



Solid Waste Management in Developing and Developed Countries: A Review

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ABSTRACT

Solid waste management is an important and essential works for any country. Solid waste management is also one of the tough, complexes, time consuming and laborious work for urban areas of the world. However the present study has conducted to assess briefly the solid waste management in developing and developed countries of the world. The study was documentary analysis type. Data and information were collected from secondary sources such as books, research, report, journals, Thesis, annual report, magazines, websites, internet etc. From the study it was found that in rural areas solid waste are dumped into their own land areas but in case of urban areas it is difficult. In urban areas solid wastes are managed by Pourashava or city corporation authorities. In developed countries, solid wastes are managed by adopting different latest vehicles, instruments machineries and technologies. For this reason solid waste management is carried out properly. So, citizens of developed countries have no headache for solid waste management. In developed countries solid wastes are recycled and again used. Some developed countries (example: Sweden) earn a lot of foreign currency by exporting recycled solid wastes. On the other hand, poor countries, least developed are not able to manage solid waste properly. For this reason the citizens of the poor and least developed countries suffer a lot. For better management of solid waste, Bangladesh and other developed countries should follow the techniques which are adopted by developed countries of the world. Bangladesh and other developed countries should visit the developed countries to get ideas how the developed countries are managing their solid wastes.

Key words: *Solid waste, Management, Developing country, developed country.*

INTRODUCTION

Waste generally means ‘something unwanted’, but its precise definition differs from one country to another (Tanaka, 1997). The Chinese often say that a thing can be both a raw material and a waste at the same time. A material is considered as waste until it is considered as beneficial again. Thus a solid (or semi-solid) material is generally considered as solid waste in the eyes of the producers when it loses its worth to them and is discarded. Solid waste is an inevitable byproduct of human beings, animals and also of industrial-commercial activities. It represents the loss of materials and/or energy for which the generator of the waste has paid. It includes solid and semi-solid materials generated from domestic, commercial and industrial premises or processes including municipal services, water and wastewater treatment plants, air pollution control devices, mining and agricultural operation. The nature and abundance of solid waste in different countries depends on geographic location (region), climate, and degree of industrialization, available resources, socio-economic conditions, religious custom, lifestyle and behavior of consumers and also on the season of the year.

OBJECTIVES OF THE STUDY

The objective of the study is as follows:

1. To assess briefly the solid waste management in developing and developed countries of the world.

METHODOLOGY OF THE STUDY

The study was documentary analysis type. Data and information were collected from secondary sources such as books, research, report, journals, Thesis, annual report, magazines, websites, internet etc.

DEFINITION OF CONCEPTS

1 Solid Waste Definition

The term solid waste may be used to refer to municipal waste and falls under seven categories: residential (household or domestic waste), commercial, institutional, street sweeping, construction and demolition, sanitation and industrial. Likewise, municipal solid waste refers to solid wastes from houses, streets and public places, shops, offices, and hospitals, which are very often the responsibility of municipal or other governmental authorities. Solid waste from industrial processes is generally not considered as municipal. However, because this waste finally ends up in the municipal waste stream, it should be taken into account when dealing with solid waste. Synonymous to solid waste are terms such as “garbage”, “trash”, “refuse” and “rubbish” especially in some literature in North America.

Table 1: Definition of Waste relating to their types

| Waste Type | Definition |
|-----------------------------|---|
| Construction debris | Detritus minerals from construction and demolition |
| Organic waste | Biodegradable component of municipal waste (e.g. food and yard waste) |
| Household-commercial waste | Waste from commercial establishments, business, the service sector, public institutions, and industries that possess similar characteristics than household waste |
| Commercial Waste | Waste with characteristics similar to household waste |
| Municipal solid waste (MSW) | Household, bulky, household-like commercial, yard, open market, and construction and demolition waste, street sweepings, etc. |
| Medical waste | Syringe, pad, injection jars, saline packet, musk, operation instruments, gauge, medicine packets, etc. |
| Agricultural waste | Paddy straw, weeds, pesticide packet, seed packet, fertilizer packet, cow dung, poultry waste, animal dead body, etc. |
| Tanning waste | Animal skin, chemical, dyeing agent, etc. |

2. Types of Solid waste

Solid wastes are usually the following types, municipal wastes, industrial wastes and Hazardous wastes etc.

a) Municipal waste

The definitions of terms and the classifications used to describe the components of solid wastes vary greatly in practice as well as in the literature. The definitions presented in (Table: 1) are intended to serve as guide for municipal solid wastes.

b) Industrial wastes

Industrial wastes are waste arising from industrial activities. They include rubbish (associated with the support personnel), process wastes, ashes, demolition and construction wastes, special wastes and hazardous wastes.

c) Hospital and Clinic Waste

There are more than 500 clinics and hospitals in Dhaka City, and all hospitals and clinics are producing huge amount of waste in every day. The present average of clinical waste generation in hospitals and clinics is calculated using 1kg/bed/day and an extra 200 kg/year for clinics. It is estimated that 20 percent of the whole hospital wastes (255 tons, 7.29 % of total solid waste generated per day) generated in the city is infectious and dangerous. Waste is collected from small bowls (plastic or metal) or plastic bins provided for each bed and emptied into larger containers. Wastes from operation theaters, laboratories, and kitchens are also dumped into these municipal bins. Since hospital wastes contain toxic and infectious materials, they are more unsafe than other types of wastes. In Dhaka, all types of medical wastes, like syringes and needles are thrown into the municipal dustbin. For this reason inflectional diseases spread out easily.

d) Tanning Waste

Tanning waste is another type of industrial waste, which is polluting the environment dangerously. There are about 149 tanning industries at savar area in Dhaka and they are producing 18,000 liters of liquid wastes and 115 tons of solid wastes. Most of the wastewater discharged into the nearby river/low lying area. Wastes from tanneries contain sulfuric acid, chromium, ammonium sulfate, ammonium chloride, and calcium. Tanning wastes have harmful impacts on environment in terms of health, welfare, and environment like fever, headaches, respiratory and skin diseases and may also bring undesirable changes in land use and fisheries. It has also negative impact on groundwater, surface water, and the ecosystem in general.

e) Agricultural Solid Waste (Source):

According to Department of Agricultural Extension, 2790 hectare of land (Tejgaon circle) are cultivated Surrounding Dhaka Metropolitan City in the area of Mirpur, Boshila & Demraetc and the Significant quantity of solid waste are produced round the year and following categories of waste produced-

Field Wastes-

Paddy field is also produced Methane (CH_4) gas.

- Weeds

- Straws etc.

Animal wastes

4771 number of diary and 1621 number of poultry farm are active in the Dhaka Metropolitan city. The farms were being created huge quantity of solid waste like-

- Animal Dung

- Dead Bodies

-Chew by the cows, Chewing gum is dangerous for Environment and also produced Methane gas (CH_4) (Source: Internet)

Agro- Industrial Waste

There are also a few number of Agro-Industry in Dhaka Metropolitan city area and produced lot of Agro- Industrial Waste-

Agro-Industrial Wastes-

- Biogas

- Bio-fertilizer

- Leather Industries

- Meat

- Alcohol production

- Fuel

- Phosphorus and calcium

- Pulp and paper etc

f) Hazardous wastes

Hazardous waste are classified as wastes that pose a substantial danger, either immediately or over a period of time, to human, plant or animal life. A waste is classified hazardous based on the fact that it exhibits any of the following characteristics: ignitability, corrosively, reactivity or toxicity.

g) E-waste

Now-a-days electronic and electrical wastes are increasing in significant rates which are the important part of the solid waste for modernization as well as technological advancement all over the world. The category of waste accounts more than 55 percent of total Municipal solid waste in industrialized countries and as high as 90 percent of total MSW in developing countries. The recycling of e-waste is required to be regulated to presence of hazardous Constituents in the components of waste electrical and electronic assemblies. Government should encourage e-waste recycling project under public-Private Partnership mode. Improper treatment and unsafe final disposition of these materials has resulted in several problems. One key problem is that related to the fact that most electronic products contain several hazardous materials, such as mercury, arsenic, lead, cadmium and others harmful chemical elements.

h) Consequence of Dengue.

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 state, but recently has sustained an upsurge in dengue outbreaks all over the country (Bangladesh). 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 waste as larval habitats of Dengue vectors (*Aedes spp.*) in rural and urban areas around Dhaka city. As a result total Death due to aedes mosquito (Dengue fever) during the year 2000-2017 was 268. Which was also a significant as well as additional waste management for both the city corporation in Bangladesh.

Solid waste Management during COVID-19

Undoubtedly the most searched and spoken world of last 2 years 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 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 catastrophic impact of COVID-19,

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 inhibit 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 and if not disposed of properly may cause the infection or help to catalyze Covid-19. In developing countries, poor solid waste management may aggravate chances of spreading COVID-19. Sustainable solid waste management is a critical parameter for the health, wellbeing and development of society. Covid-19 is a new and novel virus and experts are learning more about it over time and with evolving science. For which different types of solid waste generated during the pandemic. It is also attacked all over the world like as world war. It also killed human and hampered business, economical, educational, social progress all over the world.

Functional Elements of Solid Waste Management System

The activities associated with management of SWM from the point of generation to final disposal are grouped into the following functional elements:

- a) waste generation;
- b) Waste handling and sorting, storage, and processing at the source;
- c) collection;
- d) sorting, processing and transformation;
- e) transfer and transport; and
- f) disposal.

Functional elements are closely interconnected but they are not necessarily presented in every municipal solid waste management system. In most low and middle income countries, the system is limited to waste generation, handling at the source, collection and Disposal at landfills. In most developed countries, every functional element is found within the system.

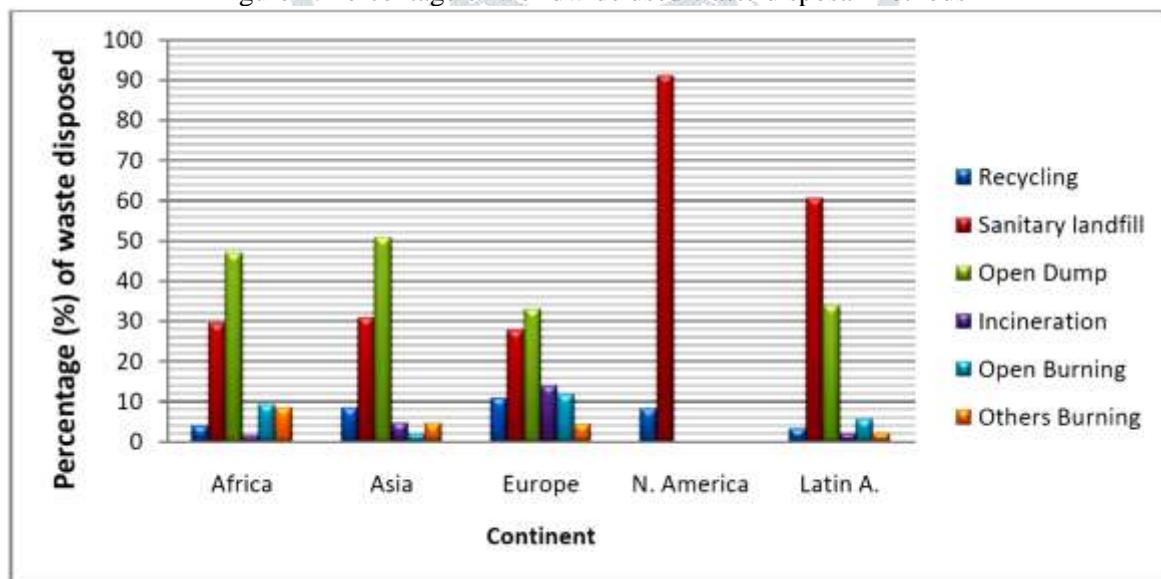
RESULTS AND DISCUSSION

1. Global Significance of Waste Management

Internationally, the focus on waste management has been on innovative recycling technologies, disposal options such as incineration, and the controversies surrounding disposal site selection (landfills & Incineration) in first world communities. However, cost reduction and environmental products are the primary issues. 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. Solid waste management is one of the main responsibilities of both urban and rural communities and the fundamental objective of solid waste management programmes 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.

Table 2: Percentage of worldwide used waste disposal methods

| Continent | Percentage of waste disposed by | | | | | |
|------------|---------------------------------|-------------------|----------|--------------|--------------|--------|
| | Recycling | Sanitary landfill | Open Dum | Incineration | Open Burning | Others |
| Africa | 3.9 | 29.3 | 47 | 1.4 | 9.2 | 8.4 |
| Asia | 8.5 | 30.9 | 50.9 | 4.7 | 1.7 | 4.5 |
| Europe | 10.7 | 27.6 | 33 | 13.8 | 11.8 | 4.4 |
| N. America | 8.1 | 91.1 | 0 | 0 | 0 | 0 |
| Latin A. | 3.2 | 60.5 | 34 | 2 | 5.5 | 2 |

Figure 1: Percentage of worldwide used waste disposal methods

Waste can be classified based on the source or industry that generates the waste stream. Municipal solid waste (MSW) has grown in volume as the world's population has grown and become more urbanized.

Table 3: Global perspective on solid waste quantities

| | Generation Rates Kg / Capita / Day | | |
|---|---|------------------------------|----------------------------|
| | Low-income Country | Middle-income country | High-income country |
| Mixed Urban waste – large city | 0.5-0.75 | 0.55-1.00 | 0.75-2.2 |
| Mixed Urban waste – small to medium city | 0.35-0.65 | 0.45-0.75 | 0.65-1.5 |
| Residential waste Only | 0.25-0.45 | 0.35-0.65 | 0.55-1.0 |

The composition of MSW depends on a number of factors such as the lifestyles of the population, their relative standards of living, general consumer patterns, and the level of technological advancement of a particular country. It is a common knowledge that waste is nothing but useful material at wrong place and there is no material in the world which is not useful in one-way or the other. Waste management has now become a pressing concern for industrial societies because they produce large volumes of waste as a result of economic growth and lifestyle choices. Waste management technologies like land filling and incineration do not offer a complete solution to this problem. The attitude of people towards waste changes as types of wastes are changing. This has brought awareness to people that the solution lies in using waste as a resource rather than to be destroyed. Public awareness and attitudes to waste can affect the population's willingness to cooperate and participate in proper waste management practices. Information on health risks as a result of deficient solid waste management are important issues which have to be continually communicated to all sectors of the society. Solid waste management is concerned with the generation, on-site storage, collection, transfer, transportation, processing and recovery, and ultimate disposal of solid wastes. Per capita waste generation for developing countries is lower than average. However, the high rates of urbanization and increasing poverty may have a considerable influence on inter country per capita waste generation. According to report, per capita waste generation from urban areas of Egypt is 0.8kg per day while in rural areas it is 0.3 kg per capita per day.

Table 4: SWM in Low and Medium Income Countries

| | Low-income Countries | Middle-income countries |
|---|-----------------------------|--------------------------------|
| Waste generation(Kg/person/day) | 0.3 to approx. 0.6 | 0.7 approx.1.1 |
| Collection coverage | Less than 70% | 80 to 90% |
| Disposal costs(US\$/person/year) | Less than 1 | 1-3 |

Table 5: SWM expenditure in total municipal budget

| | | |
|---|---|--|
| SWM expenditure in total municipal budget (%) | 15.4 to approx. 38 | 6 approx. 23,2 |
| Recycling | Informal(metal, glass, plastic, composting) | Formal + Informal(metal, glass, plastic, composting) |
| Recycling | Informal(metal, glass, plastic, composting) | Formal + Informal(metal, glass, plastic, composting) |

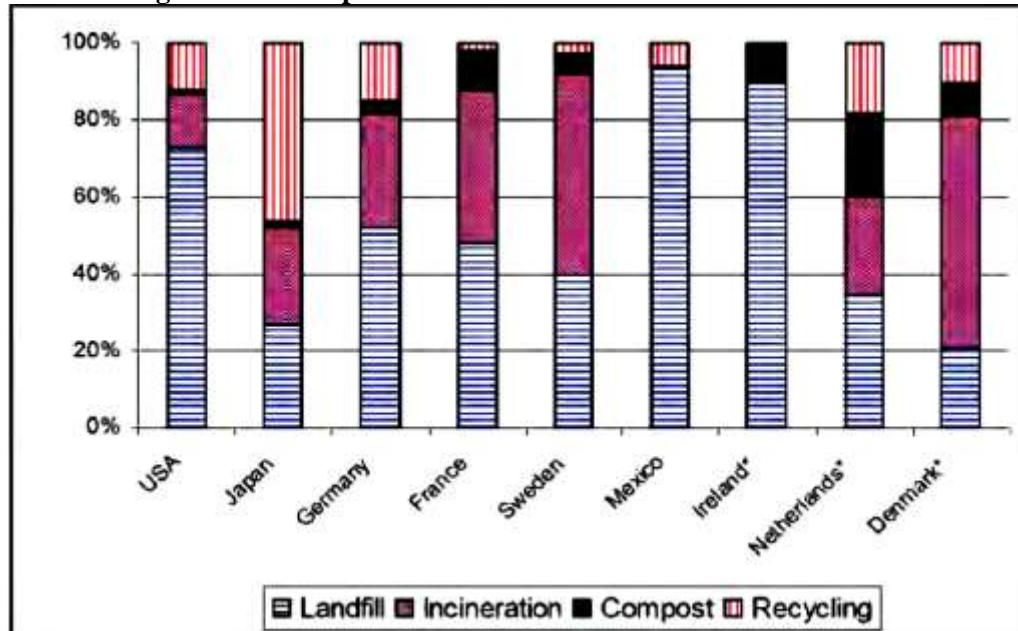
The purpose of recent EU policies has been to promote more recycling and energy extraction of products and materials thereby decreasing land filling and organic fraction not ending up in landfills at all. This comes as a result of negative environmental effects of landfills such as emissions (CO₂ and methane) to the air that affects climatic conditions and risk of water pollutant transport. EU Council Directives 1999/31/EC of April 1999 stipulates that waste materials should be separated at source, where recyclable and combustible materials are recovered for recycling and hazardous waste is phased out from production system. The significance of different options in some developed countries is shown in table 5. It is clearly seen that U.S.A is after China regarding sanitary landfill and Japan after Switzerland in incineration.

Table 6: Different treatment options of MSW (%) in some Countries

| Countries | Incineration | Biological Treatment | Sanitary landfill |
|-------------|--------------|----------------------|-------------------|
| U.S.A | 20 | 5 | 75 |
| Japan | 72.8 | 4.2 | 23 |
| Switzerland | 80 | - | 20 |
| Germany | 28 | 10 | 62 |
| France | 40 | 22 | 38 |
| Denmark | 70 | 12 | 18 |
| Sweden | 50 | 10 | 40 |
| China | 6.9 | 7.5 | 85.6 |

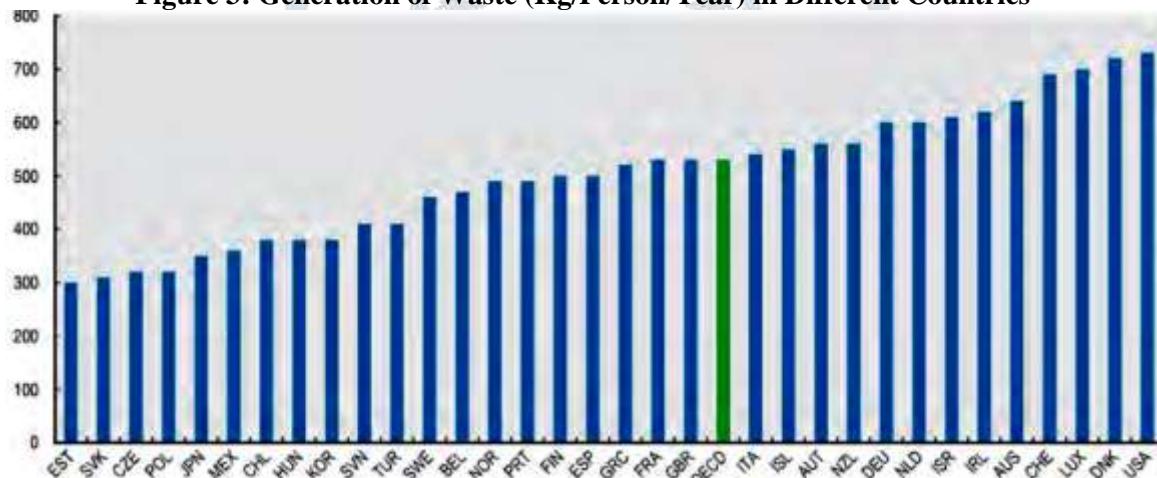
In Mexico, most of the treatment sites have stopped operating for lack of market, the high operational cost (incineration & recycling) and the bad quality of finish product resulting from composting. The outcome of this is that most of the collected waste is not treated at all and its final destiny lies in the few landfills which comply with the required technological characteristics and disposal sites that are open air dumps. In developed countries, it is worth noting that in spite of having progressed in the creation of waste recycling infrastructure, composting with or without energy generation, the disposal of solid waste in landfills is still very significant. In countries like the Netherlands, waste incineration is a method of final disposal which has been increasing. On the other hand, landfills have decreased considerably from 1,000 active sanitary landfills in the 70s to 47 in 1996. These changes were as a result of the prohibition in 1996 for land filling combustible waste and higher tariffs for land filling institute since 1999.

Figure 2: Municipal solid waste treatment in various countries



In the continent of Asia, the average generation in low income countries varies from 0.4-0.9 kg/person/day, in middle-income countries, 0.5-1.1 kg/person/day; in high income countries it is 1.1-2.0 kg/person/ day or even more as in Hong Kong: 5.1 kg/person/day. In European waste management hierarchy, land filling is the last option. In some European countries and continents, this is not yet a reality. About 95% handling of waste in the world is land filled or dumped into holes in land or directly on the banks of rivers or into the sea.

Figure 3: Generation of Waste (Kg/Person/Year) in Different Countries



Solid waste has traditionally been a local concern in most countries. Urban solid waste has become a national and international issue because of the growth in waste volumes, the environmental consequences of past disposal practices, and the potential impacts of measures adopted to address the problem of waste disposal. When considering the advancements in solid waste processing and resource recovery since four decades ago, this leads to both encouraging and disturbing trends. Until the advent of environmental awareness in the late 60s, land filling (dumping) and incineration of solid waste were the two principal means of disposal in North America. This saw the closure of many incinerators because of air pollution, dumps were closed or upgraded to sanitary land fillings, and land filling became a more widely utilized method of disposal. The effects of improper land filling because of incinerator air pollution and ground water contamination became an impetus of 16 waste volume reduction and materials recovery in efforts to conserve landfill space and reclaim nonrenewable resources. Although using the same methodologies, solid waste management practices still differ widely throughout the world. Japan burns more than 70% of its waste, while more than 84% of American waste goes into landfills.

The need for landfills has been reduced significantly in Germany in the last decade. Main reasons being that the increasing amount of waste has been channeled for recycling and recovery. The remaining solid waste goes to waste incineration, for co-incineration in coal- fired power-stations, cement kilns and for mechanical and biological treatment. In the 1970s, Germany had 50,000 landfills, while in 2000 the number of landfills had reduced dramatically to 333, Simultaneously, Germany has seen an increase in the number of waste incineration plants i.e. from seven incinerators with capacity of 718,000 tonnes/year in 1965 to incinerators with capacity of 17,800,000 tonnes/year in 2007 [34] and also mechanical-biological plants for municipal waste disposal. The three landfills in Singapore are outside the city limits and for close to four decades, there has been a 2.09 million tones increase in the amount of solid

waste generated and thus a significant demand on the waste management and disposal. On this note, land filling is the last option in the MSW management decision in Singapore. Landfill is reserved for the waste that cannot be treated or disposed of in any way and about 91% of waste collected is incinerated and about 9% along with the as generated from incineration are disposed of at Semakau landfill.

In low income countries, solid waste generation rates average only 0.4 to 0.6 Kg/person/day, as opposed to 0.7 to 1.8 Kg/person/day in fully industrialized countries. A report by Blight and Mbende and Arlosoroff noted several common differences in the composition of solid waste in developing countries:

- Moisture content is 2-3 times greater than developed countries,
- Waste density 2-3 times greater
- Large quantities of dust, dirt (street sweepings, etc)
- Large amount of organic waste (vegetable matter, etc.) 17
- Smaller particle size on average than in industrialized nations.

It is worth noting that because of increase population countries in Africa, Latin America and Asia account for nearly 40 percent of annual methane emissions from landfills, which is equal to 37 million metric tons of carbon dioxide equivalent or the amount of air emissions from more than 102 million automobiles China is now experiencing a fast increase in solid waste quantities. According to a report by Delvoie China surpassed the United States as the World's largest waste generator in 2004. By 2030, China's annual solid waste quantities will increase by another 150% - growing from 190 million tons in 2004 to over 480 million tons in 2030. This growing waste stream possesses significant impact on the society, environment and economic development. Waste categorization in China is not always consistent or comprehensive from city to city and this seriously affects the utilization of the database.

2. Solid Waste Management in Developed Countries

The problem of solid waste especially MSW in the industrialized countries has been the cause of growing concern in recent years, becoming one of the main areas of the environmental policy debate. But now, because of the growth in waste volumes, the environmental consequences of past disposal practices, there is raised concerns about the economic viability and environmental acceptability of the current waste-disposal methodologies. In Europe and also the Baltic states, waste is one of the main environmental concerns. The volume of household waste generated will likely be on the increase over the coming years as a result of the increase of amount of packaging used on products. Comparing the management of urban solid waste in the late 1970s to that of today, it is clear that there is a revolution in waste management underway in most of the industrialized countries. This revolution can be seen in four aspects;

- (i) Revolution in the management method, away from landfill and toward material recycling and energy recovery. There is a change away from landfill, toward material recycling and energy recovery.
- (ii) Strengthening of the environmental standards applied to waste management facilities which have led to the closing or upgrading of many existing facilities.
- (iii) Change in public attitude toward waste in virtually all industrialized countries. The public has come to view all methods of disposal as posing unacceptable risks.
- (iv) A profound change in attitudes toward the proper role of producer industries. This can be seen in the implementation of polluters' pays principle and companies being asked by governments to accept increasing levels of responsibility for the waste resulting from consumption of their products.

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 grows to 21%, leaving only 49% of municipal waste for land disposal. 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. 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 tones of municipal waste is generated each year in Japan, 77.4% of which is incinerated, 5.9% land filled and 16.7% recycled. 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.

3. Solid Waste Management in Developing Countries

MSWM is a major responsibility of local governments. The requirement of appropriate organizational capacity and cooperation between numerous stakeholders 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. 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.

Table 7: Capacity Development in Solid Waste

| Economic levels of countries | Low-income countries | Middle-income countries |
|------------------------------|---|---|
| Waste minimization | No organized programs, but reuse and low per capita waste generation rates are common | Some discussions on waste minimization, but rarely incorporated into any organized program |
| Collection | Service is limited to high visibility areas, the wealthy, and businesses willing to pay | Expanded collection areas. Trucks are used for Collection |
| Recycling | Recycling activities are performed by the informal sector (scrap dealers and waste pickers). Localized markets for recycling are common | While the informal sector is still involved, relatively large machinery is sometimes used for sorting and recycling. Materials are often hauled out of the city as recyclables. |
| Composting | No organized programs. Wastes including organic matter are not put to good use | Efforts toward composting are made at many parts of the city. Large composting plants are generally unsuccessful. Small-scale composting projects tend |



| | | |
|---------------------|--|--|
| | | to become more successful |
| Incineration | Not common or successful because of high capital operation cost. High percentage of moisture and inorganic matter call for supplement fuel and have a smaller impact on volume reduction | Incinerators are sometimes used but not common due to economic reasons |
| Land filling | Usually open dumping with virtually no environmental controls | Some controlled and sanitary landfills with some environmental controls. Open dumping is still common |
| Costs | Collection costs represent 80- 90% of the SWM budget. Collection fees are regulated by some municipalities, but the quality of collection service is low | Collection costs represent 50-80% of the SWM budget. Some municipalities regulate collection and disposal fees. Innovative arrangement are in place for fee collection |

4. Solid Waste Management in Asian Developing Countries

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. 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. Description of sources and types of SW in Southeast Asian countries is shown in Table 7.

Table 8; Sources and types of municipal waste in Southeast Asia

| Sources | Typical Waste generators | Types of solid waste |
|--------------------------------------|--|--|
| Domestics | Single houses and apartments | Food scraps, paper, corrugated boxes, plastics, clothing, glass, metals, ashes, and domestic hazardous waste |
| Shopping and commercial areas | Shopping centers, hotels, restaurants, markets, offices | Paper, corrugated boxes, plastics, wood, food scraps, glass, metals, special wastes, hazardous waste |
| Institutional | School, governments offices, medical care centers, prisons | As mentioned above in shopping and commercial areas |
| Public facilities | Street cleaning, landscaping, parks, beaches, recreation areas | Street cleaning, landscape and yard trimming, general waste from recreation areas |

Source: UNEP

SW generation and its composition in some Asian developing countries are shown in Table 8. The main component of SW is decomposable organic waste which has a range of 42% to 80.2%. Other SW components, which appear in less portion, are paper, plastic, cloth, metals, glass, ash and others. In Pondicherry, India, Kuala Lumpur, Malaysia and Dhaka, Bangladesh the second component of waste is paper, followed by plastic. The remains are textile, glass, metal, rubber and leather, and others.

Table 9: Solid Waste generation & composition in cities of Asian developing countries

| Country | Waste generation | | Composition | | | | | | | | | |
|----------------------|------------------|------------|--------------|-------|---------|---------|-----------|-------|--------|------|------|-----------|
| | Ton/day | Kg/cap/day | Decomposable | Paper | Plastic | Textile | Glass | Metal | Rubber | Wood | Ash | others |
| Surabaya (Indonesia) | 2160 | .8 | 72.41 | 7.26 | 10.09 | 2.68 | 1.7 | 1.41 | .46 | 2.39 | 1.48 | .12 |
| Jakarta (Indonesia) | 6000 | .65 | 68.12 | 10.11 | 11.08 | 2.45 | 1.63 | 1.90 | .55 | NA | NA | 4.12 |
| Allahabad (India) | 500 | .4 | 45.3 | 3.6 | 2.86 | 2.22 | .73 | 2.54 | 41.66 | - | - | - |
| Pondicherry (India) | 370 | .59 | 42 | 30 | 10.4 | 4.5 | 5 | 4.1 | 2.5 | 1.5 | NA | NA |
| Kathmandu (Nepal) | 523.8 | .66 | 71 | 7.5 | 12 | .9 | 1.3 | .5 | .3 | NA | NA | 6.7 |
| Bangkok (Thailand) | 8778 | 1.54 | 42.68 | 12.09 | 10.88 | 4.68 | 6.63 | 3.54 | 2.57 | 6.9 | NA | 10.0 4 |
| Phuket (Thailand) | 364 | 2.17 | 49.39 | 14.74 | 15.08 | 2.07 | 9.67 | 3.44 | 2.28 | NA | NA | 3.33 |
| Yala (Thailand) | 80 | 1.049 | 49.3 | 14.5 | 19.9 | - | 10.0 8 | .4 | - | 5.1 | NA | NA |
| K. Lumpur (Malaysia) | 3798 | 1.62 | 61.5 | 16.5 | 15.3 | 1.3 | 1.2 | .25 | .6 | .4 | .7 | NA |
| Rasht (Iran) | 420 | .8 | 80.2 | 8.7 | 9 | .4 | .2 | .7 | - | .4 | NA | .4 |
| Dhaka, Bangladesh | 5340 | .485 | 68.3 | 10.7 | 4.3 | 2.2 | .7 | 2 | 1.4 | - | NA | 10.4 |

4. Collection and Transportation of SW

In Asian developing countries, SW cycles through collection, transport and final disposal. In Jakarta only 70% waste was collected. The collection service in developing countries was conducted door-to-door, such as in Jakarta, in metro cities in India, and in Bangalore. The other difficulties in transportation of SW are the aging of waste transport vehicles and the condition of streets in Sri Lanka, and weakness in organization structures, and collection method in Yangon, Myanmar.

5. Final Disposal and Treatment

UNEP stated that methods for final SW treatment and disposal in developing Southeast Asian countries were commonly open dumping, landfill and others. These proportions were open dumping (more than 50%), landfill (10-30%), incineration (2-5%), and composting (less than 15%). The final disposal method is generally open dumped landfill. In Malaysia the amount of SW collected for final disposal, was about 70%, whereas 20-30% was dumped or thrown into river. In Bandung, the collected municipal SW was 60%, and the rest was dumped on the roadside, drainage and river. Almost similar conditions were found in Malaysia, landfill was the only method for disposal. In Indonesia, the transported SW to landfill was 69%, buried 9.6%, composted 7.15%, burnt 4.8%, and disposed to river 2.9% and others 6.55%. The Southern Province of Sri Lanka also conducted the final disposal in open dump 22 sites, and composting only 1 site of the 57 sites.

Composting is one of the treatments for solid waste, which more suitable than other treatment in Asian developing countries such as incinerator. The most composition of SW in those countries is decomposable organic, which has high moisture content. The constraints of composting in Asian developing countries included high cost in operation and maintenance, and weak in maintenance and operation of facilities, incomplete separation of non-compostable materials. Besides, as well as higher cost of compost compare to commercial fertilizers, also affect the implementation of composting UNEP. On the contrary, SWM in Asian developing countries is less financial resource, and low enforcement of environmental regulation. As the problem of composting, composting is applied in India only 10-12%, and other countries like Nepal, Pakistan, Bangladesh and Sri Lanka less than 10%. Methods for final SW treatment and disposal in developing Southeast Asian countries were commonly open dumping, landfill and others. These proportions were open dumping (more than 50%), landfill (10-30%), incineration (2-5%), and composting (less

than 15%). The final disposal method is generally open dumped landfill. In Malaysia the amount of SW collected for final disposal, was about 70%, whereas 20-30% was dumped or thrown into river. In Indonesia, the transported SW to landfill was 69%, buried 9.6%, composted 7.15%, burnt 4.8%, disposed to river 2.9% and others 6.55%. The Southern Province of Sri Lanka also conducted the final disposal in open dump 22 sites, and composting only 1 site of the 57 sites.

6. Alternative Solutions in SWM

SW generation in Asian developing countries shows an increase in plastic components. Another problem is the dominance of biodegradable organic waste (more than 40% of total weight), which is potential to emit greenhouse gases (GHGs). Therefore, appropriate strategies should be determined for solving these problems.

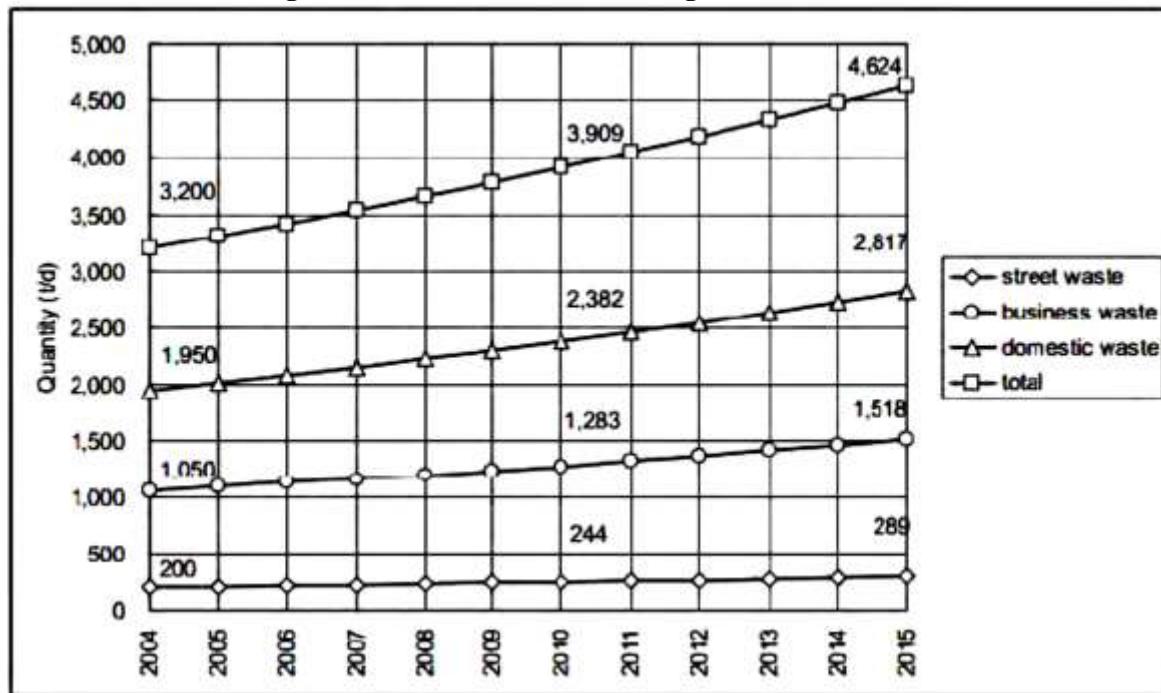
7. Changing of the Public Behavior

The improvement in living standards has changed life style and SW composition. In high-income residential areas in some developing countries recyclable material (i.e. plastics, metal, glass and others) tend to increase, because of the consumption of more packaged products. Following are some alternative solutions which have been successfully implemented in Surabaya and Medan, Indonesia. In these cities public awareness was improved after receiving guidance concerning environmental issues. The trainers were from local leaders and facilitators with the assistance of Non-Government Organizations (NGOs). This program was performed as community based SWM. The program successfully applied 3R (reduce, reuse, recycling), which included waste separation at the source and composting. In Yala, Thailand, the poor communities in reducing SW was triggered by exchanged the trash for nutrition food. They empower themselves in environmental awareness. Most of Asian developing countries face SW generation problems. The main constraints are weak organization and limited budget allocation for SWM. Therefore, in most Asian developing countries SW reduction is conducted from the source up to the landfill sites.

8. Case Studies (Bangladesh)

1. Case Study 01: The Study on the Solid Waste Management in Dhaka City by JICA (March 2005)

In March 2005 JICA developed a case study on solid waste management of Dhaka city. The objective of that study were to formulate master plan concerning solid waste management in Dhaka City with the target year of 2015 and to develop capabilities and management skills of the DCC personnel through the technology transfer during the course of the Study. The population was projected 7.7 million for 2015 and 6.7 million for 2010 respectively. The area of DCC was assumed fixed at 131 km. Quantity of solid waste to be generated was estimated based on the population growth and waste generation rate. The waste generation was projected at 3,909t/d and 4,624t/d for the years 2010 and 2015, respectively. They made disposal plan for 3 dump site. Those were Matuail, Berri Band and Uttara. Household Awareness survey was conducted by JICA study team in February 2004. The survey was composed of Household Questionnaire Survey and focus group discussion. The population was projected 7.7 million for 2015 and 6.7 million for 2010 respectively. The area of DCC was assumed fixed at 131 km. Quantity of solid waste to be generated was estimated based on the population growth and waste generation rate. The waste generation was projected at 3,909t/d and 4,624t/d for the years 2010 and 2015, respectively. They made disposal plan for 3 dump site. Those were Matuail, Berri Band and Uttara. Household Awareness survey was conducted by JICA study team in February 2004. The survey was composed of Household Questionnaire Survey and focus group discussion.

Figure 4: Forecast of Solid Waste generation amount**Figure 5: A solid waste collector is collecting waste
Case study**

- If Garbage collection is not follow the time schedule especially Reasons in the home stead area.

2. -Cause the occupants had to take the easy way to remove the solid waste in open places including the road side and at major cross roads on the main road

-Remove solid waste in open area

Actions by Residents away from the house.

-This is because garbage and solid waste loaded in the barrel, in front of their homes are full.

3. The Effects

-Animals eat like cats, dogs etc, garbage lifted late in the barrel at the front door of house will be wormy and rotten and then over flowing on the road shoulder.

-Not lasting the nauseating smell that permeates the house, every time opens the door until cause of the health and appetite.

- Experiencing severe odor and pollution as wormy and rotting garbage in the trash lifted by the garbage trucks.

- Waste water over flowing from the truck on the road surface.

- Affected neighborhoods wedding.

- Contaminate views.

- Raises displeasure.

4. Impacts of solid waste on Environment

-waste breaks down in landfills to form methane, a potent greenhouse gas.

- Change in climate and destruction of ozone layer due to waste biodegradable.

-Garbage disposal, due to waste pollutions, illegal dumping, leaching: is a process by which solid waste enter soil and ground water and contaminating them.

5. Impact of solid waste on health

- Nausea and vomiting.
- Mercury toxicity from eating fish with high levels of mercury.
- Increase in hospitalization of diabetic residents living near hazards waste site.
- Chemical poisoning through chemical inhalation.
- Cancer.
- Low birth weight.

6. Causes of increase in solid waste

Population growth, Increase in industrials manufacturing, Urbanization, Modernization, Digitalization.

7. Preventive measure

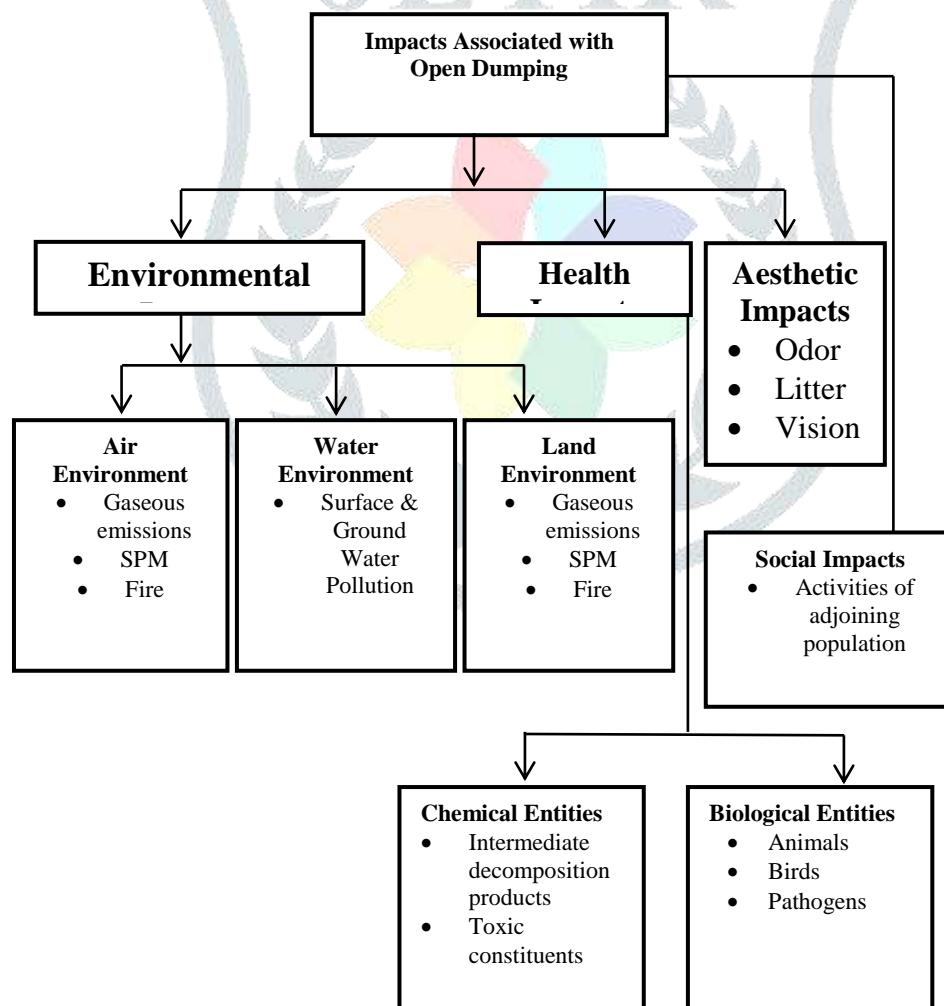
- Systematic solid waste management.
- involving public in plans for waste treatment and disposal in an Environmental friendly.
- Educate people on different ways of handling waste.
- Household level of proper segregation of waste, recycling and reuse.
- Process and product substitution example use paper bag instead of plastic bags.
- Garbage collection according to the schedule time.

8. Materials in MSW which can be separated and recycled

-paper, Glass, Plastic, Ferrous metals, Aluminum cans

Recycling is a good process as it reduces the volume of waste to be disposed off on land.

9. Impact on Environment



10. Hazardous Wastes: Types.

- Contains at least one toxic Compound.
- Catches Fire easily.
- Reactive or explosive.
- Corrodes metal containers.

11. What Harmful Chemicals are available in Home?

- Cleaning – Disinfectants, Drain, toilet and windows cleaners, Spot removers, Septic tank cleaners.
- Gardening – Pesticides, weed Killers, Ant and rodent Killer, Flea Powders.
- Paint- Latex and Oil-based paints, paint thinner solvents and strippers Stains, Varnishes and lacquers, wood preservatives, Artist paint and inks.
- Automotive- Gasoline used motor oil, Antifreeze, Battery acid, solvents, brake and transmission fluid, Rust inhibitor and rust remover.
- General- Dry cell batteries (mercury and cadmium), Glues and cements.

CONCLUSION

- Modern methods of waste management are far safer for people and gentler on the Environment.
- Recycling and composting are making rapid progress.
- Our Prodigious consumption habit has created more waste than ever before.
- Political Commitment should be strong among the developing countries for better management of solid waste.
- Awareness of the peoples should be increased towards waste management specially in developing countries.
- Integrated solid waste management is very much essential regarding efficient waste management among the developed and developing countries.
- Diplomatically relation should also be increased regarding waste management among the developed and developing countries.
- Finding ways to Re-think, reduce, reuse and efficiently recycle the materials and goods that we use stands as a key challenge for this century. At the same time Slogan for widely uses of Four Should be raised all over the world.
- Initiatives should be taken among the developed and developing Countries to reduced the emission of green house Gas (specially emission of carbon) to protect the climate change/ environmental protection as well as to stop any kind of disaster all over the world.
- Every country should obey the National/International Environmental Laws/agreements/ Conventions and waste related obligations.
- Budgetary Provisions should also be increased in a large scale for efficient solid waste management all over the Globe specially for developing countries.
- Initiatives (training/man power/ transfer of technology/modern equipment etc) should also be taken among the developed and developing Countries for efficient solid waste management to achieve the SDG all over the world. Because environment friendly solid waste management are one of the important factor to achieve the Sustainable Development Goal all over the world to Survive the present and future generation and to make this world habitable with Green Environment.

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