Solid Waste Management

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Abstract: Solid wastes are all the wastes arising from human activities that are normally solid and are discarded as useless or unwanted. The discarded waste materials are often reusable and may be considered as resource in another setting. Solid Waste Management (SWM) is to manage the society's waste in a manner that meets public health and environmental concerns and the public's desire to reuse and recycle waste materials. The quantity of solid – wastes produced generally depends upon the living standards of the population. Solid waste includes domestic wastes, municipal wastes, commercial wastes, garbage, rubbish, ashes, construction and demolition wastes, industrial wastes, hazardous wastes, hospital wastes and sewage. The paper focus on need for SWM, types of waste, Status of Municipal Solid Waste (MSW) in Indian cities, Problem associated with the MSW system. Solid waste management is one among the basic essential services provided by municipal corporations in India to keep urban areas clean. However, it is among the most poorly delivered services- the systems applied are unscientific, outdated, inefficient and the population coverage is low. The paper highlight drawbacks in present SWM Services in India and reasons for Inadequacy and Inefficiency in Services. The paper also discuss Initiatives to improve SWM in India by Government of India (GOI) and source of waste generation and action to be taken for waste management at source.

Keywords: SWM, MSW

1. INTRODUCTION

Cities are indifferent to waste quality because fort decades that have been used to zero disposal cost: dump it outside city limits and forget it. Current privatization of waste processing by composting or bio-methanation leaves cities with no interest in or incentive to improve collection of unmixed wastes to save eventual ones. There has been fairly good progress on all the early stages of the waste management cycle, despite excessive dependence on mechanical transport of easily corroded roadside steel containers. 20% of inert waste has to be disposed off through land filling techniques. There is still very little composting, and almost no land filling. Though a few cities have constructed costly land-fills with waterproof lining and in- built piping for gas venting and leachate collection, these lie empty as cities are reluctant to 'shorten the life' of their landfills by using them. Instead they shorten the life of local residents by open dumping outsides these landfills.

Land filling is most important issue of solid waste management in India and Asia at large. Especially in the regional context, sustainable, effective and most efficient ways of final disposal are most sought after. Given the standards of the industrialized world the regional settings and capabilities do not permit a direct transfer of experiences and design criteria. Consequently processes and procedures for a sound and sustainable landfill management are urgently needed.

Table 1. Classification of Waste and Sources

Types of waste	Description	Sources
Ashes & Residues	Residues from fire used for Cooking and for heating building Cinders, clinkers, thermal power plants	Household, Hospital, Institutions, Restaurant, Hotels, Dhaba.
Bulk Waste	Large auto parts, types, and stoves Refrigerators, other large Appliances furniture large crates trees, branches etc.	
Street Waste	Street sweepings, dirt, leaves, Animal droppings.	Streets, sidewalks, vacant Plots
Dead animals	Small animals cats, dogs, poultry Etc. Large animals horse cow etc.	
Construction & Demolition waste	Large roofing scrap, rubble, broken concrete, plaster, pipe etc.	Construction and demolition sites, remodeling, repairing sites
Industrial Waste and Sludge	Solid waste resulting from industry processes and manufacturing operations such as food processing waste, effluent treatment plant sludge of industry and sewage treatment plant screening grit and septic tank	Factories, power plants treatments plant.

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Hazardous Waste	Hazardous waste: pathological Waste, etc.	Household, Hospital, Institutions stores.
Food Waste (Garbage)	Waste from the preparation, cooking, and serving of food	
Rubbish	*Combustible* (Primary organic) Paper, cardboard, wood, boxes Plastics, rags, clothes, bedding Leather, rubber, grass, leaves *Noncombustible* (Primary Inorganic) Metals, tins, cans, stones, bricks Ceramics other minerals refuse	

1.1. Quantification of Solid Waste Generation

Quantity and characteristics of the waste are the major factors, which decide magnitude of waste management problem. Future per capita quantity can be estimated with the help of projected population and annual increase of per capita quantity. On the basis of the waste quantity, infrastructure requirement can be estimated. The quantity of solid waste generation depends upon factors such as standard of living, food habits and degree of commercial activities and the quality of the waste. The generation of MSW in various countries is given in Table 2 The waste generation per capita for Indian cities is given in Table 3.

Table 2. Generation of Municipal solid waste in various countries

	Urban MSW Generation (kg/capita/day)	
	In 1995	**In 2025**
Japan	1.47	1.30
Hong Kong	5.07	4.50
Korea	1.59	1.40
Malaysia	0.81	1.40
Indonesia	0.76	1.00
Sri Lanka	0.89	1.00
China	0.79	0.90
India	0.46	0.70
Bangladesh	0.49	0.60

Source: NEERI 1996

Table 3. Waste Generation per Capita in Indian cities

Population Range (Million)	Nos. of Urban centers (sampled)	Total Population (in million)	Average per capita value Kg/capita/day	Quantity (tones/day)
<0.1	328	68.300	0.21	14343.00
0.1-0.5	255	56.914	0.21	11952.00
0.5-1.0	31	21.729	0.25	5432.00
1.0-2.0	14	17.184	0.27	4640.00
2.0-5.0	6	20.597	0.35	7209.00
>5.0	3	26.306	0.50	13153.00

Source: NEERI 1996

The data shows that per capita waste generation ranges from 0.2 to 0.6 kg per day in the cities amounting to about 1.15 lakh MT of waste per day and 42 million MT annually. As the city expands, average per capita waste generation increases {Refer Table 4}.

Table 4. Waste Quantities and Waste Generation Rates in 1 million plus Cities

Selected Indian Cities	Waste quantity generated (MT/d)	Waste generation rate (kg/c/d/)
Lucknow	474.59	0.21
Nagpur	503.85	0.25
Dehradun	131	0.29
Ahmedabad	1302	0.37
Faridabad	448.01	0.38
Bangalore	1669	0.39
Meerut	490	0.46
Agra	653.57	0.49
Allahabad	509.24	0.51

Source: Akolkar 2005

The waste generation rates in India are lower than the low-income countries in other parts of the world and much lower compared to developed countries. However, lifestyle changes, especially in the larger cities, are leading to the use of more packaging material and per capita waste generation is increasing by about 1.3% per year. With the urban population growing at 2.7% to 3.5% per annum, the yearly increase in the overall quantity of solid waste in the cities will be more than 5%. It has been estimated that waste generation will exceed 260 million tonnes per year by 2047. **C**ities with 100, 000 plus population contribute 72.5% of the waste generated in the country as compared to other 3955 urban areas that produce only 17.5% of the total waste (Refer Table 5)

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Table 5. Waste Generation in Class 1 Cities with Population above 100, 000

Type of cities	Tonnes/day	Total garbage (%)
The 7 mega cities	21, 100	18.35
The 28 metro cities	19, 643	17.08
The 388 class 1 towns	42, 635	37.07
Total	83, 378	72.50

Source: MOUD 2005

Mega cities are above 4 million population and metro cities (also known as million plus cities) are the same as the identified cities. Class 1 cities with population in the 100, 000 to 1 million ranges are 388 in number. The quantity of solid waste depends on low, high and medium income group level and it varies from season to season and time to time. The information regarding waste quantity and density together with waste generated (by weight) is important while accessing the payload capacity of the collection equipment. It is possible to estimate the numbers of vehicles required from the collection and transportation of waste each day.

2. PROBLEMS ASSOCIATED WITH THE MSW SYSTEM

The major deficiencies associated with the MSWM system are described in the following sections:

Rapidly Increasing Areas to be Served and Quantity of Waste: The solid waste quantities generated are increasing due to rise in the population and increase in the per capita waste generation rate. The increasing solid waste quantities and the areas to be served strain the existing SWM system.

Inadequate Resources: While allocating resources including finance, SWM is assigned with a low priority resulting in inadequate provision of funds. Often there is a common budget for collection and treatment of sewage and SWM and the later receives a minor share of the funds. The inadequacy of human resource is mainly due to the absence of suitably trained staff.

Inappropriate Technology: The equipment and machinery are usually that which have been developed for general purpose. This results in underutilization of existing resources and lowering of the efficiency. A few attempts have been made to borrow the technology developed in other countries like highly mechanized compost plants, incinerator-cum-power plants, compactor vehicles etc. However, these attempts have met with little success, since, the solid waste characteristics and local conditions in India are much different from those for which the technology is developed.

Disproportionately High Cost of Manpower: Mostly out of the total expenditure, around 90% is accounted for manpower of which major portion is utilized for collection. Since citizens tend to throw the waste on the adjoining road and outside the bin, the work of the collection staff is increased. Hence, the cost of collection increases considerably.

Societal and Management Apathy: The operational efficiency of SWM depends on the active participation of both the municipal agency and the citizens. Since the social status of SWM is low, there is a strong apathy towards it, which can be seen from the uncollected waste in many areas and the deterioration of aesthetic and environmental quality at the uncontrolled disposal sites.

Low Efficiency of the System: The SWM system is unplanned and is operated in an unscientific way. Neither the work norms are specified nor the work of collection staff appropriately supervised. The vehicles are poorly maintained and no schedule is observed for preventive maintenance. Due to shortage of financial resources, the vehicles are often used beyond their economical life resulting in inefficient operation. Further, there is no co-ordination of activities between different components of the system. The cumulative effect of all these factors is an inefficient SWM system.

3. DRAWBACKS IN PRESENT SWM SERVICES IN INDIA

Based on the secondary data the following drawback have been identified in the existing SWM sources in India:

No Storage of Waste at Source

There is no practice of storing the waste at source in a scientifically segregated way. Citizens have not been educated to keep domestic, trade, and institutional bins for storage of waste at source and stop littering on the streets.

No System of Primary Collection from the Doorstep

There is no public system of primary collection from the source of waste generation. The waste discharged here and there is later collected by municipal sanitation workers through street sweeping, drain cleaning, etc. Street sweeping has, thus become the principal method of primary collection.

Irregular Street Sweeping

Even street sweeping is not carried out on a day-to-day basis in most cities and towns in India. Generally commercial roads and important streets are prioritized and rest of the streets are swept occasionally or not swept at all. Generally, no sweeping is done on Sundays and public holidays and a back log are created on the next working day.

The tools used for street sweeping are generally inefficient and out-dated. For instance, the broom with a short handle is still in use forcing sweepers to bend for hours resulting in fatigue and loss of productivity. Traditional handcarts/tricycles are used for collection, which do not synchronize with the secondary storage systems. Waste is deposited on the ground necessitating multiple handling.

There are no uniform yardsticks adopted for street sweeping. Though, some states/cities have prescribed work-norms, these

are not very scientific. Most of the cities allocate work to sanitation workers on Temporary basis. The work distribution ranges between 200 metres to 1000 metres of street sweeping each day. Some sanitation workers are found under worked while some over- burdened.

Waste Storage Depots

As waste is collected through traditional handcarts/tricycles that can carry only a small quantity of waste at a time, there is a practice to set up depots for temporary storage of waste to facilitate transportation through motorized vehicles. Generally, open sites or round cement concrete bins, masonry bins or concrete structures are used for temporary bulk storage, which necessitates multiple handling of waste. Waste an often spill over which is both unsightly as well as unhygienic.

Transportation of Waste

Transportation of waste from the waste storage depots to the disposal site is done through a variety of vehicles such as bullock carts, three-wheelers, tractors, and trucks. A few cities use modern hydraulic vehicles as well. Most of the transport vehicles are old and open. They are usually loaded manually. The fleet is generally inadequate and utilization is not proper. Inefficient workshop facilities do not do much to support this old and deep squad of dirty vehicles. The traditional transportation system does not match with the system of primary collection and secondary waste storage facilities and multiple manual handling of waste results.

Processing of Waste

Generally no processing of municipal solid waste is done in the country. Only a few cities have been practicing de-centralized or centralized composting on a limited scale using aerobic or anaerobic systems of composting. In some towns un-segregated waste is put into the pits and allowed to decay for more than six months and the semi-decomposed material is sold out as compost. In some large cities aerobic compost plants of 100 MT to 700 MT capacities are set up but they are functioning much below installed capacity. A few towns are practicing vermi-composting on a limited scale.

Disposal of Waste

Disposal of waste is the most neglected area of SWM services and the current practices are grossly unscientific. Almost all municipal corporations deposit solid waste at a dump-site situated within or outside the city haphazardly and do not bother to spread and cover the waste with inert material. These sites originate foul smell and become breeding grounds for flies, rodent, and pests. Liquid seeping through the rotting organic waste called leachate pollutes underground water and poses a serious threat to health and environment.

3.1. Reasons for Inadequacy and Inefficiency in Services

Role of Municipal Corporations in MSWM: Though municipal corporations have held the responsibility of managing solid waste from their inception over three centuries ago, the issue rarely got the attention it deserved. Elected representatives as well as the municipal authorities generally transfer the responsibility of managing municipal solid waste (MSW) to junior officials such as sanitary inspectors. Systems and practices continue to be outdated and inefficient. No serious efforts are made to adopt latest methods and technologies of waste management, treatment and disposal. Though a large portion of the municipal budget is allotted for solid waste management, most of it is spent on the wages of sanitation workers whose productivity is very low. There are no clear plans to enhance their efficiency or improve working conditions through the provision of modern equipment and protective gear.

Almost all the 3955 towns with population below 100, 000 run SWM services rather unprofessionally. They depend on sanitary inspectors to manage solid waste with the help of sanitation workers. In many small towns, even qualified sanitary inspectors are not posted and services are left in the hands of unqualified supervisors. The situation of cities with 100, 000 plus population is somewhat better, though far from satisfactory. In these cities, generally there are health officers who head the SWM department. In some of the larger cities qualified engineers supervise SWM seeking technical inputs from doctors as well.

Absence of Community Participation: Community sharing has a direct bearing on efficient SWM. Yet, the municipal corporations have failed to mobilize the community and educate citizens on the basics of handling waste and proper practices of storing it in their own bins at the household-, shop- and establishment-level.

In the absence of a basic facility of collection of waste from source, citizens are prone to dumping waste on the streets, open spaces, drains, and water bodies in the vicinity creating insanitary conditions. Citizens assume that waste thrown on the streets would be picked up by the municipality through street sweeping. For the general public, which is quite indifferent towards garbage disposal etiquette, the responsibility of keeping the city clean is entirely on the ULBs. This mind set is primarily responsible for the unscientific systems of waste management in the country.

4. INITIATIVES TO IMPROVE SWM IN INDIA

The Government of India (GOI) has taken several initiatives in the recent years to improve the existing SWM practices in the country. Some of the key initiatives and recommendations are discusses in this section.

Honourable Supreme Court of India Recommendation: In recent years, the current SWM system in India has got considerable attention from the Central and State Governments, and local municipalities. The first initiative was

taken by the Honourable Supreme Court of India in 1998, which result in formation of a committee to study the current status of SWM. This Committee identified the deficiencies in the existing SWM system in the country and prepared the interim Report on SWM Practices in Class- I cities. Class I cities are those cities with a population ranging between one lakh to ten lakhs (`1, 00, 000 to 10, 00, 000).

Municipal Solid Waste Management Rules-2000: As a second initiative, the Ministry of Environment and Forests (MOEF), Government of India, Published the "Municipal Solid Waste (Management and Handling) Rules" of 2000 (MSW Rules 2000). These rules were developed in conformance with Sections 3, 6, and 25 of the Environment Protection Act, 1986, and aim at standardization and enforcement of SWM practices in the urban sector. These rules dictate that "Every municipal authority shall, within the territorial area of the municipality, be responsible for the implementation of the provisions of these rules, and for any infrastructure development for collection, storage segregation, transportation, processing and disposal of municipal solid wastes." In addition, "the CPCB shall coordinate with the State Pollution Control Boards (SPCB) and the Pollution Control Committees in the matters of MSW disposal and its management and handling".

Jawaharlal Nehru National Urban Renewal Mission: Jawaharlal Nehru national Urban Renewal Mission (in NURM) is the third notable initiative undertaken by the government of India. In NURM provides funding for urban infrastructure development in 63 cities and towns of the country. This mission has been initiated in 2006 and is slated to continue until 2011.

Urban Infrastructure Development Scheme for Small and Medium Towns: The primary objectives of this scheme are to improve the urban infrastructure in towns and cities in a planned manner and to promote public-private partnership in infrastructure development. This scheme has been introduced in 2005-06 and will continue for seven years. This scheme is applicable to all cities. Towns as per 2001 census except the cities/towns covered under the NURM. One of the components of this scheme is to renew the old sewerage and solid waste disposal systems in inner (old) city areas.

5. SOURCE OF WASTE GENERATION AND ACTION TO BE TAKEN

Table 6. Waste Management at source

Source of waste generation	Action to be taken
Household	Not to throw any solid waste in the neighbourhood, on the streets, open spaces, and vacant lands, into the drains or water bodies Keep food waste/biodegradable waste in a non -corrosive container with a cover (lid) Keep dry, recyclable waste in a bin or bag or a sack Keep domestic hazardous waste if and when generated separately for disposal at specially notified locations
Multi-storeyed buildings commercial complexes private societies	Provide separate community bin or bins large enough to hold food/biodegradable waste and recyclable waste generated in the building or society. Direct the members of the association to deposit their waste in community bin
Slums	Use co mmunity bins provided by local body for deposition of food and biodegradable waste
Shops, offices, institutions, etc	If situated in a commercial complex, deposit the waste in bins provided by the association
Hotels & restaurants	The container used should be strong, not more than 100 litre in size, should have a handle on the top or handles on the sides and a rim at the bottom for easy handling

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