TCE EIACP PC-RP NEWSLETTER

AN EIACP RESOURCE PARTNER FOR PLASTIC WASTE MANAGEMENT OF INDIA

(Funded by Ministry of Environment, Forest & Climate Change, Government of India)

Theme: Waste Management

WASTE MANAGEMENT AND ITS IMPORTANCE

A typical waste management system comprises identification, collection, transportation, pre-treatment, processing and final abatement of resideues. The waste management system consists of the whole set of activites related to handling, treating, disposing or recycling waste materials

Why is Proper Waste Management Important?

Poor managed waste **"contaminates the world's oceans, transmits diseases, increases respiratory problems, harming animals that consume waste unknowingly"**.

By reducing the use of plastic and other disposable materials, we can reduce the impact of the pollution created from landfills.

Every year, around 2 billion tonnes of municipal solid waste is generated all over the world. Without proper waste management, this will increase by nearly 3.4 billion tonnes per year.

How to Opt for a Proper Waste Management System?

Focus on reducing waste at the source by designing products and processes that generate less waste. For example, use materials more efficiently, reduce packaging.

Implement a system for segregating waste at the source into categories like recyclables, organic waste, hazardous waste, and general waste.

Develop and promote recycling programs for materials such as paper, glass, plastics, and metals. Ensure there are facilities and processes in place to handle these materials efficiently.

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OCT - DEC 2023

This Newsletter Composes of Research Articles, Latest News, Know Your Polymer, Infographics / Statistical Data, Kids Corner & Awareness

Hosted By

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TCE EIACP PC-RP
EIACP Resource Partner Plastic Waste Management of India
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Editorial Message

DEAR READERS,

The world is moving towards rapid urbanization. This has resulted in generation of more quantity of waste and its dumping in open places. This creates environment problems.

The proper disposal of these waste has become the need of the day. Municipal Solid Waste management is gaining importance day by day due to threats it delivers, to the environment. On one side the quantity of the waste is going on increasing and on the other side, the space for dumping the waste is not available due to the expansion of urban areas. This has compelled to focus more on the proper management of waste in terms of identification, collection, aggregation, segregation and effective reuse of the waste by

1. Proper processing into products like manure Eg. Micro composting of wet waste.
2. Recycling, Reusing for an effective use Eg. Plastic, Glass, Metal, etc..

Innovative processes are needed to be carried out insitu. So that accumulation of the waste can be prevented and also we could be able to generate wealth from waste.

This issue on waste management throws more light on the opportunities and challenges faced by the government in detail. It also gives an idea about the influence of urban waste dumped in rural areas. The journal also provides guidelines related to

1. Waste separation and segregation
2. Food Waste Management
3. Prevention Measures practiced on waste management

In a nut this present edition speaks more about the effective waste management techniques. The regular notes on important polymers is also included in this edition.

Lets us grow together to make India, The great

Jai Hind!!

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Research Article:

Source: Elsevier

Municipal solid waste: Opportunities, challenges and management policies in India: A review

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A R T I C L E I N F O

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A B S T R A C T

Sustainable management of municipal solid waste (MSW) is the utmost importance not only because of the health and environmental concerns but also due to its disposal issues of large quantities of waste generated and to achieve the Sustainable Development Goals (SDGs). Improper management of MSW causes hazards to inhabitants. Environmental and economic implications linked with the proper eco-friendly disposal of modern-day waste, has made it essential to come up with alternative waste management practices. Several studies revealed that approximately 90% of MSW disposed of unscientific manner as open dumps and landfilling, and created severe enigma to human health and the environment as well as contaminating the food chain cycle. It has been observed that urban local bodies (ULBs) in India have a big challenge in handling huge quantities of MSW; due to high density of population and insufficient infrastructure. Door to door collection of waste, methodologies for recycling MSW, and scientific treatments are some of the challenges. Considering these facts, the Union Ministry of Environment, Forests and Climate Change (MoEF&CC) India notified the new Solid Waste Management Rules (SWM), 2016 which would be revamped solid waste management in the country. Several steps of waste management/treatments are being adopted, *i.e.,* incineration, pyrolysis, bio-refining and biogas plants, recycling and composting, composting is a sustainable low-cost option for MSW management, however, very less amount 6–7% of MSW was recycled through it. The present study emphasized a comprehensive review of the characteristics, production, collection, disposal and effective treatment technologies of MSW practiced in India.

Abbreviations: WtE, Waste to Energy; WM, Waste Management; UNFCCC, United Nations Framework Convention on Climate Change; ULBs, Urban Local Bodies; SWM, Solid Waste Management; SOM, Soil Organic Matter; SOC, Soil Organic Carbon; SLBs, Service Level Benchmarks; ppm, Parts Per Million; P, Phosphorus; NEERI, National Environmental Engineering Research Institute; N, Nitrogen; Mt, Million Ton; MSWM, Municipal Solid Waste Management; MSWC, Municipal Solid Waste Compost; MSW, Municipal Solid Waste; MoEF& CC, Ministry of Environment, Forests and Climate Change; MCD, Municipal Corporation of Delhi; MAB, Simple Mass-Balance Approach; kg m^{-3}, kilogram per cubic meter; K, Potassium; ISWM, Integrated Solid Waste Management; IPCC, Inter-Governmental Panel on Climate Change; GWP, Global Warming Potential; GHGs, Green House Gases; FOD, First-Order Decay Method; EC, Electrical Conductivity; CV, Calorific Value; CO_2, carbon dioxide; CEC, Cation Exchange Capacity; C/N, Carbon to Nitrogen Ratio; 3R concept, Reduce, Reuse and Recycling; °C, Degree Centigrade; %, per cent.

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Municipal Solid Waste Sorting Plant Model

Research Article:

Introduction

Socio-economic changes like population pressure, industrialization, migration and urbanization within vibrant society of India has led a significant increase in municipal solid wastes in India. Approximately 80% municipal solid waste (MSW) gets collected and only ~ 28% is used. Currently, India produces approximately 70 Mt MSW per year and by 2030 it will reach ~ 165 Mt if the pace is continuing, it could be reached around 436 Mt by 2050(Planning Commission Report, 2014). Continuous and indiscriminate disposal of MSW is linked to unscientific utilization, urbanization, population rate, ethics of living and lack of ecological responsiveness. Open dumping of MSW causes severe negative impacts on all aspects of the environment and human health (Sharholy et al., 2006). Unscientific assemblage and improper transportation are mainly linked to the accumulation of MSW everywhere. This is imperative to the sustainable management of MSW and is one of the main environmental problems of Indian megacities. It also involves activities relevant to the generation, storage, collection, transfer and transport, processing and disposal of solid wastes.

Organic fraction of MSW is about 48–50%, which is becoming a serious challenge in the country (Annepu, 2012; Meena et al., 2022). Environmental pollution, human health risk, and shortage of disposed area are the main cause of its improper disposal. MSW in Indian megacities is largely pre disposed in the landfill; nevertheless, a very less fraction of MSW (6–7%) is to be used for composting (Annepu, 2012). Controlling of MSW is a very severe issue for ULBs in Indian megacities because of urbanization, industrialization, as well as economic pace, have resulted in increased generation of MSW per capita. Therefore, effective management of solid waste is major issue for cities having high population density. However, significant improvements in social, economy and the environment but the situation of MSW treatments in the country remained the same. The informal sector played an important role in extracting values from MSW, with about 90% of residual waste dumped than appropriate landfilling (Narayan, 2008). There is a need of the day for scientific sustainable management of MSW, which requires an advanced management system and infrastructure. Present technologies for the management of solid waste are incompetent and have a negative impact on human health, environmental pollution and the economy of the country.

In recent years, it is the need of the hour to prepare strategic and detailed management of SWM plans by the urban local bodies (ULBs). This review focuses on the use of MSW as an organic amendment for reclamation of salt-affected soils. The present article comprehensively studies SWM practices and regulations and their application in the soil as organic amendments as well as organic fertilizers for sustainable crop production in India. Research should focus on these concerns globally in the future to reduce ecological disturbances, establish environmental standards, and evaluate the viability of policies in various nations and how they affect the socio-economic circumstances of the local people.

Production potential of MSW in India

Population pressure is a major contributing factor to increasing quantities of MSW in India. Estimated quantity of MSW generated in India ~ 55 Mt with an annual rate of growth of around 5%. Solid waste generation is about 0.1 kg, 0.3–0.4 kg and 0.5 kg per capita per day in small, medium and large cities and towns in India, respectively (CPB, 2005). Reportedly, 1.33% of waste is generated annually per capita per year. A summary of MSW generated by different cities in India is presented in Table1. The production potential of municipal solid waste in major cities of India as showed in Table 1. It includes residential, municipal, mining, agricultural, industrial etc.

Classification of solid waste

Solid wastes can be categorised based on its source, composition, phase, treatment and others (Table 2). Rubbish may include a variety of materials which may be combustible (paper, plastic etc.) or incombustible (glass, metal etc.). There are special wastes such as construction debris, leaves and street litter, abandoned automobiles, and old appliances that are collected and managed separately. It consists of organic matter (51%), recyclables (17.5%) and others *i.e.,* inert (31%) (Annepu, 2012). Notably, the actual composition may differ due to the informal separation of recycling wastes at the source. The municipal solid waste characterisation in India as showed in Fig. 1.

Physical characteristics of MSW

Physical characterisation of MSW can be done through parameters like moisture, particle size, density and permeability. CPCB (2005) reported the physical characteristics of MSW in different cities of India, which is depicted in Table 3. There are several physical parameters to characterize solid waste out of these; moisture content has been a critical factor for the monetary possibility of waste treatment by means of incineration due to its requirement of energy for evaporation of water. In composting and anaerobic digestion processes moisture plays crucial for decomposition rate of waste. The waste density of MSW can be measured as mass per unit volume hence influential in determining the design of elements of the solid waste management system. The field capacity of waste has been useful for measuring the leachates in landfills. Another physical parameter hydraulic conductivity of solid waste governs the movement of liquid and gases in landfills.

Chemical characteristics of MSW

For an effective waste management system understanding chemical behaviour and chemical characterization of MSW hold the key. If solid wastes are to be used as fuel, or are used for any other purpose, we must know their chemical characteristics (NEERI, 1995). Chemical characteristics of MSW according to population range were presented in Table 4.

Future projections of MSW generation in India

Predictions of waste generation quantity and composition and understanding their current management status are essential for developing sustainable management practices. Population forecasts usually differ according to the underlying method used for forecast. Method of arithmetic increase has been found beneficial if there has been a constant increase in population (in absolute numbers) over the past few decades. This computation is appropriate for large, historic cities with significant development. When applied to tiny, average, or very new cities, it will produce results that are below their true worth. Using data from previous census reports, this method determines the average population growth rate every decade. The population of the following decade is calculated by multiplying this increase by the current population. Therefore, it is anticipated that the population is growing steadily.

Arithmetic increase method:

$$\mathbf{P} = \mathbf{P}_1 + \mathbf{k}(\mathbf{t} - \mathbf{t}_1) \quad \text{(i)}$$

$$K_a = \frac{P_2 - P_1}{t_2 - t_1} \quad \text{(ii)}$$

Where P = population for projected year; P_1 = population in year a (base year); P_2 = current population; t_1 = base year; t_2 = current year; t = period of the projection in decades; k = population growth rate (constant).

Research Article:

Table 1
Production potential of municipal solid waste in major cities of India (CPB, 2005).

Name of city	Population (as per 2001	Waste generation rate (kg/ capita/day	Compostable (%)	Recyclables (%)	C/Nratio
Agartala	18,998	0.40	58.57	13.68	30.02
Agra	1,275,135	0.51	46.38	15.79	21.56
Ahmedabad	3,520,085	0.37	40.81	11.65	29.64
Aizwal	228,280	0.25	54.24	20.97	27.45
Allahabad	975,393	0.52	35.49	19.22	19.00
Amritsar	966,862	0.45	65.02	13.94	30.69
Asansol	475,439	0.44	50.33	14.21	14.08
Bangalore	4,301,326	0.39	51.84	22.43	35.12
Bhubaneswar	648,032	0.36	49.81	12.69	20.57
Chandigarh	808,515	0.40	57.18	10.91	20.52
Chennai	4,343,645	0.62	41.34	16.34	29.25
Coimbatore	930,882	0.57	50.06	15.52	45.83
Dehradun	424,674	0.31	51.37	19.58	25.90
Delhi	10,306,452	0.57	54.42	15.52	34.87
Dhanbad	199,258	0.39	46.93	16.16	18.22
Faridabad	1,055,938	0.42	42.06	23.31	18.58
Gandhinagar	195,985	0.22	34.30	13.20	36.05
Greater Mumbai	11,978,450	0.45	62.44	16.66	39.04
Guwahati	809,895	0.20	53.69	23.28	17.71
Hyderabad	3,843,585	0.57	54.20	21.60	25.90
Imphal	221,492	0.19	60.00	18.51	22.34
Indore	1,474,968	0.38	48.97	12.57	29.30
Jabalpur	932,484	0.23	58.07	16.61	28.22
Jaipur	2,322,575	0.39	45.50	12.10	43.29
Jammu	369,959	0.58	51.51	21.08	26.79
Jamshedpur	1,104,713	0.31	43.36	15.69	19.69
Kanpur	2,551,337	0.43	47.52	11.93	27.64
Kavaratti	10,119	0.30	46.01	27.20	18.04
Kochi	595,575	0.67	57.34	19.36	18.22
Kolkata	4,572,876	0.58	50.56	11.48	31.81
Lucknow	2,185,927	0.22	47.41	15.53	21.41
Ludhiana	1,398,467	0.53	49.80	19.32	52.17
Madurai	928,868	0.30	55.32	17.25	32.69
Meerut	1,068,772	0.46	54.54	10.96	19.24
Mumbai	1,437,354	0.40	52.44	22.33	21.58
Nagpur	2,052,066	0.25	47.41	15.53	26.37
Nashik	1,077,236	0.19	39.52	25.11	37.20
Patna	1,366,444	0.37	51.96	12.57	18.62
Pondicherry	220,865	0.59	46.96	24.29	36.86
Pune	2,538,473	0.46	62.44	16.66	35.54
Raipur	605,747	0.30	51.40	16.31	22.50
Rajkot	967,476	0.21	41.50	11.20	52.56
Ranchi	847,093	0.25	51.49	9.86	20.23
Shillong	132,867	0.34	62.54	17.27	28.86
Shimla	142,555	0.27	43.02	36.64	23.76
Srinagar	898,440	0.48	61.77	17.76	22.46
Surat	2,433,835	0.41	56.87	11.21	42.16
Tiruvanantapuram	744,983	0.23	72.96	14.36	35.19
Vadodara	1,306,227	0.27	47.43	14.50	40.34
Varanasi	1,091,918	0.39	45.18	17.23	19.40
Vijayawada	851,282	0.44	59.43	17.40	33.90
Vishakhapatnam	982,904	0.59	45.96	24.20	41.70

Gap analysis of MSW

The assessment of information on the current status of solid waste recycling in the ULBs with respect to the requirements of existing regulation, policies, guidelines, and identified service level benchmarks (SLBs) will result in an identification of key shortfalls in achieving the desired level of services and shall form the basis for preparing a plan to improve the MSWM system. Fig. 2 illustrated a schematic diagram depicting the issues to be considered while assessing gaps in MSW service provision. The basic objective of the baseline study is to understand the existing solid waste system as accurately as possible; analyse system deficiencies concerning to SWM Rules, 2016; and utilise that information for further planning, implementation, and monitoring processes. Local conditions shall be considered while assessing the inadequacy of existing services and planning for the future with due consideration of local demography, physical location, and growth objectives of social and environmental conditions.

Waste quantification

Waste generation rates are quantified by measuring the load of waste in collection vehicles either at a municipal or private weighbridge in the city. Alternately, the volumes of different vehicles used for the transportation of waste are considered and a thumb rule of 400–500 kg per cubic meter (kg m^{-3}) is applied to determining the quantity of waste transported per trip per type of vehicle. The flow diagram for points of quantification is depicted in Fig. 3.

Measurement of quantity of transported waste

The quantity of waste measured at transfer stations or processing or disposal sites does not accurately reflect waste generation rates (ERM, 2000), since these measurements do not include factors like waste disposed at unauthorised places, vacant lots, alleys, ditches; etc.; waste recovered by *kabadi* system; and waste recovered by informal waste

Research Article:

collectors or waste pickers from the streets, bins, and intermediate transfer points, etc. The *kabaddi* system is an informal sector which plays a very important role in the municipal solid waste management value chain by recovering valuable materials from waste. The amount of waste carried by collection vehicles is measured at a public or private weighbridge in the city to determine the waste generation rates of city. Alternatively, the capacities of various vehicles used for moving waste are taken into account, and a general guideline of 400–500 kilogrammes per cubic metre (kgm^{-3}) is used to calculate the amount of waste moved every trip per kind of vehicle.

$$Waste\ Collected = Quantity\ of\ Waste\ Transported\ by\ Each\ Vehicle \times No.\ of\ Trips \quad (iii)$$

Impact of municipal solid waste on environmental and human health

The environmental and health implications are linked with the disposal of garbage which mounting in developing countries. Therefore, sustainable MSW management methods are being executed to minimizing environmental losses of pollutant gases related with climate change due to greenhouse gases (GHGs) and acidification of the ecosystem through ammonia evolution. Several management techniques for SWM management have been investigated to quantify nitrogen (N) and carbon (C) losses concerning to various environmental and operational conditions but their overall impact is still uncertain (Pardo et al., 2015). Handling of medical waste poses a high risk. Breeding of disease vectors primarily flies and rats have a detrimental impact on human health (Royal Commission on Environmental Pollution, 1984). Hazardous materials originated from industries and their mixing with MSW creates a potential risk to human health (Alam and Ahmade, 2013). Contamination of heavy metals in the food chain cycle due to the unscientific disposal of municipal solid waste and liquid industrial effluents having metal toxicity discharged to the drainage system and/or open dumping site causes other types of problem as follows (Royal Commission of Environment pollution, 1984) (a) chemical poisoning through chemical inhalation, (b) uncollected waste can obstruct the stormwater runoff resulting in flood, (c) low birth weight, (d) cancer, (e) congenital malformations, (f) neurological disease, (g) nausea and vomiting, (h) mercury toxicity from eating fish with high levels of mercury, (i) plastic found in oceans ingested by birds, (j) results in high algal population in rivers and sea, (k) degrades to water and soil quality (Liu et al., 2015). The decomposition of waste into constituent chemicals is a common source of local environmental pollution (Fig. 4).

Greenhouse gas emissions from solid waste sector

Greenhouse gases (GHGs) are a primary cause of climate change. These gases absorb infrared radiation emitted from the earth hence increasing in the average temperature of the earth. There is no doubt that solid waste sector has been a significant contributor to GHG emissions globally. The Inter-Governmental Panel on Climate Change (IPCC) reported that post-consumer waste accounted for up to 5% of the total global GHGs emissions in 2005 (IPCC, 2007). It has been reported that emission of GHGs occurs not only during the management of waste (as during transportation) but also in the decomposition of waste in dumpsites. Unscientific management of waste contributes a significant amount of embodied emissions. These emissions can be minimized or reduced through proper handling, resource recovery as

Table 2
Describes type of wastes on basis of its source. It includes residential, municipal, mining, agricultural, industrial and others adapted from Nandan et al. (2017).

Source	Typical waste generators	Type of solid waste
Residential	Household activities	Food waste, paper, cardboard, plastics, wood, glass, metals, electronic items etc.
Municipal services	Street cleaning, landscaping, parks and other recreational areas, water and wastewater treatment plants	Tree trimmings, general wastes, sludge etc.
Mining	Open-cast mining, underground mining	Mainly inert materials such as ash
Industrial	Manufacturing units, power plants, process industries etc.	Housekeeping wastes, hazardous wastes, ashes, special wastes etc.
Construction and Demolition	New construction sites, demolition of existing structures, road repair etc.	Wood, steel, concrete, dust etc.
Commercial & Institutional	Hotels, restaurants, markets, office buildings, schools, hospitals, prisons etc.	Bio-medical waste, Food waste, glass, metals, plastic, paper, special wastes etc.
Agriculture	Crops, orchards, vineyards, dairies, farm etc.	Agricultural wastes, hazardous wastes such as pesticides

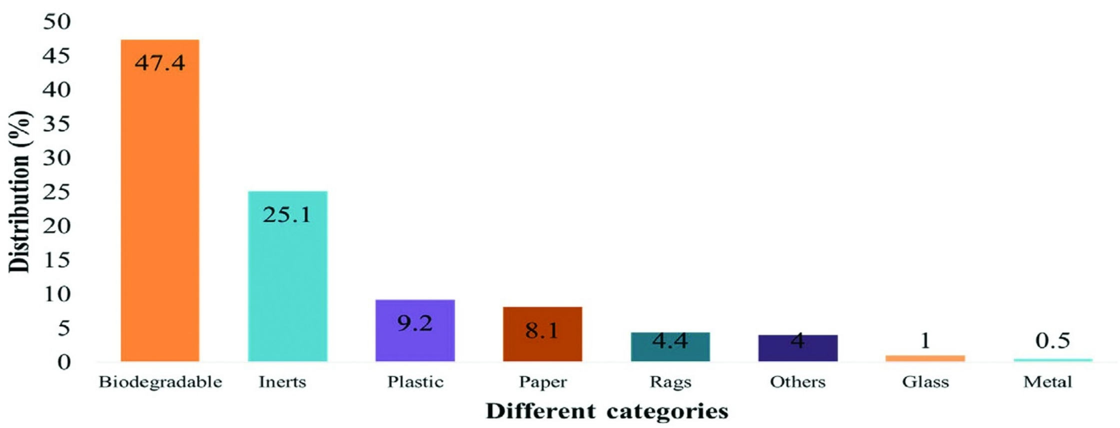

Fig. 1. Municipal solid waste characterisation in India (CPCB, 2005).

Research Article:

Table 3
Physical characteristics of MSW generated from different cities of India (CPCB, 2007).

City	Paper	Textile	Leather	Plastic	Metal	Glass	Ash, fine earth others	Compostable matter
Ahmedabad	6.0	1		3			50	40
Bangalore	8.0	5		6	3	6	27	45
Bhopal	10.0	5	2	2		1	35	45
Calcutta	10.0	0.3	1	8		3	35	40
Coimbatore	5	9		1			50	35
Delhi	6.6	4	0.6	1.5	2.5	1.2	51.5	31.78
Hyderabad	7	1.7		1.3			50	40
Indore	5	2		1			49	43
Jaipur	6	2		1		2	47	42
Kanpur	5	1	5	1.5			52.5	40
Kochi	4.9			1.1			36	58
Lucknow	4	2		4	1		49	40
Ludhiana	3	5		3			30	40
Madras	10	5	3				33	44
Madurai	5	1		3			46	45
Mumbai	10.0	3.6	0.2	2		0.2	44	40
Nagpur	4.5	7	1.9	1.25	0.35	1.2	35.4	30.40
Patna	4	5	2	6	1	2	35	45
Pune	5			5		10	15	55
Surat	4	5		3		3	45	40
Vadodara	4			7			49	40
Varanasi	3	4		10			35	48
Visakhapatnam	3	2		5		5	50	35
Average	5.7	3.5	0.8	3.9	1.9	2.1	40.3	41.8

Table 4
Chemical characterization of MSW based on population pressure in India (NEERI, 1995).

Population category	Nitrogen (total N)	Phosphorus (P_2O_5)	Potassium (K_2O)	C/N ratio	C.V. kcal/kg
>5.0	0.56	0.52	0.52	30.11	> 800.70
2.0–5.0	0.56	0.69	0.78	22.45	907.18
1.0–2.0	0.64	0.82	0.72	23.68	980.05
0.5–1.0	0.66	0.56	0.69	21.13	900.61
0.1–0.5	0.71	0.63	0.83	30.49	1009.89

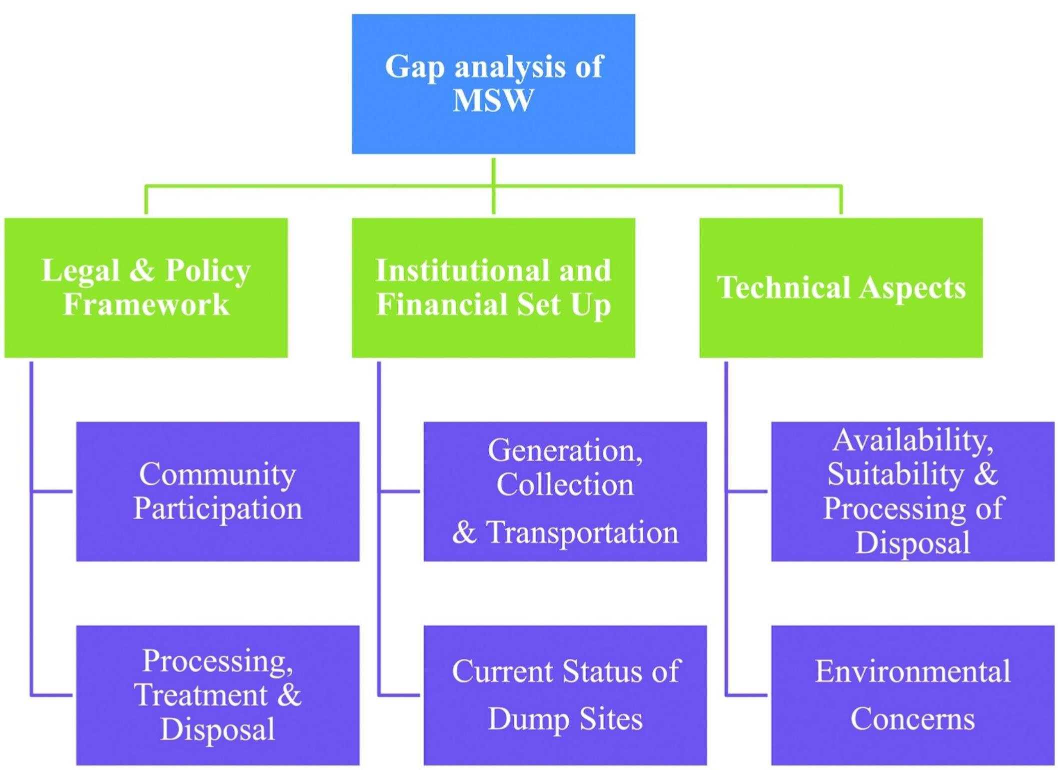

Fig. 2. Assessment of current situation or status and gap analysis in the country.

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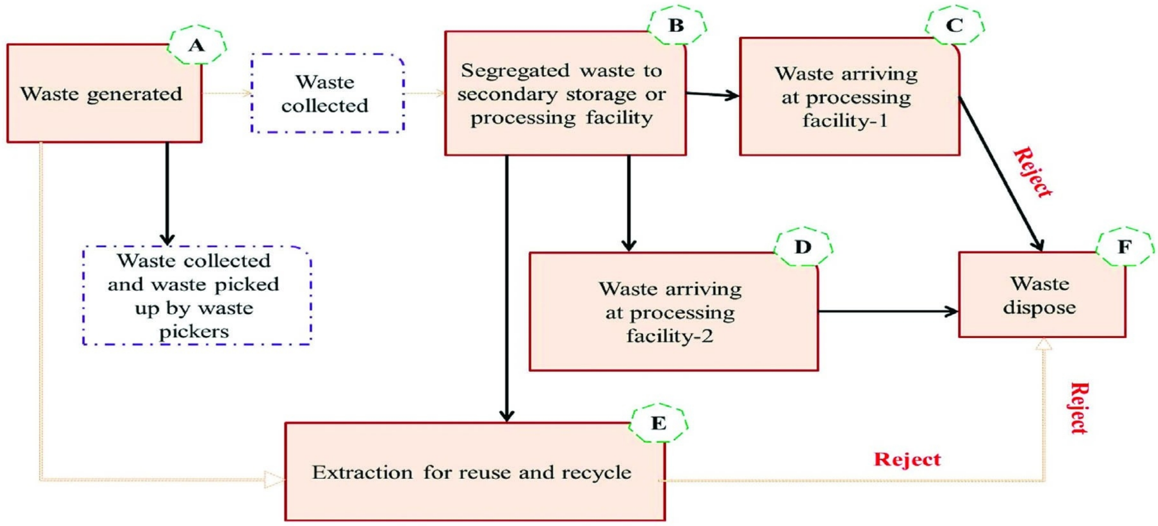

Fig. 3. Flow diagram for points of quantification.

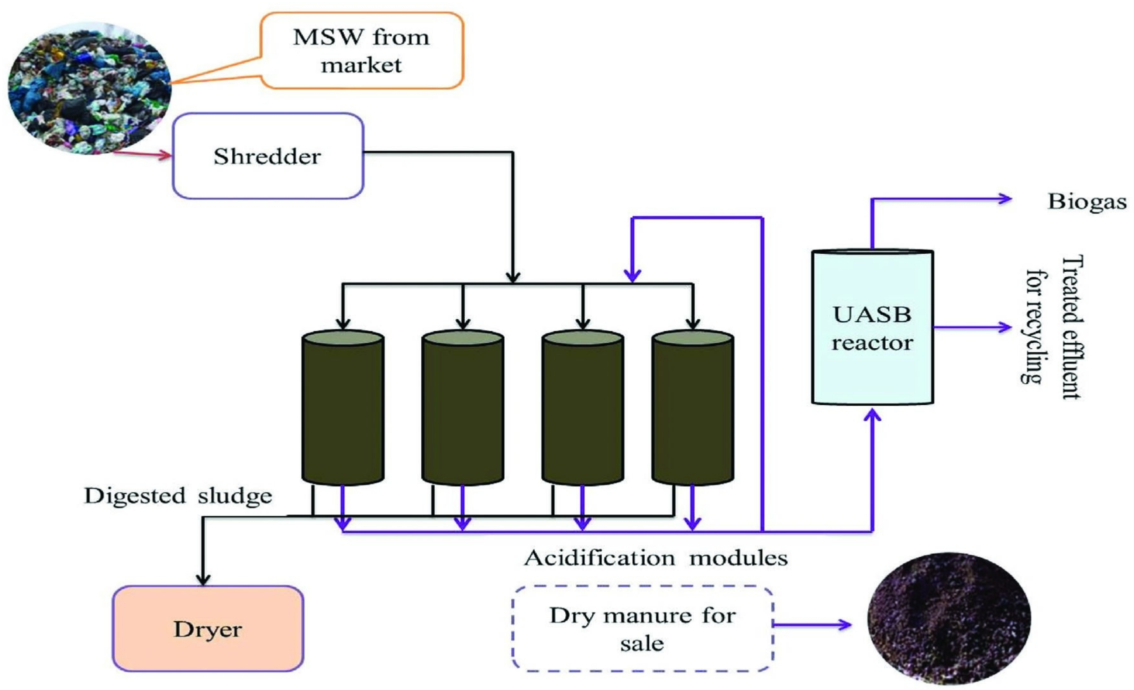

Fig. 4. Acidification and methanation phase.

well as recycling. The relationship between waste and GHG is explained as the potential benefits of adopting better waste management techniques/methods to overcome the problem of climate change.

Solid waste management affects GHG emissions

The main processes like i) Consumption without any consideration for resource conservation creates excess demand for extraction and manufacturing of goods from virgin materials, all of which contribute to greenhouse gas emissions in varying amounts at different stages of production and consumption. ii) Mixing wet waste with dry waste at the source of generation results in several negative downstream effects. iii) The increased volume of unprocessed mixed waste adds to transport demand which in turn increases fossil fuel consumption for the collection and transportation of waste from the source of generation to the landfill sites. iv) When the mixed waste (sometimes as high as 70%) is dumped at landfill sites, methane gas is released source of which is an anaerobic decomposition of biodegradable waste present in the waste. v) Leachate oozing out of decomposing biodegradable matter releases nitrous oxide. vi) Any act of burning of waste releases carbon dioxide and other harmful gases. Based on these activities, the International Solid Waste Alliance (2009) estimates that emissions from landfill sites, due to the decomposition of biodegradable waste, are the biggest source of GHG emissions from the waste sector globally.

Estimating GHGs emissions

IPCC advocates two methods of estimating GHG emissions from solid waste management, *i.e.*, the simple mass-balance approach (MBA) (IPCC default method) and the first-order decay method (FOD). In MBA method, it is assumed that all the methane gas from the waste is release in the current year of disposal itself. In the FOD method, on the other hand, factors in the period of biological degrada-

Research Article:

tion are taken into consideration. Apart from this difficulty to get the necessary information and historical data required for FOD estimation for faithful emission inventories projection are also responsible for use of this method. For best results, data collection in this sector should take local circumstances into account to the extent possible. For example, increasing amounts of waste disposed will lead to overestimation, while decreasing amounts will lead to lower side estimation of annual emissions (IPCC 2001).

As per the IPCC convention, only methane emission from landfill sites is estimated/ reported,

$$\text{Methane Emissions}: \frac{\text{kt}\,CO_2e}{yr} = MSW_t \times MSW_f \times MCF \times DOC \times DOC_f \times [(F \times MCR) - R] \times 1 - OF]\,25 \quad \text{(iv)}$$

where:

MSW_t = total mass of waste generated (kilo tonne/year); MSW_f = fraction of MSW disposed at landfill sites; MCF = methane correction factor for aerobic decomposition in the year of deposition (=0.4); DOC = degradable organic carbon in the year of deposition (Cgms/ waste gms, ~0.11); **IPCC recommended values given in parenthesis, multiplied by 25 for methane to carbon dioxide global warming potential equivalence conversion.*

Rules and regulations of MSW management in India

Solid Waste Management Rules, 2016 stipulate that the local authorities shall prepare a strategic plan for solid waste management, as per state policy and strategies on solid waste management within six months from the date of notification of state policy and strategy and submit a copy to respective departments of State Government/Union territory administration or agency authorised by the State Government/Union territory administration. These rules have been revised after sixteen years. Solid waste management is mandatory function of municipal; it is compulsory for all municipal authorities to execute this service effectively to maintain cleanness in the cities and towns, as well as to dispose the solid waste management in an environmentally well acceptable manner, complying with the solid waste management Rules, 2016.

Municipal solid waste management in India

India seriously revetment the resource and technical expertise which are necessary to handle huge quantities of solid waste disposal (Kausal et al., 2012). Fortunately, India has leading innovative techniques of waste disposal which are being used, composting (aerobic composting and vermicomposting) and waste to energy (WtE) (incineration, palletisation, bio-methanation). WtE technologies for disposal of MSW are a relatively new concept in India. However, these techniques have been tried and tested in developed countries with positive results, these are yet to get off the ground in India largely because financial viability and sustainability are still being tested (Sharholy et al., 2008). An incineration and bio methanation type of waste-to-energy system of solid waste disposal has also been worked in India but contributes at a minor level in the present scenario. In India only 6–7% of the MSW is used for composting purposes, the remaining amount of MSW is disposed off through landfilling (Annepu, 2012).

Methods/technologies for MSW management in India

Composting

Composting is the decomposition of organic matter by microorganisms in warm moist, aerobic and anaerobic environments. Therefore, composting of MSW is the simplest and most cost-effective technology for treating the organic fraction of MSW (Meena et al., 2019). The organic fraction in solid waste (SW) as progressed toward decomposition produces smell and odor problems. Scientific disposal of MSW is essential to reduce its pollution potential and several recycling methods are proposed for this purpose. A simplified process of aerobic composting is presented in Fig. 5.

Composting can be carried out in two ways *i.e.*, aerobically and anaerobically. During aerobic composting, aerobic microorganisms oxidize organic compounds to Carbon di oxide, Nitrite and Nitrate. Anaerobic decomposition, the anaerobic microorganisms metabolizing the nutrients, also breaks down the organic compounds via process of reduction. An anaerobic process, final product is subjected to some minor oxidation when applied to land (CPHEEO, 2000). Recently, composting of MSW is being encouraged and used by researchers and farmers for sustainable crop production across the world (Gautam et al., 2010).

Composting in the frame of integrated MSW management

The most accepted option of integrated solid waste management (ISWM) strategy *i.e.*, adoption of resource recovery strategies and composting, ensures that waste is processed appropriately to facilitate further use of the material (Fig. 5). Composting is a biological process of stabilising biomass either in the presence or absence of free oxygen, carried out by a host of microbes. Aerobic composting, which is carried out in the presence of air, is far more popular because it is much faster compared with "trench" composting where direct access to air is denied. Processing of MSW by this process yields humus rich compost (organic manure) along with macronutrients and micronutrients for plants. Composting is an environmentally beneficial waste recycling mechanism and not a waste disposal mechanism (Suppl. Table 1).

Constraints faced by the composting sector in India

Composting of MSW started in the late 1970 s when some mechanical compost plants were set up across the country. The concerned urban local bodies (ULBs) were the owner and operators of the compost plants. These facilities were a replica of plants from the industrial countries without the necessary adaptation exercise; consequently, these capital-intensive facilities were heavily mechanised and faced maintenance problems. An evaluation of the mechanical compost plants was carried out by the National Environmental Engineering Research Institute (NEERI) during 1980–1982. Since the input garbage was mixed and the design was not adequate for the removal of non-compostable fractions quality of the final product was poor, leading to lukewarm response from the market and a poor unviable price. The scenario changed in the early 1990 s with the entry of private sector equipment fabricators, plant operators, etc. Mechanisation was reduced by almost eliminating the pre-processing stages (*e.g.,* the mechanical compost plant of the Municipal Corporation of Delhi, 1981). In the later years, the euphoria was replaced by the realisation that the good price belonged to the niche market of plantations and some cash crops. And with more and more operating plants, the bulk of the compost had to be sold to the farmers, who could not afford it. The number of quality parameters to evaluate the compost maturity: physical, chemical and biological, including microbial activity, C/N ratio, pH, EC, CEC, organic chemical constituents, reactive carbon, humification parameters, temperature, color, odor, structure, specific gravity, plant assays, respiration, enzyme activity and others (Bernal et al., 2009; Bazrafshan et al., 2016).

Vermicomposting

Organic fractions or biodegradable portions of waste can easily convert into nutrient enriched products by worms. In composting heat is generated during the composting process, which is very harmful and would kill the worms; whereas in a vermicomposting, a conducive environment is maintained thus worms thrive and reproduce very

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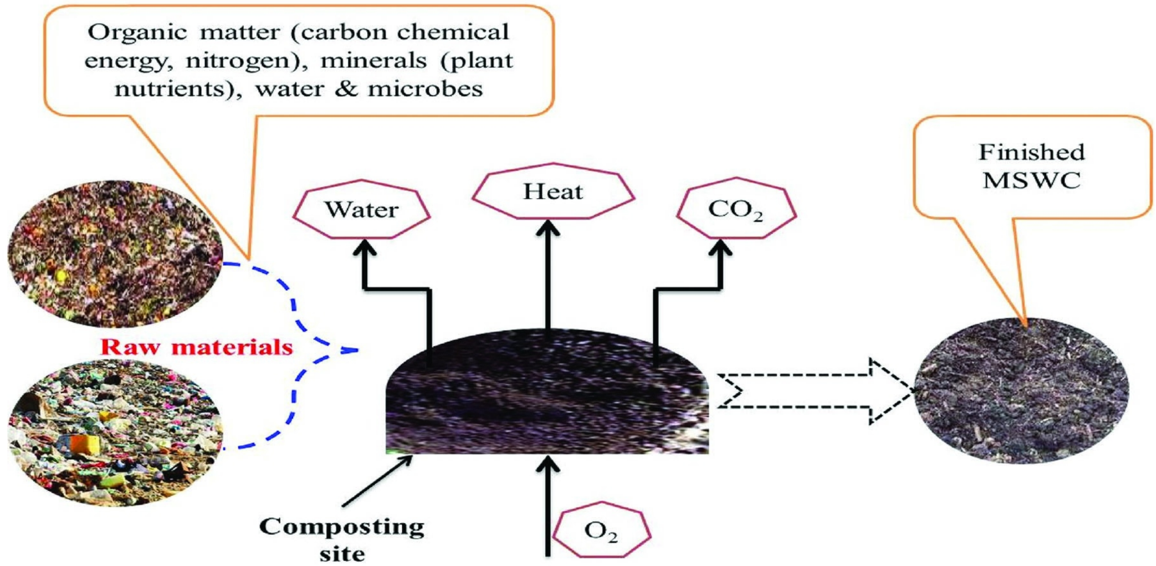

Fig. 5. Aerobic process for municipal solid waste composting, adapted from Rynk (1992).

well. In vermicomposting, worms properly processed an organic fraction of waste excreting them as an organic material which is well matured and contains high amount of plant available nutrients. As far as nutrient concentration is concerned vermicompost is much higher than ordinary composts (Aalok et al., 2008; Srinivasarao et al., 2014). Nutrient enriched manure produced through vermicomposting is free from any odors and looks like a dark brown material (Manyuchi and Phiri, 2013).

Landfilling

Landfilling has been the most convenient way to dispose municipal solid waste in low-laying areas. Penetration of leachates from landfills poses very serious problem for crops grown near landfills, the leachates can contaminate the ground water and ultimately it might be taken up by plants. Landfilling sites produce harmful gases and leachate, thus there is a possibility to harm human and natural ecosystems. Methanogens degrade the complex molecules in landfill of waste, and produced CH_4 and CO_2 (90%), leachates released from landfills can cause surface and ground water pollution (Nagarajan et al., 2012; Smahi et al., 2013).

Bio-methanation

Conversion of organic matter from municipal solid waste into methane as well as manures by microbial treatments in absence of air is considered as bio-methanation. Solid waste generated from the agriculture-based industry has high organic matter content and is treated through bio-methanation, because it produces uses biogas and nutrient enriched manure. The important product of bio-methanation is biogas. It consists of CH_4 and CO_2, which are use full by using as electricity as wellas fuel for cooking foods (Annepu, 2012). There are several bio-methanation technologies have been executed in various cities for vegetable wastes and fruit waste (Velmurugan and Ramanujam, 2011; Prakash and Singh, 2013).

Incineration

Treatment of waste by the thermal process in which raw waste materials can be recycled as feed stock known as incineration (Zaman, 2010). Incineration contrasts the bio-methanation process; it occurs in the presence of air at 850 °C temperature, and wastes are converted into CO_2, water and non-combustible product along with solid residues (DEFRA, 2007; Zaman, 2010; Moustakas and Loizidou, 2010). Indian cities have limited to hospital and biological waste incineration, it might be due to the high organic fraction (40–60%), high moisture contact (40–60%) and low CV content (800–1100 kcal/kg) in solid waste (Kansal, 2002; Rajput et al., 2009).

Integrated solid waste management system (ISWM)

Integrated solid waste management (ISWM) basically depends upon the characteristics and quantities of solid waste produced in ULBs, financial liabilities and capabilities of authorities to effective project implementation. ISWM provides a framework to develop a sustainable system approach that should be economical, socially well acceptable as well as environmentally efficient and effective (Fig. 6 and Fig. 7). ISWM system involves several treatment techniques and functioning of system for effective collection and shorting of MSW for improving social, economic, and environmental conditions of the municipality (Suppl. Table 2).

Waste segregation based on 3R concept

ISWM is very much relevant to the 3R approach emphasizes on the importance of waste reduction, reuse and recycling over other forms of waste processing (Table 5). The execution of these

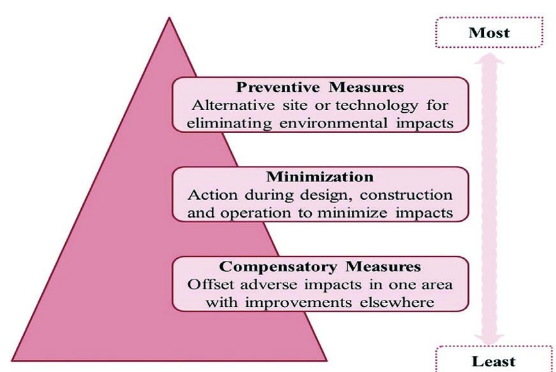

Fig. 6. Hierarchy of environmental impact mitigation options adapted from Hayter S, 2015.

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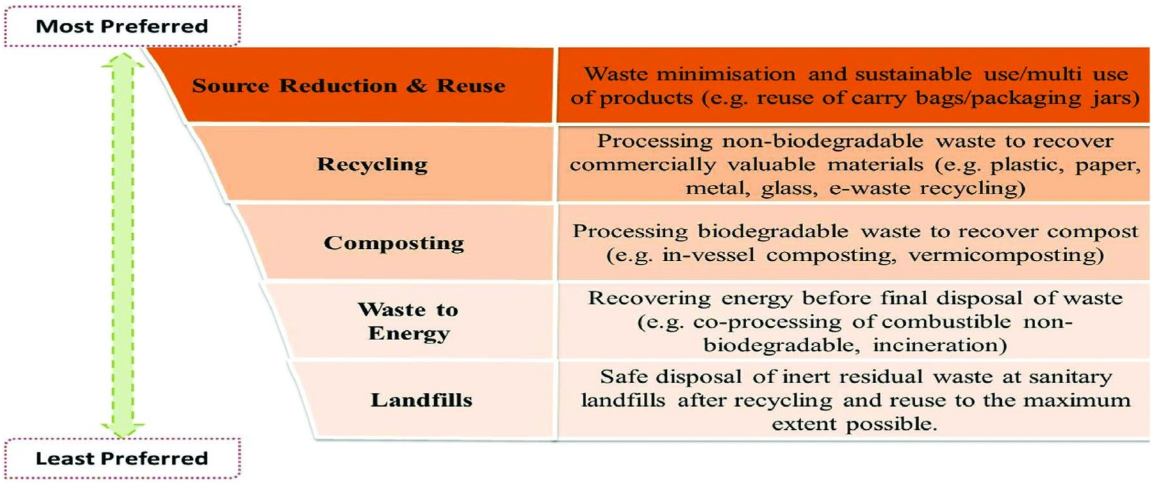

Fig. 7. Integrated solid waste management hierarchy ranks according to their environmental benefits (CPHEEO, 2000).

Table 5
Effects of MSW compost on soil properties and crops yield discussed.

MSWC (Mg ha^{-1})	Crops	Comments	References
Alfalfa-150, cocksfoot. −60	Alfalfa and cocksfoot	Organic carbon increased	Montemurro et al. (2006)
100 (2 applications)	Clover	Increased N, Zn, Cu, Ni, and Cr uptake, pot experiment	Murillo and Cabrera (1997)
90 and 270	Corn	Composts highly variable year to year	Mamo et al. (1999)
40.0	*Hordeum maritimum*	Significantly increased in carbon, nitrogen and potassium under both non-saline and saline conditions	Lakhdar et al. 2011
16.0	Mustard and pearl millet	Yield was significantly increased over control, field experiment	Meena, et al. 2016a
15, 30, and 60	N/A	Increased water holding capacity, pH, soil Zn and Cu concentrations, pot experiment	Hernando et al. (1989)
15, 30, and 60	N/A	Increased water holding capacity, pH, soil Zn and Cu concentrations, pot experiment	Hernando et al. (1989)
5.9–6 and 40	Rice	Increased yield, pH (field experiment); high rates did not affect microbiology of soil (pot experiment)	Bhattacharyya et al. (2003)
10, 20, 30, 40, and 50	Ryegrass	High rates can provide sufficient N for ryegrass, E.C. increased with rate, soil P retention decreased, pot experiment	Iglesias-Jimenez and Alvarez (1993)
10, 20, 30, 40, and 50	Ryegrass	High rates can provide sufficient N for ryegrass, E.C. increased with rate, soil P retention decreased, pot experiment	Iglesias-Jimenez and Alvarez (1993)
35, 70, and 140	Tomatoes	Increased soil concentrations of Cd, Cu, Pb, Ni, and Zn, fruit uptake was not observed	Ozores-Hampton and Hanlon (1997)
0.03, 0.06 and 0.12	Wheat	Increase yield, downward movement of P observed, pot experiment	Bar-Tal et al. (2004)

principles helpful in minimizing the quantities of waste generated from different sources as well as also helps in the human health and environmental risk which are associated with it. Maximization of resource recovery at all stages of MSW management has been advocated by both approaches.

Waste segregation: Waste segregation has been considered as the biggest obstacle to effective solid waste management. Waste segregation is popularly used by developed countries, but countries like India mostly collect MSW in a mixed form. Reasons for this can be attributed to a lack of public awareness and fewer advancements in source separation techniques. Source separation is essential to increase recycling effectively and efficiently, this improves the performance of waste treatment units due to good quality of feed and lesser amount of impurities. The following are some of the most crucial waste segregation criteria: 1) segregation at source: segregation at source is the first and most crucial waste management principle. Garbage separation at the source ought to be practiced at home, in schools, offices, and markets. Separate bins can be used to dispose of trash. 2) different treatments for various solid waste types: one must use the methods that are appropriate for the particular type of trash. For instance, a technique that works for waste from general markets might not work for waste from slaughterhouses. 3) treatment at the closest location: the treatment of solid waste should be as decentralized as feasible. The best place to treat the waste produced is at the place where it was created, which is every home.

Reduce: The use of green elements as raw materials, extension of waste life cycle, reducing energy, optimum design and heat losses, replaces of raw materials can help to reduce the amount of waste generation. The 'Reduce' step has been considered the top-ranking step of MSW management due to effectively in reducing economical costs and environmental impacts associated with handling.

Reuse: Reuse' means usage (or utilization) of a product in the same application for which it was originally used. For example, a plastic bag can carry groceries for home from the market over and over again, a tin can be used as a multipurpose container. This involves disassembling the product, cleaning and refurbishing the useful parts and stocking those parts in inventory.

Recycling: The recovery of materials is given second priority in the solid waste management hierarchy after source reduction. Recycling includes the collection and separation of recyclables and processing them into useful raw materials for other products. This step can be classified as pre-consumer and post-consumer recyclable materials. An example of a resource recovery system for mixed solid waste is shown in Fig. 8.

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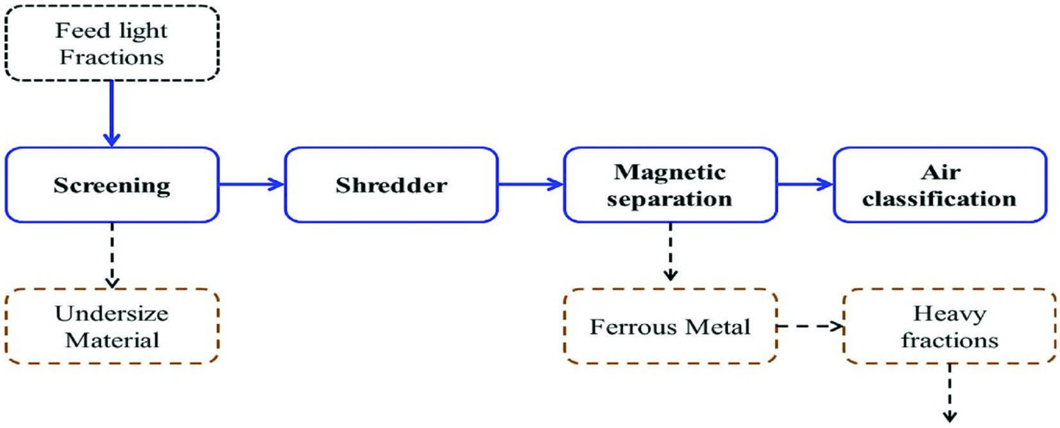

Fig. 8. Resource recovery system for mixed solid waste.

Source reduction and reuse: The most preferred route for waste management in the ISWM hierarchy has been thwarting the generation of waste at various stages including design, production, packaging, use, and reuse of products. Waste prevention helps to reduce handling, treatment, and disposal costs and various environmental impacts such as leachate, air emissions, and generation of GHGs. Minimization of waste generation at source and reuse of products are the most preferred waste prevention strategies.

Waste to energy: Where material recovery from waste is not possible, energy recovery from waste through the production of heat, electricity, or fuel is preferred. All over the world, landfills which integrate the capture and use of methane are preferred over landfills which do not capture the landfill gas. As per the hierarchy, the least preferred option is the disposal of waste in open dumpsites. However, Indian laws and rules do not permit the disposal of organic matter into sanitary landfills and mandate that only inert rejects (residual waste) from the processing facilities, inert street sweepings, etc. can be landfilled. In cases where old dumps are to be closed, there is a possibility of capturing methane gas for further use. However, repeated burning of waste significantly decreases the potential of capturing methane.

Application of MSW compost to normal soils

In general, composts have a beneficial effect on sustainable agriculture production due to its tendency to replenishment of nutrients in soil solution as slow release as compared to chemical fertilizers (Table 6). Application of compost with nutrient enrichment as well as inoculation with microorganisms, it provides a conducive environment for long-term benefit to the crops. Therefore, nutrient enriched compost released N at slower rate (1–3% of total N/year) and inhibited the N losses in the form of leaching and volatilization. On other hand, the N release rate from chemical fertilizers is faster and available to only one crop or very shorter time in comparison to composts (Meena et al., 2018; Meena et al., 2022). The integration of compost and chemical fertilizers application in soil could be highly important and nutrients released in a gradual and slow manner and subsequently affect plant growth and finally yield (Ahmad et al., 2006). Therefore, a biodegradable portion of MSW could convert into valued product and use as soil conditioner blended with N/phosphorus compound to enhance the nutrient use efficiency of fertilizers. In addition, composts inoculated with N-transforming (ammonifying) nitrifying organisms provoke significant improvements in microbial activity in the soil. Similarly, compost blended with phosphorus solubilizing microbes (Meena and Biswas, 2014a; 2014b).

Application of MSW compost to salt-affected soils

Application of MSWC in saline soils, the yield of crops had significantly improved as compared to the control. Application of MSWC

Table 6
State wise energy generation potential of MSW in India (). adapted from Saini et al., 2012

State/Union Territory	Total MSW (Tons/day)	Energy Potential (MW)
Lakshadweep	3.74	0.07
Arunachal Pradesh	13.56	0.27
Nagaland	14.52	0.29
Sikkim	14.71	0.29
Daman and Diu	25.63	0.51
Dadar and Nagar Havelli	25.75	0.51
Meghalaya	54.25	1.08
Manipur	61.03	1.21
Mizoram	64.37	1.28
Himachal Pradesh	71.53	1.42
Andaman and Nicobar Islands	105.46	2.10
Tripura	137.90	2.74
Pondicherry	185.66	3.69
Goa	221.92	4.42
Assam	341.73	6.80
Uttarakhand	424.00	8.44
Jammu and Kashmir	746.24	14.85
Orissa	839.25	16.70
Jharkhand	942.55	18.76
Chhattisgarh	1077.02	21.43
Kerala	1689.02	33.61
Bihar	1956.78	38.94
Haryana	2184.78	43.48
Madhya Pradesh	4633.63	92.21
Punjab	4645.00	92.44
Rajasthan	4671.89	92.97
Gujarat	7930.91	157.83
Karnataka	8296.02	165.09
Tamil Nadu	9501.77	189.09
Andhra Pradesh	9998.97	198.98
Delhi	11873.06	236.27
West Bengal	12069.24	240.18
Uttar Pradesh	13651.39	271.66
Maharashtra	22434.35	446.44
Total in India	**120,908**	**2406.06**

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Abstract of Selected Research Article:

Solid Waste Management in India: A State-of-the-Art Review:

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This paper presents the current scenario of solid waste management aspects and its challenges in India, which will benefit developing and low-income countries. The leading cause of waste generation is the growing population and the new lifestyle due to the increased per capita income. Consequently, the magnitude of solid waste is continuously growing along with its compositional diversity. In earlier days, the wastes were organic and could be disposed of in low-lying areas conveniently without causing any adverse impact on the environment. But today, the organic fraction of waste has steeply declined while the inorganic portion has increased manifold. Moreover, wastes from industries, hospitals, construction sites, households, and many other sources severely affect the environment and public health. Also, the chemicals generated from the improper disposal of these wastes enter the air, soil, and water resources, causing hazardous and toxic effects in countries that could not implement the adopted policy framework strictly. A state-of-the-art review is conducted in this paper to further search other primary and prevalent reasons behind the inability of proper waste management and to find a real solution.

Keywords:
Challenges, Municipal solid waste, Solid waste management, State-of-the-art review, Waste characterization, Waste generation

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Influencing factors of domestic waste characteristics in rural areas of developing countries:

Waste management in rural areas has become a major challenge for governments of developing countries. The success of waste management decisions directly lies in the accuracy and reliability of the data on which choices are based; many factors influence these data. Here, we examined the factors influencing domestic waste in rural areas of developing countries (RADIC), using both field surveys and by reviewing previous literature. The social factors included population, education and culture. There was a positive linear relationship between waste generation amount and population size (R2 = 0.9405). Environmental education, training and demonstration projects played a positive role in improving people's awareness of the benefits of recycling and reducing waste. Traditional and national cultures, consumption and living habits contributed to variations in the generation and composition of domestic waste. Generally, practices related to conservation of and reverence for nature and green consumption encourage people to reduce, reuse and recycle waste in their daily life. Economic factors included household income and expenditure, energy and fuel structure, and types of industry that occurred in villages. A Kuznets inverted "U" curve relationship existed between domestic waste generation and people's income in rural areas of China. However, the waste generation rate had a linear relationship with the gross national income per capita in RADIC. The composition, bulk density and calorific value of domestic waste were variously affected by the energy and fuel structure and the types of industry that occurred.

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Latest News on Solid Waste Management

Ref: https://www.thehindu.com/news/cities/Madurai/kodaikanal-grapples-with-waste-management/article67433824.ece

Kodaikanal grapples with waste management

Published - October 18, 2023 06:58 pm IST

The Prakasapuram landfill near Perumalmalai on Kodaikanal hills is overflowing. Activists say it is not just the leachate from the landfill that enters the streams that flow through the pristine shola forest adjacent to it but also solid waste. These streams are the water source for the residents.

Activist Avijit Michael has moved the court seeking steps to biocap it. Though a Municipal Solid Waste Management Rule, 2016, states that garbage dump in hill stations should not be located in fragile zones, the Prakasapuram landfill defies the edict.

Municipal Commissioner P. Sathiyanathan says, "Unike waste management in the plains, micro composting cannot be done on the hills." Kodaikanal municipality has 40,000 residents and sees 80 lakh tourists every year. But there are only 19 garbage bins across the town. The sanitary staff do the house-to-house collection of waste.

"Our main problem is the waste being generated by the huge number of homestays. They get plan approval saying they are residences only but allow visitors to stay during weekends. So, we face revenue loss and are also unable to gauge the amount of waste generated. If a household generates 750 grams of waste in a day, for homestays it runs into a few kgs. Thy are dumped into nearby streams, " says Mr. Sathiyanathan.

Another official says these homestays are registered with the Tourism Department but do not get the required permits from the municipality. "We have started biomining at the landfill site and construction of a retaining wall will begin soon," he adds. But activists say biomining is not the solution as microplastic and other waste would have seeped and contaminated the groundwater.

Fig: The municipal garbage dump at Prakasapuram on Kodaikanal hills.

R. Rajamanikam and Iti Maloney of Kodaikanal International School Centre for Environment and Humanity say there is no proper waste audit. No information on quantum of waste, its composition, which sector generates what waste, how they are collected and how they can be recycled.

"After the COVID-19 pandemic, there has been more awareness among the stakeholders and the Kodai school has done programmes on waste management in the 23 government schools. We are also in talks with the hospitality sector and cab owners' association on managing the waste," says Ms. Iti.

Waste segregation at source is a must but many households dispose waste directly into streams.

During the recent long weekend, about 1,000 tourist vehicles arrived and left 600 kg of waste in the shola forests in the town. So more needs to be done on collecting waste from tourists. Silver foils and low-grade plastic account for a major share. "On entering the hills, the tourists can be given bags to put their waste and they can be returned at the toll gate when they leave," Mr. Rajamanikam says.

Similarly, empty chips packets form a major part of the waste. As farmers in Kodaikanal grow potatoes, chips units can be started with government subsidy and sold under 'Kodai' brand to tourists in brown bags, says Ms. Iti.

Know Your Polymer

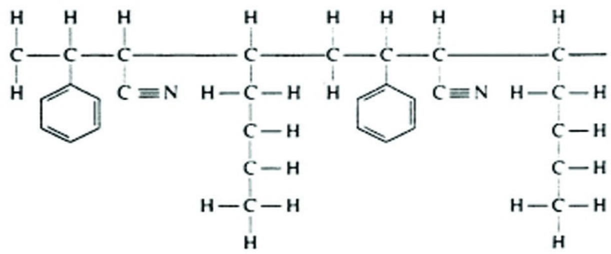
ABS (Acrylonitrile Butadiene Styrene)

Introduction:

ABS plastic, or Acrylonitrile Butadiene Styrene, is a tough and durable thermoplastic material that has been used extensively in the manufacturing of various products. It is known for its high strength, toughness, heat resistance, and electrical insulation properties

How ABS is made?

ABS is produced by emulsion or continuous mass technique. The chemical formula of Acrylonitrile Butadiene Styrene is $(C_8H_8 \cdot C_4H_6 \cdot C_3H_3N)_n$. The natural material is an opaque ivory color. It is readily colored with pigments or dyes.



Properties of ABS:

- High rigidity, good weldability, and insulating properties.
- Good impact resistance, even at low temperatures.
- Good abrasion and strain resistance.
- High dimensional stability (Mechanically strong and stable over time)
- High surface brightness and excellent surface aspect

Applications:

ABS plastic is commonly used in the construction of electronic components such as computer keyboards, cameras, auto parts, medical device components, and many other items. In addition to its versatile uses in industrial applications, this powerful thermoplastic material can also be found in everyday household items such as toys and recreational goods.

Infographics

What goes in your bins?

✔ YES | ✘ NO

RECYCLE

Clean items for recycling – not in bags

Batteries – Please recycle them with your blue bin
If you have any batteries that you need to recycle – it's easy. All you need to do is put them in any plastic bag, and attach the bag to the handle of your **BLUE** bin **(not your green bin as previously).**

Your batteries will then be sorted for recycling by type, with the chemicals inside them extracted to be used again, and the metal casings melted down and recycled.

Paper, magazines and envelopes

Large tins

Greetings cards

Cardboard

Cartons

Empty aerosols

Glass bottles and jars

Cans, tins and metal jar lids

Shredded Paper (Put in old envelope)

Plastic bags, film and wrapping

Plastic bottles, tubs, pots and trays

NO:

- Nappies/sanitary waste
- Envelopes containing bubble-wrap (for example, Jiffy Bags)
- Wood, plasterboard
- Food or garden waste
- Pyrex, plate glass, glass dishes or light bulbs
- Saucepans/other metal items not listed on the left
- Foil-lined plastic pouches (for example from pet food)
- Crisp packets
- Expanded polystyrene or Styrofoam
- Plates/crockery
- Clothing and textiles
- Video and cassette tapes

COMPOST

Food waste

Untreated wood and sawdust

Garden waste

NO:

- Non-compostable items
- Plastic & plastic bags (including biodegradable/ corn starch)
- Nappies
- Soil or stones
- Painted or treated wood
- Cat or dog waste
- Plant pots and seedling trays

REDUCE

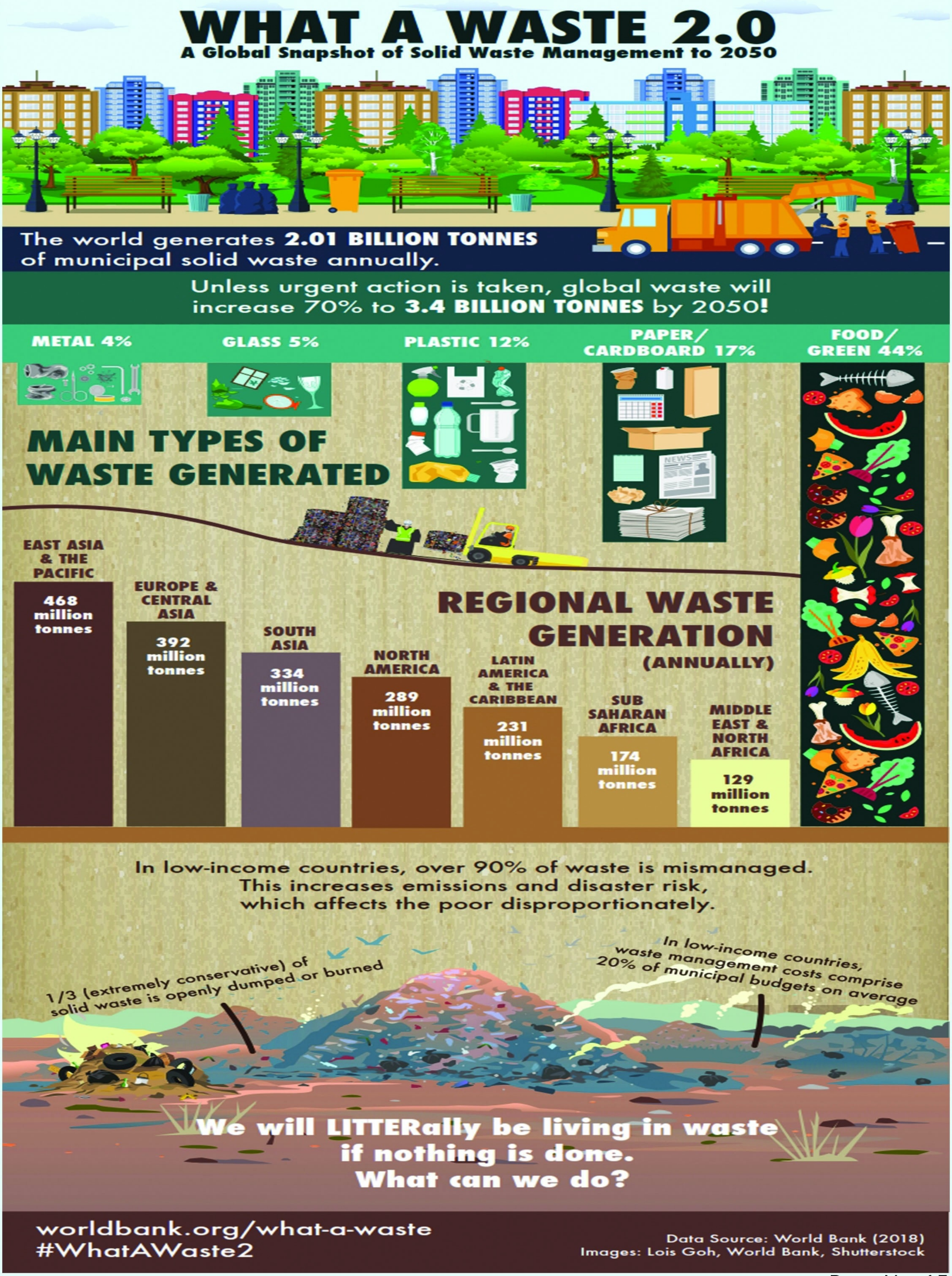
Please try to reduce other rubbish that can not be recycled or composted

General rubbish

NO:

- Rubble
- Bricks
- Soil
- Very heavy items
- Electrical items (take to tips near Thriplow or Milton)

Statistical Info



Awareness

Waste Segregation Guidelines

1. Organic Waste

(Do **NOT** use a plastic liner)

Kitchen Waste
Vegetable/fruit peels
Cooked food/Leftovers
Egg shells
Chicken/fish bones
Rotten fruits/vegetables
Tissue paper soiled with food
Tea bags/Coffee grinds
Leaf plates

Garden waste *
(small quantity only; from Apt)
Fallen Leaves/twigs
Puja flowers/garlands
Weeds

2. Dry Waste

(Use only **reusable** bags for disposal)

Plastic (Must be rinsed if soiled)
Plastic covers/bottles/boxes/items
Chips/toffee wrappers
Plastic cups
Milk/Curd packets

Paper (Must be rinsed if soiled)
Newspaper/Magazines
Stationery/Junk mail
Cardboard cartons
Pizza boxes
Tetrapaks
Paper cups and plates

Metal
Foil containers
Metal cans

Glass (handle with care)
Unbroken glass bottles

Other dry waste
Rubber/Thermocol
Old mops/Dusters/Sponges
Cosmetics,
Ceramics, Wooden Chips,
Hair
Coconut shells

E-waste (handle with care)
Batteries
CDs/Tapes
Thermometers

Bulbs/tube lights/CFLs **
(hand over separately)

3. Reject Waste

(Do **NOT** use a plastic liner)

Sanitary waste
(Use a newspaper for wrapping)
Diapers/Sanitary napkins
Bandages
Condoms
Nails
Used tissues
Medicines
Swept dust

(Limited quantities of mixed waste is allowed, such as heavily soiled plastic or soiled paper)

Sharps § (small quantities only; wrap in newspaper and hand over separately)
Razors/Blades
Used syringes
Injection vials

Construction debris/Inerts ¤
(Hand over separately)

Rubble
Paints
Silt from drains
Cement powder
Bricks
Flower pots

Broken glass
(wrap in newspaper)

* **Garden waste** from our campus grounds will be picked up separately.
** Hand over your fused **tube-lights and bulbs** separately. There is a separate bin for these items in the basement.
§ There is a separate bin for the **sharps** items in the basement.
¤ **Construction debris** in large quantities will be charged extra per load.

Bruhat Bengaluru Mahanagara Palike
Segregation at source is MANDATORY.
Non-compliance will be penalized.

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Kids Corner

Teach Kids 5rs of Food Waste Management

5RS OF FOOD WASTE MANAGEMENT

R – Refuse

Say "no thanks" to single-use plastic bags, bring your own reusable shopping bags and containers. Skip freebies if you won't use them.

R – Reduce

Plan your meals for the week to avoid impulse buys. Make a grocery list and stick to it! Use smaller plates to control portion sizes.

R – Reuse

Leftovers become tomorrow's lunch! Pack them in cute containers or jars. Expired spices can be repurposed into DIY cleaning solutions.

R – Repurpose

Start a compost bin for food scraps and turn them into nutrient-rich fertilizer for your garden. Get creative with expired ingredients!

R – Recycle

Check your local guidelines and only recycle food packaging that belongs in the bin. Rinse everything to avoid attracting pests.

6 TIPS TO PREVENT WASTE

1 Store fruits and veggies separately to reduce food wastage

2 Recycle Newspapers

Along with newspapers, recycling centers also accept cardboards, tissue boxes, phone books and catalogues.

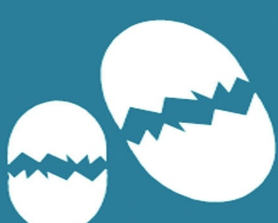
3 While recycling, always remember

- No need to peel off labels from bottles.
- Cartons and plastic bottles are recyclable.
- Billing envelopes can be recycled as well.
- Get rid of the plastic lining from cereal boxes before recycling.

4 Reuse containers

Jams and peanut butter jars are examples of reusable containers that can be used for future food storage. When you want to replace them, it's time to recycle.

5 Instant composting



For quick composting, egg shells and coffee grounds can be sprinkled in your gardens immediately after consuming.

6 Compost at home

TCE EIACP PC-RP