste Collection Vehicles	=147Nos
Heavy Equipment:	= 18 nos.
Average Waste Disposal in Landfill	= 2,750 Tons/day
Landfill Operation Cost	=244.41 BDT/Ton * WASTE

Mostly uncollected from drain, water bodies, canals, and newly extended area.

Figure 11: Map of Dhaka City

Benefits of 4R's/Findings

The benefits of 4-R'sfor the society and environment:

- Green House Gas (GHG) reduction through energy efficiency and resource efficiency and can reduce the Carbon Dioxide (CO2) emission.
- Attracting foreign direct investment through emission reduction credits and pollution reduction and other environmental benefits
- Prevent pollution and enriches soil condition and can provide a healthy environment to the people of the cities
- Environmental Friendly.
- Low cost because the activities are in the category of non- structural waste management.
- Activities of tokaiis reduced hence they will come in the main stream of the society.
- No. traditional method allowed managing the waste.
- Make the dwellers of Dhaka city to be SMART, though which are the visions of Bangladesh Govt.
- The training, workshop and seminar are urgently required to efficiencies management of the waste as well as to implement the 4r strategy.
- Campaigning is very much effective to increase the public perception regarding the 4r strategy.
- Existing waste management rules/ procedure should be followed.

Action Plan of 4R's

Under the action plan of 4Rs, the solid waste management (SWM) system will provide a reliable, sustainable waste separation system at source i.e. a house-to-house solid waste collection service. It can ensure that all residual waste is transported and the remaining fraction disposed of in socially responsible manner in a safe environment. It can achieve a recycling efficiency of at least 90 percent. In conjunction with other implementing stakeholders, 4Rs can make progress in initiating and improving the projects areas it approaches.

The Action Plan of this 4Rs project has four components:

- Separation at source
- Reduction
- Reusing
- Recycling

The action plan will be structured under the principles of efficient, accountable and transparent infrastructure service provision.

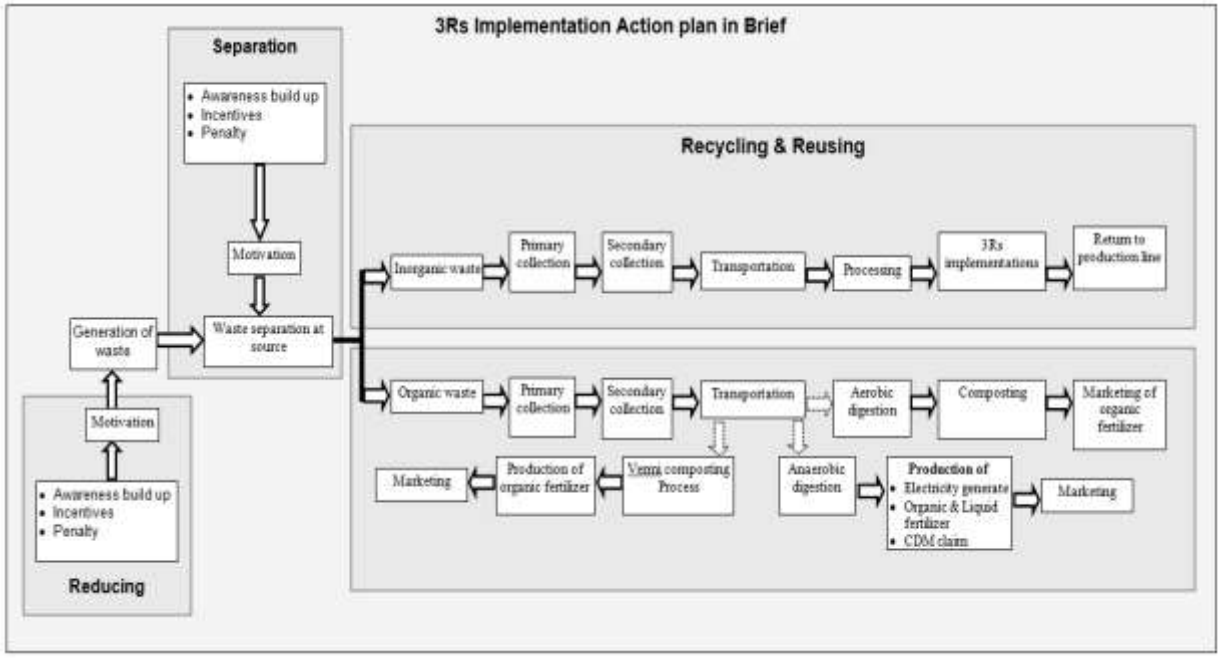

Figure 12: 4Rs Implementation action plan in brief way

Risk Assessment and Management of 4R's

4Rs approach for sustainable solid waste management is relatively new to Bangladesh; therefore, obviously there would be some risk with this plan. Risk assessment and risk management are part of the broad landscape of conceptual approaches; action planning and tools that strengthen the sustainable management for this 4Rs project would address the risk factors related to the plan.

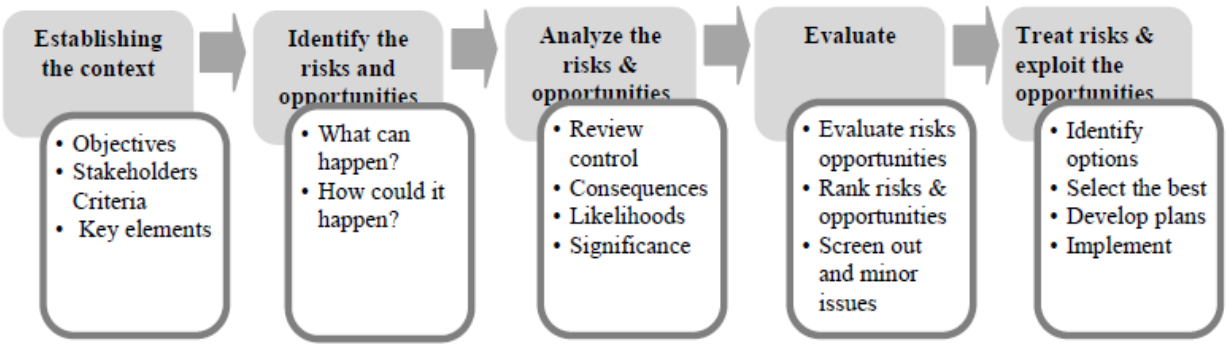

Figure 13: Process of Risk Management

Predicted risks and their mitigation plan could arise from the following points which need to be mitigated:

a. Regulatory hurdles, technology limitations, public/stakeholders perception etc (household waste collection)
b. Political commitment
c. Protection from the waste pickers
d. Non-compliance in source separation
e. Disaster events
f. Health risk of waste collector

Smart Bangladesh is about being inclusive, about the people, the citizens of Bangladesh. Built on the 4 pillars of Smart Citizens, Smart Government, Smart Economy and Smart Society, it is about bridging the digital divide by innovating and scaling sustainable digital solutions that all citizens, regardless of their socio-economic background, all businesses, regardless of their size, can benefit from. Building on the launch pad created by Digital Bangladesh, Smart Bangladesh is the next major step towards realizing **Bangabandhu's dream of Sonar Bangla become a Golden Bangladesh.**

CONCLUSION

In a nutshell, waste management must be put in place from micro level of household to macro levels of city, state and nation. Towards sustainable waste management, 4Rs can play a vital role to protect environment from green house gas emission and convert waste into invaluable resources.

- Capacity Building of City Corporation and Community Based Organizations: With the implementation of the project simultaneously capacity building of city corporations and community bases organizations (CBO) will take place.
- Socioeconomic and environmental benefits of the 4Rs Plan: long-term objective is therefore to reduce the environmental degradation caused by solid waste. By using anaerobic methods to manage the biodegradable waste, we are able to:
  1. Minimize waste that needs to be disposed in centralized landfills, thus no need to extend existing landfill capacity become reduce the environmental impact of disposal sites(land fill)
  2. Benefit the soil by using organic compost instead of chemical fertilizers and ensures sustainability of the project at the local level; Reduced GHG emission and less air, water and soil pollution because of MSW
- Empowerment of Women: The scheme aims at empowering women, and in particular women from socially and economically disadvantaged groups and living with disabilities, by offering them continuous employment and a guaranteed salary.
- Poverty Alleviation and Improved Occupational Health: There will also be opportunities for the start-up of micro-enterprises in recycling, e.g. recycling of paper, Cartons and Pet bottles. Good working conditions, continuous training and the adoption of scientific and professional methods of handling waste will minimize health risks and other occupational hazards that are common in informal settings.
- Making the waste into resource by composting: Waste always has been treated as a burden to the community and the city corporation. But the scenario has changed now; there are various techniques and processes through which the municipal solid waste can be converted into valuable resources. If the waste generation is low then it can be compost or if the biodegradable waste generation is high, then it can generate electricity by using anaerobic digestion depending upon the feasibility. Comparatively the anaerobic digestion (produce electricity, solid and liquid fertilizer, 90- 95% CDM claim) process is more desirable in terms of economic returns.

Thus if implemented successfully this 4R's scheme will be a win-win situation for all stakeholders as well as to live the people of present and future generation under Dhaka city in a green Environment.

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