Waste Management; BETCK105F/205F

M: 1 Introducing Municipal Solid Waste Management

Classification of Solid wastes (Source and Type based,)
Solid Waste Management (SWM),
Elements of SWM,
ESSWM (Environmentally sound SWM),
EST (Environmentally sound technologies),
Factors affecting SWM,
Indian scenario,
Progress in MSW (Municipal Solid Waste) management in India, Indian and global scenario of E-Waste.

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Introducing Municipal Solid Waste Management

Classification of Solid Wastes:

Solid wastes are the organic and inorganic waste materials such as product packaging, grass clippings, furniture, clothing, bottles, kitchen refuse, paper, appliances, paint cans, batteries, etc., produced in a society, which do not generally carry any value to the first user(s). Solid wastes, thus, encompass both a heterogeneous mass of wastes from the urban community as well as a more homogeneous accumulation of agricultural, industrial and mineral wastes. While wastes have little or no value in one setting or to the one who wants to dispose them, the discharged wastes may gain significant value in another setting. Knowledge of the sources and types of solid wastes as well as the information oncomposition and the rate at which wastes are generated/ disposed is, therefore, essential for the design and operation of the functional elements associated with the management of solid wastes.

Source-based classification

These include the following; Note that the density of waste changes as it moves from the source of generation to the point of ultimate disposal, and such factors as storage methods, salvaging activities, exposure to weather, handling methods and decomposition influence the density.

1. **Residential:** This refers to wastes from dwellings, apartments, etc., and consists of leftover food, vegetable peels, plastic, clothes, ashes, etc.
2. **Commercial:** This refers to wastes consisting of leftover food, glasses, metals, ashes, etc., generated from stores, restaurants, markets, hotels, motels, auto-repair shops, medical facilities, etc.
    a. **Institutional:** This mainly consists of paper, plastic, glasses, etc., generated from educational, administrative and public buildings such as schools, colleges, offices, prisons, etc.
    b. **Municipal:** This includes dust, leafy matter, building debris, treatment plant residual sludge, etc., generated from various municipal activities like construction and demolition, street cleaning, landscaping, etc.
    c. **Industrial:** This mainly consists of process wastes, ashes, demolition and construction wastes, hazardous wastes, etc., due to industrial activities.
    d. **Agricultural:** This mainly consists of spoiled food grains and vegetables, agricultural remains, litter, etc., generated from fields, orchards, vineyards, farms,etc.
    e. **Open areas:** this includes wastes from areas such as Streets, alleys, parks, vacant lots, playgrounds, beaches, highways, recreational areas, etc.

Type-Based Classification:

Classification of wastes based on types, i.e., Physical, Chemical, and Biological characteristics of wastes, is as follows;

1. **Garbage:** This refers to animal and vegetable wastes resulting from the handling, sale, and storage, preparation, cooking and serving of food. Garbage comprising these wastes contains putrescible (rotting) organic matter, which produces an obnoxious odor and attracts rats and other vermin. It, therefore, requires special attention in storage, handling and disposal.
2. **Ashes and Residues:** These are substances remaining from the burning of wood, coal, charcoal, coke and other combustible materials for cooking and heating in houses, institutions and small industrial establishments. When produced in large quantities, as in power-generation plants and factories, these are classified as industrial wastes. Ashes consist of fine powdery residue, cinders and clinker often mixed with small pieces of metal and glass. Since ashes and residues are almost entirely inorganic, they are valuable in landfills.
3. **Combustible and Non-Combustible Wastes:** These consist of wastes generated from households, institutions, commercial activities, etc., excluding food wastes and other highly putrescible material. Typically, while combustible material consists of paper, cardboard, textile, rubber, garden trimmings, etc., non-combustible material consists of such items as glass, crockery, tin and aluminum cans, ferrous and non-ferrous material and dirt.
4. **Bulky Wastes:** These include large household appliances such as refrigerators, washing machines, furniture, crates, vehicle parts, tyres, wood, trees and branches. Since these household wastes cannot be accommodated in normal storage containers, they require a special collection mechanism.
5. **Street Wastes:** These refer to wastes that are collected from streets, walkways, alleys, parks and vacant plots, and include paper, cardboard, plastics, dirt, leaves and other vegetable matter. Littering in public places is indeed a widespread and acute problem in many countries including India, and a solid waste management system must address this menace appropriately.
6. **Biodegradable and Non-Biodegradable Wastes:** Biodegradable wastes mainly refer to substances consisting of organic matter such as leftover food, vegetable and fruit peels, paper, textile, wood, etc., generated from various household and industrial activities. Because of the action of micro-organisms, these wastes are degraded from complex to simpler compounds. Non- biodegradable wastes consist of inorganic and recyclable materials such as plastic, glass, cans, metals, etc.

Biodegradable and Non-Biodegradable Wastes:Degeneration Time

Category	Type of waste	Approximate time taken to degenerate
Biodegradable	Organic waste such as vegetable and fruit peels, leftover foodstuff, etc.	A week or two week
	Paper	10-30 days
	Cotton Cloth	2-5 months
	Woolen items	1year
	Wood	10-15 years
Non-biodegradable	Tin, Aluminum, and other metal items such as cans	100-500 years
	Plastic bags	One million years
	Glass bottles	undetermined

Dead Animals:

With regard to municipal wastes, dead animals are those that die naturally or are accidentally killed on the road. Note that this category does not include carcasses and animal parts from slaughter-houses, which are regarded as industrial wastes. Dead animals are divided into two groups – large and small. Among the large animals are horses, cows, goats, sheep, pigs, etc., and among the small ones are dogs, cats, rabbits, rats, etc. The reason for this differentiation is that large animals require special equipment for lifting and handling when they are removed. If not collected promptly, dead animals pose a threat to public health since they attract flies and other vermin as they decay. Their presence in public places is particularly offensive from the aesthetic point of view.

Abandoned Vehicles:

This category includes automobiles, trucks and trailers that are abandoned on streets and other public places. However, abandoned vehicles have significant scrap value for their metal, and their valueto collectors is highly variable.

Construction and Demolition Wastes:

These are wastes generated as a result of construction, refurbishment, repair and demolition of houses, commercial buildings and other structures. They consist mainly of Earth, Stones, and Concrete, Bricks, Timber, roofing and Plumbing Materials, Heating Systems and Electrical Wires and parts of the general municipal waste stream.

Farm Wastes:

These wastes result from diverse agricultural activities such as planting, harvesting, production of milk, rearing of animals for slaughter and the operation of feedlots. In many areas, the disposal of animal waste has become a critical problem, especially from feedlots, poultry farms and dairies.

Hazardous Wastes:

Hazardous wastes are those defined as wastes of industrial, institutional or consumer origin that are potentially dangerous either immediately or over a period of time to human beings and the environment. This is due to their physical, chemical and biological or radioactive characteristics like ignitability, Corrosivity, reactivity and toxicity. Note that in some cases, the active agents may be liquid or gaseous hazardous wastes. These are, nevertheless, classified as solid wastes as they are confined in solid containers. Typical examples of hazardous wastes are empty containers of solvents, paints and pesticides, which are frequently mixed with municipal wastes and become part of the urban waste stream. Certain hazardous wastes may cause explosions in incinerators and fires at landfill sites. Others such as pathological wastes from hospitals and radioactive wastes also require special handling. Effective management practices should ensure that hazardous wastes are stored, collected, transported and disposed of separately, preferably after suitable treatment to render them harmless.

Sewage Wastes:

The solid by-products of sewage treatment are classified as sewage wastes. They are mostly organic and derived from the treatment of organic sludge separated from both raw and treated sewages. The inorganic fraction of raw sewage such as grit and eggshells is separated at the preliminary stage of treatment, as it may entrain putrescible organic matter with pathogens and must be buried without delay. The bulk of treated, dewatered sludge is useful as a soil conditioner but is invariably uneconomical. Solid sludge, therefore, enters the stream of municipal wastes, unless special arrangements are made for its disposal.

Classification of Solid Wastes:

Solid Waste Management (SWM) is associated with the control of waste generation, its storage, collection, transfer and transport, processing and disposal in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics, public attitude and other environmental considerations.

SWM has socio-economic and environmental dimensions. In the socio-economic dimension, for example, it includes various phases such as waste storage, collection, transport and disposal, and the management of these phases has to be integrated. In other words, wastes have to be properly stored, collected and disposed of by co-operative management. In addition, poor management of wastes on the user side such as disposing of wastes in the streets, storm water drains, rivers and lakes has to be avoided to preserve the environment, control vector-borne diseases and ensure water quality/resource.

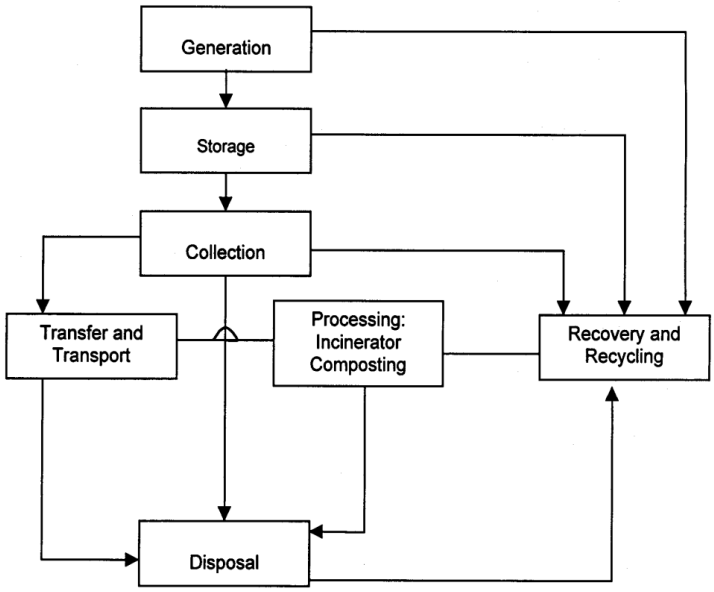
Solid Waste Management (SWM)

Type	Description	Source
Garbage	Food Waste; waste from the preparation, cooking and serving food. Market refuse, waste from handling, storage, and sale of produce and meat.	Households, Institutions and Commercial concerns such as Hotels Stores, Restaurants Markets.
Combustible	Combustible paper, cardboard, cartons, wood, boxes, plastic, rags, cloth, bedding, leather, rubber, grass, leaves, yard trimmings etc.	
Non-Combustible	Non- Combustible Metals, Tin Cans, Glass Bottles, Crockery, Stones etc.	
Ashes	Residues from fires used for cooking and for heating build cinders.	
Bulky Washes	Large auto parts, tyres, stoves, refrigerators, other large appliances, furniture, large crates, trees, braches, slumps, etc.	Streets, sidewalks, alleys, vacant lots, etc.
Street Washes	Street sweepings, dirt, leaves, etc.	
Dead Animals	Dogs, Cats, Rats, Donkeys, etc.	
Abandoned Vehicles	Automobiles and Spare parts	Automobiles and Spare pats
Construction and demolition Wastes	Roofing, and sheathing scraps, rubble, broken concrete, plaster, conduit pipes, wire, insulation, etc.	Construction and demolition sites
Industrial wastes	Solid waste resulting from industry processes and manufacturing operations, such as food processing wastes, boiler house cinders, wood plastic and metal scraps, shavings etc.	Factories, power plants, etc.
Hazardous waste	Pathological wastes, explosives, radioactive materials, etc.	Households, Hospitals, Institutions, Stores, Industry, etc.
Animal and Agricultural Wastes	Manure, crop residues, etc.	Live stocks, farms, feedlots, and agriculture.
Sewage Treatment Residues	Coarse screening grit, septic tank sludge, dewatered sludge	Sewage treatment plants ad septic tanks

SWM system: Functional Elements SWM

A SWM system refers to a combination of various functional elements associated with the management of solid wastes. The system, when put in place, facilitates the collection and disposal of solid wastes in the community at minimal costs, while preserving public health and ensuring little or minimal adverse impact on the environment.

SWM System Functional Elements



The functional elements that constitute the system are;

1. **Waste Generation:**

Wastes are generated at the start of any process, and thereafter, at every stage as raw materials are converted into goods for consumption. The source of waste generation, determines quantity, composition and waste characteristics. For example, wastes are generated from Households, Commercial Areas, Industries, Institutions, Street Cleaning and other municipal Services. The most important aspect of this part of the SWM system is the identification of waste.

2. **Waste Storage:**

Storage is a key functional element because collection of wastes never takes place at the source or at the time of their generation. The heterogeneous wastes generated in residential areas must be removed within 8 days due to shortage of storage space and presence of biodegradable material. Onsite storage is of primary importance due to aesthetic consideration, public health and economics involved. Some of the options for storage are plastic containers, conventional dustbins (of households), used oil drums, large storage bins (for institutions and commercial areas or servicing depots), etc. Obviously, these vary greatly in size, form and material.

3. **Waste Collection:**

This includes gathering of wastes and hauling them to the location, where the collection vehicle is emptied, which may be a transfer station, a processing plant or a disposal site. Collection depends on the number of containers, frequency of collection, types of collection services and routes. Typically, collection is provided under various management arrangements, ranging from municipal services to franchised services, and under various forms of contracts. Note that the solution to the problem of hauling is complicated. For instance, vehicles used for long distance hauling may not be suitable or particularly economic for house-to-house collection. Every SWM system, therefore, requires an individual solution to its waste collection problem.

4. **Transfer and Transport:**

This functional element involves:

I. The transfer of wastes from smaller collection vehicles, where necessary to overcome the problem of narrow access lanes, to larger ones at transfer stations;

II. The subsequent transport of the wastes, usually over long distances, to disposal sites.

III. The factors that contribute to the designing of a transfer station include the type of transfer operation, capacity, equipment, accessories and environmental requirements.

5. **Processing, Recovery, and Recovery:**

Processing is required to alter the physical and chemical characteristics of wastes for energy and resource recovery and recycling. The important processing techniques include compaction, thermal volume reduction, and manual separation of waste components, incineration and composting.

Recovery and Recycling:

This includes various techniques, equipment and facilities used to improve both the efficiency of disposal system and recovery of usable material and energy. Recovery involves the separation of valuable resources from the mixed solid wastes, delivered at transfer stations or processing plants. It also involves size reduction and density separation by air classifier, magnetic device for iron and screens for glass. The selection of any recovery process is a function of economics, i.e., costs of separation versus the recovered-material products. Certain recovered materials like glass, plastics, paper, etc., can be recycled as they have economic value.

6. **Waste disposal:**

Disposal is the ultimate fate of all solid wastes, be they residential wastes, semi-solid wastes from municipal and industrial treatment plants, incinerator residues, composts or other substances that have no further use to the society. Thus, land use planning becomes a primary determinant in the selection, design and operation of landfill operations. A modern sanitary landfill is a method of disposing solid waste without creating a nuisance and hazard to public health. Generally, engineering principles are followed to confine the wastes to the smallest possible area, reduce them to the lowest particle volume by compaction at the site and cover them after each day's operation to reduce exposure to vermin.

Environmentally Sound Solid Waste Management (ESSWM):

In any waste or resource management system, we must pay attention to the interaction between human activities and the ecosystem. We have to recognize that human activities including consumption of goods/services, production of wastes, etc., have a serious impact on the carrying capacity of the ecosystem. This in turn affects human health, as the environment deteriorates.

The fundamental principles of ESSWM, which take into account economic and social issues along with environmental impact consideration, include the following;

1. To ensure sustainable development of the ecosystem and human environment.
2. To minimize the impact of human activities on the environment
3. To minimize the impact on the environment and maximize the ecosystem's carrying capacity.
4. To ensure the implementation of ESSWM through environmentally soundtechnologies

Environmentally Sound Technologies (EST):

EST refers to cost effective and energy efficient technologies, which generally perform better on the environment, as they do not pollute the ecosystem's vital components such as air, land or water and consider the reuse, recycling orrecovery of wastes.

EST can be categorized broadly as follows;

1. **Hard EST**:

This includes equipment, machines and other infrastructure with their material accessories to handle waste products and monitor/measure the quality of air, water and soil.

2. **Soft EST**:

These support and complement hard technologies and include nature-based technologies and management tools. Nature-based technologies include processes and mechanisms nature uses within a specific ecosystem (such as vermin composting) and its carrying capacity, while management tools include system and procedures, policy and regulatory frameworks, and environmental performance standards and guidelines.

3. **Affordability:**

This means low investment, reasonableness, maintenance- free and durability.

4. **Validity:**

This refers to effectiveness, easy operation and maintenance.

5. **Sustainability:**

This means low impact, energy saving and cultural acceptability.

Factors affecting SWM System:

1. **Quantities and Characteristics of Wastes:**

The quantities of wastes generated generally depend on the income level of a family, as higher income category tends to generate larger quantity of wastes, compared to low-income category. The quantity ranges from about 0.25 to about 2.3 kg per person per day, indicating a strong correlation between waste production and per capita income. One of the measures of waste composition (and characteristics) is density, which ranges from 150 kg/m^3 to 600 kg/m^3. Proportion of paper and packaging materials in the waste largely account for the differences. When this proportion is high, the density is low and vice versa. The wastes of high density reflect a relatively high proportion of organic matter and moisture and lower levels of recycling.

2. **Climate and Seasonal Variations:**

In cold climates, drifting snow and frozen ground interfere with landfill operations, and therefore, trenches must be dug in summer and cover material stockpiled for winter use. Tropical climates, on the other hand, are subject to sharp seasonal variations from wet to dry season, which cause significant changes in the moisture content of solid waste, varying from less than 50% in dry season to greater than 65% in wet months. Collection and Disposal of wastes in the wet months are often problematic.

High temperatures and humidity cause solid wastes to decompose far more rapidly than they do in colder climates. The frequency of waste collection in high temperature and humid climates should, therefore, be higher than that in cold climates. In sub-tropical or desert climate, there is no significant variation in moisture content of wastes and low production of leachate from sanitary landfill. High winds and windblown sand and dust, however, causespecial problems at landfill sites. While temperature inversions can cause airborne pollutants to be trapped near ground level, landfill sites can affect groundwater by altering the thermal properties of the soil.

3. **Physical Characteristics of an Urban Area:**

In urban areas, where the layout of streets and houses is such that access by vehicles is possible and door-to-door collection of solid wastes is the accepted norm either by large compaction vehicle or smaller vehicle. The picture is, however, quite different in the inner and older city areas where narrow lanes make service by vehicles difficult and often impossible. Added to this is the problem of urban. where population is growing at an alarming rate. Access ways are narrow, unpaved and tortuous, andtherefore, not accessible to collection vehicles. Problems of solid waste storage and collection are most acute in such areas.

4. **Financial and Foreign Exchange Constraints:**

Solid waste management accounts for sizeable proportions of the budgets of municipal corporations. Thisis allocated for capital resources, which go towards the purchase of equipments, vehicles, and fuel and labour costs. Typically, 10% to 40% of the revenues of municipalities are allocated to solid waste management. In regions where wage rates are low, the aim is to optimize vehicle productivity. The unfavorable financial situation of some countries hinders purchase of equipment and vehicles, and this situation is further worsened by the acute shortage of foreign exchange.

5. **Cultural Constraints:**

In some regions, long-standing traditions preclude the intrusion of waste collection on the precincts of households, and therefore, influence the collection system. In others, where the tradition of caste persists, recruits to the labour force for street cleaning and handling of waste must be drawn from certain sections of the population, while others will not consent to placing storage bins in their immediate vicinity. Waste management should, therefore, be sensitive to such local patterns of living and consider these factors in planning, design and operation.

6. **Management and Technical Resources:**

Solid Waste Management, to be successful, requires a wide spectrum of workforce in keeping with the demands of the system. The best system for a region is one which makes full use of indigenous crafts and professional skills and/or ensures that training programmes are in place to provide a self-sustaining supply of trained work force.

SWM- The Indian Scenario:

The problem of Municipal Solid Waste Management has acquired alarming dimensions in India especially over the last decade, before which waste management was hardly considered an issue of concern as the waste could be easily disposed of in an environmentally safe manner. However, with time, due to changing lifestyles of people coupled with unplanned developmental activities, urbanization and industrialisation, the waste quantity and characteristics have changed, and as a result, managing solid wastes has become torturous.

The physical and chemical characteristics of Indian city refuse, nonetheless, show that about 80% of it is compostable and ideal for biogas generation due to adequate nutrients (N P K), Moisture Content of 50-55% and a carbon-to-nitrogen ratio of 25-40:1. Therefore, the development of appropriate technologies for utilization of wastes is essential to minimize adverse health and environmental consequences.

Against this backdrop, let us discuss below the quantum of wastes generated in India, their composition, disposal methods, recycling aspects, and health and environment impacts;

1. **Waste Quantum:**

The per capita waste generation rate is about 500 g/day. This along with increased population has contributed to higher total waste generation quantum, as shown in Table, adding to the problems of Municipalities:

Waste Generation Statistics

Year	Per capita waste generated (g/day)	Total urban municipalwaste generated (Mt/year)
1971	375	14.9
1981	430	25.1
1991	460	43.5
2000	500	48.8
2010	600	~70.2

During the last decade, garbage was generated in India at nearly twice the rate of the population growth. Estimates of the solid wastes generated in Indian towns and cities (299 Class I cities with >100,000 in population and 345 Class II towns) range from 52,000 tonnes to 85,000 tonnes of city garbage every day (while Delhi alone produces 4500-5000 tonnes of municipal solid waste per day). Out ofthis, only 2,832 tonnes get various types of treatment.

In addition, studies in 9 major metropolitan centres in India indicate that the quantum of wastes generated ranges from 1000 tonnes per day in Patna, to 5800 tonnes per day in Mumbai, out of which 80-85% is collected, and the rest is left unattended.

MajorCities	Garbage Generated (Tonnes per Day)	Garbage Cleared (Tonnes per Day)	Annual MunicipalBudget (Rs. In crores)
Delhi	3880	2420	1016.28
Kolkata	3500	3150	250.00
Mumbai	5800	5000	2436.00
Bangalore	2130	1800	237.00
Chennai	2675	2140	145.00
Lucknow	1500	1000	48.00
Patna	1000	300	15.00
Ahmadabad	1500	1200	270.00

2. Waste Composition:

Studies reveal that the percentage of the organic matter has remained almost static at 41% in the past 3 decades, but the recyclables have increased from 9.56% to 17.18% as shown in Table 1.5 below:

Physico-chemical Characteristics of Municipal Solid Waste

Component	Percentage on wet weight basis	
	1971-73 (40 Cities)	1995 (23 Cities)
Paper	4.14	5.78
Plastics	0.69	3.90
Metals	0.50	1.90
Glass	0.40	2.10
Rags	3.83	3.50
Ash and fine earth	49.20	40.30
Total compostable matter	41.24	41.80

Garbage in Indian cities is estimated to contain about 45-75% biodegradable waste with 50-55% moisture; 35-45% being fruits, vegetable and food biomass; and 8-15% non-organic materials like plastic, metal, glass, stones, etc. Among various recyclables, plastics have had a quantum jump from 0.69% to 3.9%, Plastics due to their unique properties of flexibility, high impact strength, resistance to corrosion and rigidity have replaced valuable natural resources like wood and metals. Of the current consumption of 1.9 million tonnes of plastics, 15% are from the packaging sector, as packaging materials reach the waste bin as a post-consumer waste. Much of this does not have a recycling value, and hence its disposal without any treatment.

3. Waste Disposal Methods:

About 90% of the municipal waste collected by the civic authorities in India is dumped in low-lying areas outside the city/town limits, which have no provision of leachate collection and treatment, and landfill gas collection and use. As a result, leachate containing heavy metals finds its way to the undergroundwater, rendering it unfit for drinking. The landfill gas escapes into the atmosphere, adding to the greenhouse emissions, which otherwise could be used as thermal fuel. Solid waste management can be an income generating activity with cost benefits. However,

since the Indian city refuse has alow calorific value with high moisture content and quantity of non-combustibles, it is not suitable for incineration, and currently none of the municipal corporations in India runs a full-scale incineration plant. The potential for power generation from urban municipal wastes is tremendous, estimated to generate up to 1000 MW of electricity.

4. **Recycling:**

This involves collection of recyclables from various sources, which ultimately reach recycling units. It is estimated that about 40-80% of plastic waste gets recycled in India, as compared to 10-15% in the developed nations of the world. However, due to lack of suitable government policies, incentives, subsidies, regulations, standards, etc., related to recycling, this industry is still far behind its western counterparts in terms of technology and quality of manufactured goods. Nevertheless, recycling in India is a highly organized and profit-making venture, though informal in nature.

5. **Health Impacts:**

Due to the absence of standards and norms for handling municipal wastes, municipal workers suffer occupational health hazards of waste handling. At the dumpsites in the city of Mumbai, for example, 95 workers were examined and it was found that about 80% of them had eye problems, 73% respiratory ailments, 51% gastrointestinal ailments and 27% skin lesions. Also, municipal workers and rag pickers who operate informally for long hours rummaging through waste also suffer from similar occupational health diseases ranging from respiratory illnesses, infections to headaches and nausea, etc. Studies among the 180 rag pickers at open dumps of Kolkata city reveal that average quarterly incidence of diarrhoea was 85%, fever 72% and cough and cold 63%.

6. **Environmental impacts:**

In addition to occupational health, injury issues and environmental health also need to be mentioned in the context of waste management. Contaminated leachate and surface run-off from land disposal facilities affects ground and surface water quality. Volatile organic compounds and dioxins in air-emissions are attributed to increasing cancer incidence and psychological stress for those living near incinerators or land disposal facilities. Drain clogging due to uncollected wastes leading to stagnant waters and subsequent mosquito vector breeding are a few of the environmental health issues, which affect the waste workers as well as the public.

Progress of MSW Management in India:

Over the years, the problems faced due to MSW were highlighted by civic and environmental activists. This resulted in framing rules for MSW in the year 2000(MSWM, 2000; GOI, see Annexure 1) which are directed by the Supreme Court and MoEF. In October 2004, specific directions to the larger cities to meet the requirements of these rules were issued by Supreme Court. In 2005 Ministry of Urban Development giving priority to MSWM has allocated grants to the tunes of Rs 25000 million covering 423 classes I towns as part of 12th finance committee.

Guidelines for preparation of detailed project reports for MSWM using 12th Finance Commission Grants:

Detailed Project Report (DPR) needs to be prepared as per the guidelines laid down in the Manual on SWM, which include:

1. Existing status of SWM in the towns including mechanism and infrastructure for collection, transportation, treatment and disposal. The details include existing equipment/machinery and the infrastructure available with ULB with the condition and its age. The mechanism & O/M of the equipment available, present establishment expenditure, technical and non-technical manpower available.
2. Field study is carried out in commercial / institutional and residential areas to assess the quantity of garbage generated in the city before planning the system and report of the field study be included in the DPR.
3. Complete physical characterization of waste, including moisture content, density, etc. as well as weight and volume of quantity of bio-degradable, non bio-degradable and recyclables available in the waste produced in the town everyday and test report for quality of garbage from a standard test laboratory .
4. Existing system of collection, storage, transportation, processing, treatment and disposal of waste and proposed system of collection, transportation and process of treatment and disposal, fully justifying the process adopted including in-house facility of maintenance and repair if available in ULB.
5. Justification for equipment & machinery required, if any, for collection and transportation based on the time and motion study in order to ensure optimum utilization of the same.
6. Detailed designs and drawing of proposed Solid Waste Management System including

sanitary landfill / waste processing plants should be included in the DPR. Details of the survey and geo-hydrological investigation carried out for development of sanitary land fill.

7. Mechanism of operation and maintenance of equipment and machinery and its upkeep, preventive maintenance on regular basis for existing and proposed equipment and machinery.
8. Mechanism of operation and maintenance of sanitary land fill / waste processing plant on self sustaining basis including details of engagement of private sector, if any.
9. A routing plan for storage and collection of garbage, marked out on the city's layout plan, to facilitate easy operations in SWM services.
10. Proposed institutional and financial reform after completion of scheme.
11. An action plan for effective O/M through imposition of user charges.
12. Details of suitable land for setting up of integrated waste management facility in possession including land for sanitary landfill While preparing the detailed project report for any city / town.

The guidelines laid down in the Manual on Municipal Solid Waste Management published by this Ministry in May, 2000 should be considered and each component of the project prepared as per the norms laid down therein, and management programmes and plans, especially with respect to the implementation of disposal, and resource and energy recovery options.

The objective of SWM is to minimize the negative environmental effects and identified the functional elements of SWM as waste generation, storage, transfer and transport, processing, reuse and recycling and final disposal.

Module: 1

Question No. 1

1. Define solid wastes. Explain the source based classification of solid wastes.
(10M, Jan./Feb. 2023)
2. Explain the various functional elements of solid waste management.
(10M, Jan./Feb. 2023)
3. With a neat flow diagram, explain the functional element of solid waste management.
(10M, June/July 2023)
4. Explain the classification of source based and type based solid waste.
(10M, June/July 2023)

Question No. 2

1. List out the various factors affecting solid waste management system. Explain any two.
(10M, Jan./Feb. 2023)
2. Write short notes on Indian scenario of management of solid waste.
(10M, Jan./Feb. 2023)
3. Explain factors affecting solid waste management system.
(10M, June/July 2023)
4. Explain environmentally sound technologies (EST) with example.
(10M, June/July 2023)