Solid Waste Management: Prospects and Challenges in India

Dr. Anupama Kushwaha
Associate Professor
Department of Economics
J.D.V.M. P.G. College Kanpur

Abstract
Solid waste management (SWM) is a major problem for many urban local bodies (ULBs) in India, where urbanization, industrialization and economic growth have resulted in increased municipal solid waste (MSW) generation per person. Effective SWM is a major challenge in cities with high population density. Achieving sustainable development within a country experiencing rapid population growth and improvements in living standards is made more difficult in India because it is a diverse country with many different religious groups, cultures and traditions.
Despite significant development in social, economic and environmental areas, SWM systems in India have remained relatively unchanged. The informal sector has a key role in extracting value from waste, with approximately 90% of residual waste currently dumped rather than properly landfilled. There is an urgent need to move to more sustainable SWM, and this requires new management systems and waste management facilities. Current SWM systems are inefficient, with waste having a negative impact on public health, the environment and the economy.

Keywords: *urbanization, Sustainable, Waste Management, Landfill, Ecology, Hazardous waste, Biodegradable, Segregation*

Introduction

India is experiencing rapid urbanization between 2001to 2010. The decade of 2001 to 2010 has witnessed growth of many mega cities in India This mushrooming of Mega cities is associated with globalization of the economy, changing culture and technology. Megacities in India include Ahmedabad (6.3 million), Hyderabad (7.7 million), Bangalore (8.4 million), Chennai (8.6 million), Kolkata (14.1 million), Delhi (16.3 million) and Greater Mumbai (18.4 million). The population of India was 1252 million in 2013, compared with 1028 million in 2001. Population growth is a major contributor to increasing Municipal Solid Waste in India.

Achieving sustainable development within India that is experiencing rapid population growth and improvements in living standards has become difficult due to diversity in religion, cultures and traditions. Despite significant development in social, economic and environmental areas, Waste Management Systems in India have remained relatively unchanged. A report found that effective waste management is relatively expensive, usually comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported. A large portion of waste management practices deal with municipal solid waste (MSW) which is the bulk of the waste that is created by household, industrial, and commercial activity. According to the **Intergovernmental Panel on Climate Change (IPCC),** municipal solid waste is expected to reach approximately 3.4 Gt by 2050. Measures of waste management include measures for integrated techno-economic mechanisms of a circular economy, effective disposal facilities, export and import control and optimal sustainable design of products that are produced.

Waste generation in India

In India, the volume of waste generation has been increasing rapidly over the last few years As mentioned in "Swachhata Sandesh Newsletter" by the MoHUA, January 2019, about 147,613 metric tonnes (MT) of solid waste is generated per day, from 84,475 wards. The 2014 report by the "Task Force on Waste to Energy," under the Planning Commission, estimates that urban India will generate 2,76,342 tonnes per day (TPD) of waste by 2021; about 4,50,132 TPD by 2031; and 11,95,000 TPD by 2050. The per capita waste generation is 450 grams per day, and has increased at a rate of 1.3 percent per annum.The amount of waste generation in 84,456 wards varies from 32 MT to 22,080 MT per day, as on January 2020. Maharashtra generates the highest, at 22,080 MT per day (from 7,322 wards) while Sikkim generates the lowest, at 89 MT per day (from 53 wards). Amongst the Union Territories (UTs), Delhi generates the highest amount of waste; at 10,500 MT per day. Daman & Diu is the lowest waste generator in India.

Figure 1- Total Waste Generated and converted by States and Union Territories in India

State/ UT's	Total Waste	Total waste conversion
Andhra Pradesh	3409	6141
Andaman & Nicobar	24	90
Arunachal Pradesh	75	181
Assam	943	1432
Bihar	3377	2272
Chandigarh	26	479
Chhattisgarh	3217	1650
Daman & Diu	28	32
Dadar & Nagar Haveli	15	55
Delhi	294	10500
Goa	217	250
Gujrat	1427	10274
Haryana	1496	4783
Himanchal Pradesh	497	377
Jammu & Kashmir	1081	1489
Jharkhand	932	2135
Karnataka	6464	10000
Kerala	3536	2696

State/ UT's	Total Waste	Total waste conversion
Madhya Pradesh	7115	6424
Maharashtra	7322	22080
Manipur	306	174
Meghalaya	114	268
Mizoram	264	236
Nagaland	234	461
Orissa	2024	2721
Puducherry	122	415
Punjab	3123	4100
Rajasthan	5389	6500
Sikkim	53	89
Tamil Nadu	12814	15437
Telangana	2112	8634
Tripura	310	450
Uttar Pradesh	12007	15500
Uttaranchal	1170	1589
West Bengal	2938	7700
Total / Average	**84475**	**147613**

Waste characteristics

Waste is characterized as undesirable and unusable materials and is viewed as a substance that is of no utilization. Waste that we find in our environmental elements is otherwise called trash. Trash is considered as a strong waste that incorporates waste from our homes (homegrown waste), waste from schools, workplaces, and so on (civil waste) and waste from ventures and production lines (modern waste). It can be anything from household garbage to industrial effluents, batteries, electronics, construction materials, and more. Waste can be solid, liquid, or gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological, household, municipal, organic, biomedical, radioactive wastes. In some cases, waste can pose a threat to human health. Health issues are associated throughout the entire process of waste management. Health issues can also arise indirectly or directly. Directly, through the handling of solid waste, and indirectly through the consumption of water, soil and food. Waste is produced by human activity, for example, the extraction and processing of raw materials. Waste management is intended to reduce adverse effects of waste on human health, the environment, planetary resources and aesthetics.

Types of Wastes

Besides the classification based on their **sources of matter**, such as **Solid waste, Liquid waste, and Gaseous/ e waste,** waste can also be classified as biodegradable and non-biodegradable. In general, the waste might be ordered into the accompanying classes:

Solid Waste– These are the undesirable substances that are disposed of by human culture. This incorporates rubbish or trash from families, schools, workplaces, commercial centers, cafés and contains things like food trash, utilized plastic sacks, soft drink jars and plastic water bottles, broken furnishings, broken home apparatuses, clothing This includes metropolitan, rural, biomedical, and radioactive waste.

Liquid Waste- Wastes created from washing, flushing, or fabricating cycles of ventures are called fluid wastes.

Gaseous Waste--These are the wastes delivered as gases from cars, plants, or consuming non-renewable energy sources like oil. They get blended in different gaseous climates and sporadically cause occasions like brown haze and corrosive downpour.

Figure 2- Types Of Waste

Biodegradable Waste- Waste that consists of organic matter is referred to as biodegradable waste. Food and paper are perfect examples. Major sources of biodegradable waste are households and some types of commercial establishments such as restaurants, hotels, food processing units etc. Some biodegradables can also come from industries, animal farms, and agricultural farms.

Non-Biodegradable Waste- Non-biodegradable waste cannot be further decomposed via the action of the microorganisms. Such waste is the major source of toxins in the landfills. Chemicals, metals, plastics, paints, rubber, etc. are examples of non-biodegradable wastes. These materials can remain in landfills for thousands of years without any damage. Toxins from metals and plastics get soaked into the earth and pollute the soil and water sources

Hazardous waste - Hazardous waste is waste that is dangerous or potentially harmful to our health or the environment. Hazardous wastes can be liquids, solids, gases, sludge, discarded commercial products or the by-products of manufacturing processes**.**

Non-hazardous waste: It is any waste that does not cause harm to people or the environment, and regulations for disposal of non-hazardous waste are less strict. For non-hazardous waste transfer, a waste transfer note must be filled out and kept on record. In its simplest form, non-hazardous waste is any waste that cannot be classified as hazardous.

Household/Domestic Waste

Domestic waste is garbage and waste materials discarded from households. It can include food materials, plastics, cardboard, rubber, metal, paper, wood, fabric, chemicals, etc. Domestic waste can be organic or inorganic. Most of the food waste generated in domestic premises is organic. Batteries, electronics, and metals are inorganic waste.

Industrial Waste:-Every industry contributes to environmental waste that gets added to the soils and landfills on the planet. The industrial waste can be in the form of solids, liquids, and gases. The sources of industrial waste are the power generation plants, metal processing industries, cement plants, iron and steel manufacturing industries, manufacturing units for leather goods, food packaging, chemicals, transport equipment, resins, plastics, and paper. Even water treatment plants generate industrial waste. Industrial solid waste contains metals, chemicals, plastics, demolition materials, medical trash, ashes, packaging, and other hazardous materials. Sludge from industries contains toxins, which are harmful to the environment.

E- waste: The type of solid waste, perhaps the fastest-growing component in many developed countries, is electronic waste, or e-waste, which includes discarded computer equipment, televisions, telephones, and a variety of other electronic devices. Concern over this type of waste is escalating. Lead, mercury, and cadmium are among the materials of concern in electronic devices, and governmental policies may be required to regulate their recycling and disposal.

Agricultural Waste -- Agricultural waste refers to waste generated due to agriculture-based activities or operations. Chemicals from fertilizer Pesticides and chemicals, harvest wastes from agricultural activities, and fertilizer run-offs from fields are various types of agricultural waste. It also includes waste from slaughterhouses, poultry farms, feedlots, vineyards, dairies, and agricultural farms. Fertilizer run-offs are a major source of waste that pollutes local water sources and soil, and oceans in a major way.

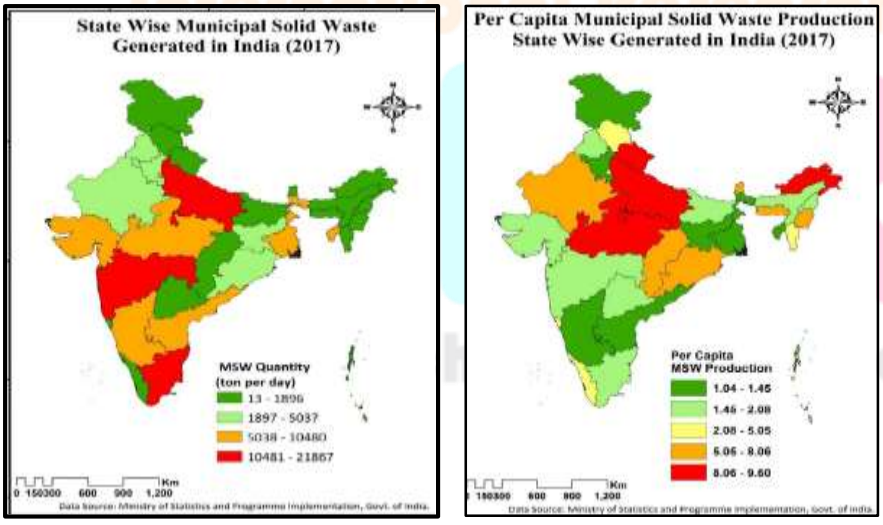
Commercial Waste – Commercial waste refers to the waste from commercial or business establishments. Any trash or waste material from restaurants, hotels, markets, or offices is commercial waste. Industrial and domestic waste is not included in this category. Any waste generated from the premises or places of business or trade is termed commercial waste. Paper, food, plastics, glass, fabrics, and even toxins are examples of commercial waste.

Chemical Waste-Chemical waste includes any waste material consisting of chemicals. Its sources include industries, farms, commercial establishments, and even households. Cleaners and refrigerants are examples of household chemical waste. Both industrial and domestic use of batteries can be harmful without proper recycling of waste. Television tubes, computers, and components of appliances contain chemicals that contribute to chemical-based pollution. Lead and mercury from electronic parts can seep into the soil, thus increasing toxicity in soil and water.

Waste Generation and Its Characteristics

Waste generation rate depends on many factors, such as population density, economic status, per Capita Income, economic development and Industrial development, cultural and individual behavior of the society. It provides data on MSW generation in different states, indicating high waste generation in Maharastra (21867 tonnes per day), Tamil Nadu (14500 tonnes per day), Gujarat (10480 tonnes per day), Karnataka (8697 tonnes per day), Delhi (8370 tonnes per day). Lowest waste generation occurs in Arunachal Pradesh (13 tonnes per day), Lakshadweep (21 tonnes per day), Sikkim (49 tonnes per day), Daman & Diu (85 tonnes per day).

Figure3:State wise MSW generation in India **Figure 4: Per capita MSW production (Statewise)**



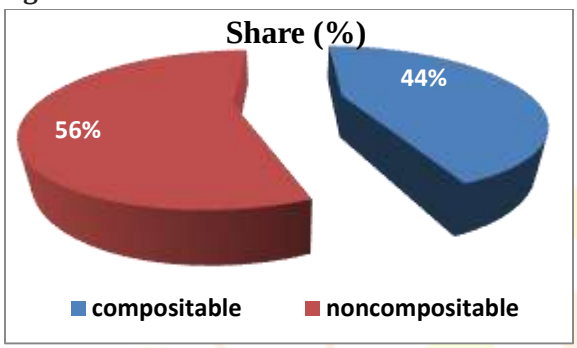
Source: MoHUA, 2019

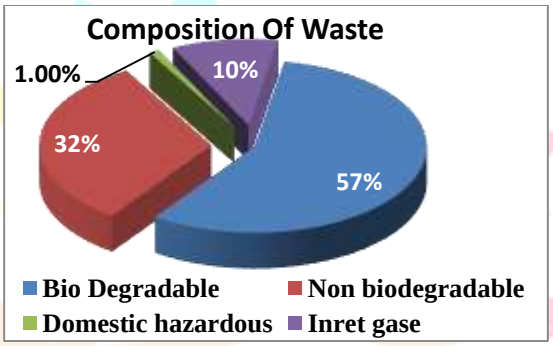
Estimating the quantity and characteristics of MSW in India and forecasting waste generation is vital for a successful waste management planning. The quantity of MSW generated also depends on various contributing factors like living standards, type of commercial activities and their scale, individual choices of the society like eating habit, reuse and recycling etc.

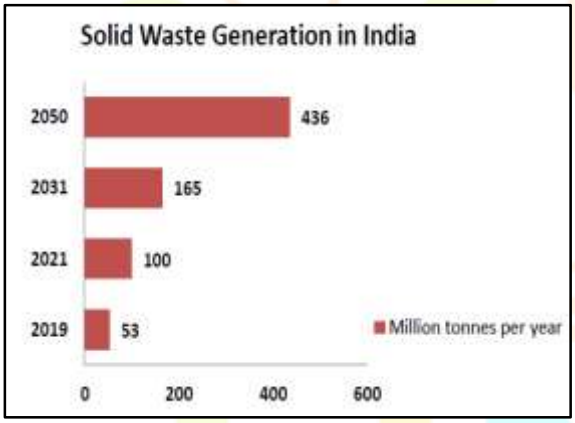
Waste Characterization data

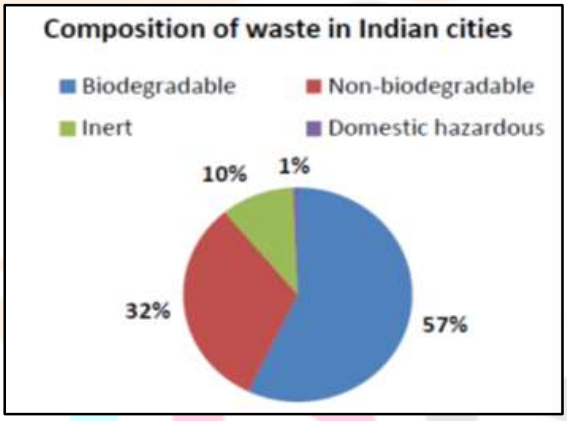
Economy and commercial activity impacts the composition of waste, as high income groups use more packaged products, resulting in higher volumes of plastics, paper, glass, metal and textiles. Changes in waste composition can have impact on waste management practices. The average composition of MSW produced by Indian cities is approximately 44 weight percentage organic waste which is compostable, rest is non-compostable around 56 weight percentage, out of which 40 weight percentages is sluggish and 16 weight percentage potentially recyclable materials. Organic waste is mostly sourced from households where as inert waste is generated from construction, demolition and road sweeping. Inert waste which is almost 40 weight percentage is generally landfilled. In 2016 however, MoEF &CC notified the Construction and Demolition (C&D) Waste Management Rules. Construction and Demolition (C&D) waste should not be considered as waste but a resource. These should be recovered, recycled and reused. Construction and Demolition (C&D) waste should be segregated into various categories like concrete, soil, steel and wood, plastics, bricks and mortar.

Fig. – 5 & 6









Waste Management

Waste management (or waste disposal) includes the processes and actions required to manage waste from its initiation to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms. The aim of waste management is to reduce the dangerous effects of such waste on the environment and human health. A large part of waste management deals with Municipal Solid Waste, which is created by industrial, commercial, and household activity.

Solid waste management (SWM) has arisen as one of the most massive developmental challenges in urban India. Number of studies indicates that the unsafe disposal of waste generates dangerous gases and leachates, due to microbial decomposition. According to the 12th Schedule of the 74th Constitution Amendment Act of 1992, Urban Local Bodies (ULBs) are responsible for keeping cities and towns clean. However, most ULBs lack adequate infrastructure and face various planned and institutional weaknesses, such as poor institutional capacity, financial constraints, and a lack of political will.

WASTE SEGREGATION

Segregated waste is also cheaper to dispose of because it does not require as much manual sorting as mixed waste. This is the separation of wet waste and dry waste. The purpose is to recycle dry waste easily and to use wet waste as compost. When segregating waste, the amount of waste that gets landfilled reduces considerably, resulting in lower levels of air and water pollution. Importantly, waste segregation should be based on the type of waste and the most appropriate treatment and disposal. This also makes it easier to apply different processes to the waste, like composting, recycling and burning. It is important to practice waste management and segregation as a community work. One way to practice waste management is to ensure awareness among common public.

Municipal Solid Waste (MSW) or Solid Waste

All non-hazardous solid waste from a community that requires collection and transport to a processing or disposal site is called **refuse or Municipal Solid Waste (MSW)**. This refuse includes garbage and rubbish. Garbage is mostly decomposable food waste; rubbish is mostly dry material such as glass, paper, cloth, or wood. Garbage is highly decomposable, whereas rubbish is not. Trash is rubbish that includes bulky items such as old refrigerators, couches, or large tree stumps. Trash requires special collection and handling. Construction and demolition (C&D) waste (or debris) is a significant component of total solid waste quantities, although it is not considered to be part of the MSW stream. However, because C&D waste is inert and nonhazardous, it is usually disposed of in municipal sanitary landfills.

Separation of Solid Waste

One key aspect of efficient Solid Waste Management is "Waste Segregation." It has now been made mandatory for waste generators to deposit their waste in colour-coded bins—blue for dry waste and green for wet waste—to ensure proper recovery, reuse and recycling. Wet waste is used for composting or biomethanation in a decentralised manner. Tamil Nadu has achieved 100 percent segregation in 20 of its 50 smaller municipalities, and 80–90 percent in the rest. However, in most states, the mixing of segregated and unsegregated waste remains a serious problem. To motivate people to segregate their waste, the MoHUA launched a "Source Segregation Campaign" on World Environment Day 2017, under the Swachh Bharat Mission. Under this Campaign, all cities and towns were to adopt "source segregation" as a mass movement. About 63,204 wards (74.82%) have achieved 100% waste segregation at the household level as of January 2019. In Chhattisgarh and Kerala, all households in all wards have successfully adopted the practice of waste segregation. Amongst the UTs, Daman & Diu and Dadra & Nagar Haveli have achieved 100% source segregation.

Table : 100% Source Segregation by Wards under SBM, as of January 2019

State/ UT's	Total Wards	Ward with 100% source segregation
Andhra Pradesh	3409	3300
Andaman & Nicobar	24	23
Arunachal Pradesh	75	11
Assam	943	368
Bihar	3377	1107
Chandigarh	26	24
Chhattisgarh	3217	3217
Daman & Diu	28	28
Dadar & Nagar Haveli	15	15
Delhi	294	50
Goa	217	173
Gujrat	1427	1187
Haryana	1496	935
Himanchal Pradesh	497	490
Jammu & Kashmir	1081	137
Jharkhand	932	1187
Karnataka	6464	935
Kerala	3536	490
Madhya Pradesh	7115	6346

Maharashtra	7322	7005
Manipur	306	196
Meghalaya	114	27
Mizoram	264	230
Nagaland	234	30
Orissa	2024	1402
Puducherry	122	116
Punjab	3123	2664
Rajasthan	5389	4419
Sikkim	53	50
Tamil Nadu	12814	10891
Telangana	2112	1008
Tripura	310	243
Uttar Pradesh	12007	8294
Uttaranchal	1170	669
West Bengal	2938	558
Total / Average	84475	63201

Solid waste is usually separated into three categories:

(i) Bio-degradable waste or organic waste (food and kitchen waste, green waste vegetables, flower, leaves, fruits and paper, etc.),
(ii) Inert and non-biodegradable waste (construction and demolition waste, dirt, debris, etc.)
(iii) Recyclable waste (plastic, paper, bottles, glasses, etc.).

According to the report of the Task Force of the Planning Commission puts biodegradable waste at 52%, followed by inert and non-biodegradable component at 32%. The proportion of recyclable waste is 17% increased steadily over the years. According to available data in some cities, biodegradable waste fluctuates between 55 and 60% per year.

The increasing quantity of plastic waste has become a substantial challenge and is a major contributor to environmental degradation. India generates 26,000 tonnes per day (TPD) of plastic waste, i.e. 9.4 million tonnes per annum. To address this issue, the National Green Tribune (NGT) has directed the Central Pollution Control Board (CPCB) to implement a strict ban on the import of plastic waste in India, since it is toxic to the environment. Moreover, massive plastic collection drives have been conducted, and as of 21 October 2019, a massive 4,024 MT of plastic waste has been collected with the help of over 6.41 crore citizens. Much of this non-recyclable plastic is used in constructing the roads and furnace oil.

Waste Collection and Transport

Waste collection and transport are essential elements of SWM. But unfortunately only 75–80 %of the total municipal waste gets collected and only 22–28% of this is processed and treated. A large portion of the collected waste is often dumped indiscriminately, clogging the drains and sewerage systems. These also become breeding grounds for rodents and insects, which are vectors of deadly diseases. According to a study released by ICRIER in January 2019, Delhi has the lowest collection of garbage (39 percent) while Ahmedabad has the highest (95 percent).

The country's informal sector plays a huge role in waste management. However, informal-sector workers are not officially recognised and lack legal status and protection. They collect more than 10,000 tonnes of reusable waste every day, without protective equipment such as gloves and masks, and often even the essentials of uniforms and shoes.

The new SWM rules of 2016 have mandated the door–to-door collection of segregated waste, with waste generators obligated to pay a "user fee" to the waste-collectors. However, the rules do not provide details on how the fee is decided—whether it is charged based on the quantity or type of waste generated. According to the "Swachhata Sandesh Newsletter," 81,135 wards (96.05 percent) out of 84,475 wards across India have achieved 100 percent door-to-door waste collection as of January 2020, including all wards in Andhra Pradesh, Arunachal Pradesh, Chhattisgarh, Goa, Gujarat, Karnataka, Madhya Pradesh, Mizoram, Rajasthan,

Sikkim and Uttarakhand. All UTs, too, now have 100 percent provision of door-to-door collection. At the city-level, Mysuru has made significant progress in this area, as well as in source segregation. Mumbai and Chennai have achieved 80 percent door-to-door collection.

Fig.7 : 100% Door-to-Door Collection by Wards & Total Waste Processing% under SBM, as of January 2019

State/ UT's	Total Wards	Ward with 100% source segregation	Total Waste Processing %
Andhra Pradesh	3409	3409	63
Andaman & Nicobar	24	24	95
Arunachal Pradesh	75	75	00
Assam	943	698	53
Bihar	3377	3276	51
Chandigarh	26	26	95
Chhattisgarh	3217	3217	90
Daman & Diu	28	28	75
Dadar & Nagar Haveli	15	15	100
Delhi	294	294	55
Goa	217	217	70
Gujrat	1427	1427	87
Haryana	1496	1401	48
Himanchal Pradesh	497	490	78
Jammu & Kashmir	1081	809	16
Jharkhand	932	897	60
Karnataka	6464	6464	54
Kerala	3536	3022	71
Madhya Pradesh	7115	7115	87
Maharashtra	7322	6590	58
Manipur	306	270	58
Meghalaya	114	27	4
Mizoram	264	264	35
Nagaland	234	148	60
Orissa	2024	2009	48
Puducherry	122	122	13
Punjab	3123	3064	61
Rajasthan	5389	5389	72
Sikkim	53	53	70
Tamil Nadu	12814	12429	68
Telangana	2112	2020	78
Tripura	310	277	53
Uttar Pradesh	12007	11872	58
Uttaranchal	1170	1170	46
West Bengal	2938	2527	9
Total / Average	**84475**	**81135**	**80**

Source: MoHUA, 2020

The **transportation of solid waste** is yet another challenge, since many cities lack proper transport facilities. The vehicles typically used for primary collection are handcarts or tricycle with containers or bins, tricycle with hydraulic tipping containers, light commercial vehicles (mini truck) with hydraulic tipping containers, four-wheeled mini trucks with international standard garbage collection bins. The selection of vehicles usually depends on various factors such as the quantity of waste, distance, road width and condition, and process technologies. To save travel time, minimise human errors, and improve the monitoring system, many ULBs have installed Global Positioning System (GPS), Geographic Information System (GIS) and Global System for Mobile Communication in their trucks to collect waste from secondary sources for waste disposal.

Processing, Treatment and Disposal of Solid Waste

The processing technologies currently adopted in India include composting, bio methanation, recycling, refuse-derived fuel, incineration, pyrolysis, waste-to-wealth and waste-to-energy. Which technology is used

depends on a variety of factors: the kind and quantity of waste available and its calorific value, fund and resource availability, capital investment, cost recovery, in-house capacity of ULBs, land availability, and environmental sensitivity to locations. Chhattisgarh processes the highest proportion of waste (90%) amongst all states, while Meghalaya processes the lowest (four percent). Amongst the UTs, Dadra & Nagar Haveli processes 100 percent waste, whereas Chandigarh processes 95 percent. Delhi processes only 55 percent, which is below the average of 60 percent across 84,475 wards. Large quantities of waste are usually processed through either biomethanation or **composting technology** for generating biogas, electricity and compost. Biogas has 55–60 percent methane and can be used as fuel for power generation. For the treatment of biodegradable waste, the commonly adopted methods are aerobic composting and vermicomposting. This compost is used for growing vegetables and plants in homesteads.
A key component of composting is the efficient segregation of waste, which has becomes a constraint in India, where mixed waste is often dumped in open areas. (This is also a major contributor to global warming.) Segregation can help reduce the burden of transportation of waste as well as lower leachate and greenhouse gas (GHG) emissions. If the waste is segregated at source, various components can be utilised in different types of production processes, generating marketable use value.

Source segregation of waste helps in recovering and utilising a higher percentage of recyclable waste. Dry waste contains several non-recyclable components, such as plastic bags, laminated metallized plastics shredded paper and textiles. While glass, plastics and metals are recyclable, paper is both recyclable and biodegradable. Currently, "seven million tons of paper is being consumed in India for packaging, of which only 33 percent is being collected and recycled." Used newspapers, textbooks, magazines etc. are either used for making paper bags or recycled to produce newsprint and writing or printing papers. The reuse and recycling of plastic require little energy during production. Shopping bags can be converted to eco-friendly recycled products.

The 2016 SWM Rules define recycling as "**the process of transforming** segregated solid waste into a new product or a raw material for producing new product." Reusable and recycled waste constitutes 18–20 percent of the total waste, and the process of separating them from mixed waste is both energy- and time-intensive. Recyclable material is generally collected by rag pickers, waste-pickers, wandering waste buyers, dealers and recycling units, which reduces the volume of waste and saves the cost of collection, transportation and disposal; lowers the burden on landfill sites; and reduces pollution and other environmental impacts. Moreover, recycling has significant economic benefits, such as reducing the need for import of raw materials and fertiliser, and providing livelihood opportunities for recyclers. From an economic perspective, recycling pays only when the additional cost of collection materials, sorting them for recycling, and recycling and marketing them is recovered from the recycled product.

Disposal of Solid Waste

Waste dumping and open burning continue to be the principal methods of waste disposal in India. Most of the cities and towns dispose of their waste by depositing it in low-lying areas outside the city. The report of the Planning Commission of 2014 found that over 80 percent of the waste collected in India is disposed of indiscriminately in dump yards in an unhygienic manner, leading to health and environmental degradation.

Landfilling technology is frequently used for the disposal of waste in India. However, the dumping grounds are often unsustainable as landfills, since they have no foundations, liners, levelling, cover soil, leachate management or treatment facility. A widely used technology for recycling residual waste (RDF) is which uses combustion to provide heat and power. Adopting recycling with this technology can significantly reduce dumping in India. RDF for resource recovery is not only an economically viable option for solid waste but also greatly reduces the requirement for landfill space.

Emerging Challenges in SWM

India is the third-largest producer of solid waste, after China and the United States. It faces significant challenges associated with waste collection, transportation, treatment and disposal. ULBs are -equipped to

handle the increasing quantity of waste, which is a direct result of India's ever-increasing urban population and average income, leading to drastic changes in the consumption pattern in cities. The key challenges in India are as below:

1. Lack of waste segregation and doorstep collection,
2. The use of inappropriate technologies for treatment, and
3. The indiscriminate disposal of waste.
4. Conflicting Data on the waste generation in India is, as there is no system of periodic data collection on waste generation.
5. ULBs failed to establish systems and technologies required for segregation, collection and processing of different categories of waste.
6. There is a lack of public awareness regarding the process of segregation.
7. Waste collection efficiency is low in India, due to non-uniformity in the collection system except in case of private contractors and non- governmental organizations.
8. Waste to Energy (WtE) is a widely used technology in India, but most Waste to Energy plants cannot function effectively due to operational and design issues.
9. Local authorities lack adequate funding and infrastructure. Thus, they are unable to adopt innovative and appropriate technologies for waste treatment and disposal.
10. Most cities and towns in India dispose of their waste by depositing it in low-lying areas outside the city, without taking adequate precautions.
11. There is a lack of proper planning and in digitization of sophisticated waste process facilities, as well as the provision of regular training to waste-collectors.

RECOMMENDATIONS

In order to have a satisfactory, efficient, and a sustainable system of solid waste management, the following aspects need consideration.

- Targeting waste reduction at source
- Technological recommendation
- Efforts towards institutional and regulatory reforms.

I- Targeting Reduction at Source

Waste reduction at source can be accomplished in three ways: (1) fees and tax incentives to promote market-mechanisms to effect source reduction, (2) mandatory standards and regulations, and (3) education and voluntary compliance with policies by business and consumers

- ***Market actions for waste reduction***

By charging for the environmental and economic costs of production and disposal of waste upfront, market forces can be employed to improve the efficiency of waste management. By incorporating the cost of disposal also in the production cost, tendency to use less packaging or adoption of the recyclable/reusable packaging material would be promoted. At the consumer end also the tendency to reuse the material would be promoted.

- ***Mandatory standards for waste reduction***

Setting mandatory standards could make business responsible for the waste it generates. For instance, Germany has implemented a mandatory recycling programme in which, theoretically, the seller of consumer goods must take back all the package waste that is produced. In India the regulatory agencies should take the lead in setting up rules prescribing targets for waste reduction in various manufacturing sectors.

- ***Education and voluntary compliance***

The alternative policy consists of a voluntary programme of consumer education and business initiatives. One of the tools to achieve this could be adoption of EMS (Environmental Management System) which is necessarily a voluntary initiative. The industries adopting EMS have achieved economic benefits also while achieving better environmental performance.

II - Technological Recommendations

India has lagged behind in terms of adopting technologies for solid waste management. In particular, collection, treatment and disposal of waste require urgent consideration.

- ***Collection of waste***

The preferred option would be to revamp the existing collection service structure to provide community with waste bins, conveniently placed for the people to deposit domestic waste, and door to door collection of waste. This along with separation of waste, at source, into biodegradable and non-biodegradable components would not only reduce the cost of transportation for final disposal but also provide segregated organic waste stock for waste to energy activities.

- ***Treatment and disposal***

Proper segregation of waste would lead to better options and opportunities for its scientific disposal. Recyclables for example, could be straightaway transported to recycling units, which, in turn, would pay the corporations for it, thereby increasing their income. Finally, the inert material that will be required to be sent to landfill would be of much lower quantity compared to un-segregated waste, consequently increasing the life of our existing disposal facilities.

III- Institutional And Regulatory Reforms

The financial constraints, institutional problems within the departments, fragile links with other concerned agencies, lack of suitable staff, and other allied problems prevent the urban local bodies from delivering and maintaining an efficient waste management system. In this context, it is also necessary to harness and integrate the role of three other emerging actors in this field—the private sector, NGO's, and rag pickers—into the overall institutional framework.

The private sector is now becoming a key player in a number of industrialized nations. Private sector participation can help upgrade technical and managerial expertise, increase efficiency in operation and maintenance, improve customer services, apart from bringing in the capital to support the government in its efforts at waste management. There is a strong case for comprehensively involving the private sector and encouraging it to invest in waste management in India. Private entrepreneurs in India are entering into activities like the collection and transportation of waste, and lately into treatment processes. Private companies can, along with door-to-door collection, take on such tasks as secondary collection and transportation including vehicle-maintenance.

Non-governmental organizations can play an important role in effectively projecting the community's problems and highlighting its basic requirements for urban services. They could help in organizing the ragpickers into waste-management associations/groups under the supervision of the urban local body and the relevant residents' associations or market associations.

CONCLUSION

The disposing activities of the garbage in the open dumping practices are prevalent around the country. Some of the commonly practiced methods by which waste could be managed are: burning, land filling and composting (Narayana, 2009). But these methods have been found largely inefficient and harmful not only to the environment and humans but to the innocent animals. The disposal activities lead to land degradation, air pollution, and water pollution. The quantity and the characteristics of the waste might vary from place to place.

There are many reasons which are directly and indirectly contributing to the enormous quantity of the solid waste worldwide and becoming one of the most important environmental problems for the global community. Some of the key contributors in this problem are exponential increase in population, indiscriminate natural resource exploitation, economic and industrial development, increased per capital income and consumerism. Indiscriminate and unsustainable usage of resources has not only stressed out our natural resources but created menace of huge waste generation. The amount of waste generated has direct correlating with the amount of resource exploitation.

In India our current waste disposal practices and attitude is to just get rid of the waste and throw it away. Improper disposal of waste not only causes pollution, it affects ground water, local flora and fauna, causes many diseases and has

huge environmental and economic cost. We need to change our attitude and waste management techniques, both at individual and implementation level. We need to adopt scientific, sustainable, environment friendly as well as cost effective solutions. Considering the present urban trends, it's not the least bit shocking to say that the Municipal Solid Waste quantum in India will see a rise of double the present volumes by ten years down the line.

The SWM system in India is in a critical state, as ULBs have largely failed to manage solid waste efficiently. Being heavily dependent on the state governments for funding, these local bodies lack the resources to acquire new land or obtain the technologies required for SWM. Moreover, waster pickers, who are key workers in the industry, lack legal status and protection, and are hardly effective or capable of enforcing systems in the collection and segregation of waste. For the situation to improve, institutional and financial issues must be addressed on priority. To enhance the efficiency of SWM in India, citizen participation should be promoted, especially in source segregation and treatment processes. The policy agenda for sustainable SWM must drive behavioral change amongst citizens, elected representatives and decision-makers, to minimize wastage and littering, and increase reuse and recycling. Community awareness and a change in people's attitudes towards solid waste and their disposal can go a long way in improving India's SWM system.Proper regulations for waste management and recycling are required to control the damage from the pollution caused by waste generated from everywhere. Without them, pollution control will remain an utopia.

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