Toxics Link
for a toxics-free world

Clean Communities

A comprehensive guide to effective solid waste management

Bindas, Toxics Link's spokesperson on waste management issues, presents a detailed but easy-to-follow approach to solid waste management, in a manner as compelling to the experienced campaigner as it is for those just starting out to make a difference in their community.

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Meet Bindas, the genius genie of the dustbin. She has a passion for junk jewellery but absolutely despises junk food – after all, she has to watch her waste line!

She is the superwoman of waste and can magically materialise in any bin at a moment's notice. All she needs is a little bit of wire, some cloth and most importantly, some junk she can use for jewellery.

She knows everything about waste, and is always ready to put that knowledge to fruitful use. She loves putting waste to imaginative uses, and does not tire of letting people know what to do with their waste, taking on various roles in her efforts to do so.

December 2005; Toxics Link

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About Toxics Link

Toxics Link is an environmental NGO, dedicated to bringing toxics related information into the public domain, both relating to struggles and problems at the grassroots as well as global information to the local levels. We work with other groups around the country as well as internationally in an understanding that this will help bring the experience of the ground to the fore, and lead to a more meaningful articulation of issues. Toxics Link also engages in on-the ground work especially in areas of municipal, hazardous and medical waste management and food safety among others. We are also involved in a wider range of environmental issues in Delhi and outside as part of a coalition of non-governmental organisations.

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Preface

The problem of Municipal Solid Waste Management is assuming alarming proposition, because waste generation is increasing at a rapid pace. The reasons may be attributed to changing consumption patterns and lack of capacity of those who have the legal mandate to discharge this responsibility. Consumption, linked to per capita income has a strong relationship with waste generation, which is further linked to increasing urbanisation. Urbanisation not only concentrates waste, but also raises generation rates since rural consumers consume less than urban ones. India will probably see a rise in waste generation from less than 40, 000 MT per year to over 125, 000 MT by the year 2030.

Waste management is literally the process of managing waste materials, normally those produced as a result of human activities. It involves the collection, transport, processing and/or disposal of waste materials. Municipalities have the legal mandate to carry out these activities. However, due to lack of financial and infrastructural resources, there is vast gap in demand and supply. Lack of capacity to comprehend the problem adequately compounds the problem, which is also due to absence of knowledge about the technological developments that can provide solutions to various problems concerning the sector. At the same time, due attention needs to be paid that we do not adopt new and expensive technologies, that are being pushed to deal with our urban waste problem, ignoring their environmental and social implications.

Moreover, there is no Indian policy document, which examines waste as part of a cycle of production-consumption-recovery or perceives the issue of waste through a prism of overall sustainability. Toxics Link is engaged in creating awareness among all the stakeholders about various critical issues involved. We are not only facilitating the interventions at the local level, but also trying to find crucial linkages and other relevant issues through research studies. Raising issues at the policy level at the appropriate platforms is part of the agenda.

Toxics Link, in its documentation process, found that decentralised community based solid waste management interventions have been fragmented and are often contradictory. They have been following various approaches as per local needs and understanding of the subject matter. But basically these approaches have evolved by trial and error methods and over a period of time. Questions asked by the community members and service providers while organizing several training workshops form the basis for the preparation of this manual.

The need for such a manual was also felt because the manuals and reference materials which are available presently like ***Manual on Solid Waste Management*** by ***CPCB*** deal with the subject from the municipality's perspective. Consequently, solutions suggested therein are highly capital-intensive and technology oriented. All these solutions are irrelevant from community interventions' perspective, which neither have access to resources nor the capacity to opt for such solutions. Local field practitioners, who lack academic training to understand these complicated and high-skill oriented suggestions, are managing majority of these interventions.

This manual attempts to fill the above-mentioned gap and tries to find solutions from a community's perspective. Especially so as there is realisation in the policy arena that end users' involvement is essential for successful municipal solid waste management. Additionally, the manual is useful for all the stakeholders as it chalks out a strategy for engagement of all concerned.

Acknowledgements

Toxics Link greatly appreciates and acknowledges the effort of Dr. Sachin Chowdhry, who took a deep interest in understanding the issue in its right perspective. He collated information from various sources, analyzed them and finally prepared this guidebook after consultations with experts. It is his tireless effort and clear understanding that has helped Toxics Link in getting this Guidebook ready to reach out to large number of practitioners and institutions engaged on the issue of Solid Waste Management.

We would like to thank Ms. Anomita Goswami for her editorial inputs and suggestions. The subject matter required a lot of information about the ground realities and concerns of each stakeholder. This publication would not have been completed without the support of members of the Communities and Waste programme of the organisation, particularly Mr. Indrajeet Rai and Ms. N. Linthoingambi.

We also acknowledge excellent support provided to Dr. Chowdhry by the library staff of Toxics Link and TERI, who sourced all the necessary documents and publications and facilitated the collection of information. We also acknowledge the library staff of Indian Institute of Public Administration for helping in locating relevant materials.

Toxics Link acknowledges Splash! Communications who have made valuable contribution to the final publication and are responsible for designing and printing this Guidebook.

We also express our sincere gratitude to The Ford Foundation for supporting the issue and helping us in bringing out this Guidebook.

Toxics Link
December 2005

CHAPTER 1

Waste, and how to deal with it

What exactly is 'waste'?

Anything that is rendered useless by us is waste. So, generation of waste is linked to human activities. What we discard, reject, abandon or otherwise release into the environment becomes waste. This could be as simple as throwing the packaging material of the clothes we buy, or the routine vegetable wastes, and as complicated as disposing of household electrical or electronic appliances, which may have hazardous components.

Broadly, waste may be generated throughout the product life cycle – during the extraction and processing of raw materials or during their processing into intermediate and final products and finally during the consumption of these products. Apparently, the waste could be in solid, liquid or gaseous form. For example, during the making of plastic products a lot of toxic material is released into the atmosphere and effluents are discharged into the water sources. These products when burnt after use release dioxins into the air.

This manual focuses on solid waste, the term used to describe non-liquid waste materials arising from domestic, trade, commercial, agricultural, industrial activities and from public services. We usually call this garbage. If not managed properly, these waste materials can have adverse impact on the environment and serious consequences for public health, arising from contamination of soil, water or air and the spread of diseases through vectors thriving on waste. The problem of urban solid waste is assuming alarming proportions.

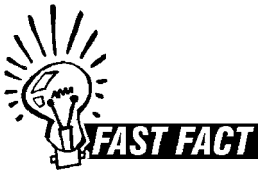
Types of solid waste

With growing urbanization, we are increasingly generating more waste. Urban solid waste is diverse in nature and can be broadly categorized in the following categories, though these are not discrete and tend to overlap:

Municipal solid waste

Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is

In 1947, cities and towns in India generated an estimated 6 million tonnes of solid waste; in 1997 it was about 48 million tonnes.



More than 25% of municipal solid waste in India is not collected at all; 70% of Indian cities lack the capacity to transport it.

generated mainly from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste generated has been increasing rapidly, and its composition has been changing. In 1947, cities and towns in India generated an estimated 6 million tonnes of solid waste, in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities are lacking in the capacity to transport it, and there are no sanitary landfills to dispose of the waste. Existing landfills are neither well equipped or managed nor lined properly to protect against contamination of soil and groundwater.

Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminium foil, plastic and other such non-biodegradable items that cause irreparable harm to the environment. There are different categories of waste, each of which takes its own time to degenerate.

Municipal solid waste/garbage can be broadly categorized as:

- **Domestic waste:** Kitchen waste, vegetable, flower, leaf, and fruit.
- **Toxic waste: O**ld medicine, paint, chemicals, bulb, spray cans, fertilizer and pesticide containers, batteries, shoe polish.
- **Recyclable waste:** Paper, glass, metals, and plastic.
- **Construction waste:** Construction and demolition activities generate a high volume of waste, popularly known as *malba*, which is often dumped on the roadside, back lanes or into drains.

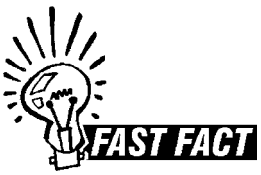
Bio-medical waste

Healthcare establishments like hospitals, nursing homes, clinics, blood banks, veterinary hospitals, etc. generate substantial amount of potentially infectious waste. Besides comprising soiled bandages, used cotton, pathological and anatomical waste, the hospital waste also includes used syringes, tubes, bottles, and various plastic and glass materials. Often it finds way into the Municipal Solid Waste, though, it constitutes only a small proportion of total municipal

waste. Consequently, it may contaminate other wastes if not disposed of in a proper manner. So, it poses danger to the health of rag pickers as well as the municipal workers. In fact, keeping this in mind, the Government has issued norms making it mandatory for hospitals to segregate infectious and non-infectious waste before disposal. To this effect, the Ministry of Environment and Forests (MoEF), Govt of India formulated the Biomedical Waste (Management and Handling) Rules, 1998, which bind all healthcare establishments in the country.

Hazardous waste

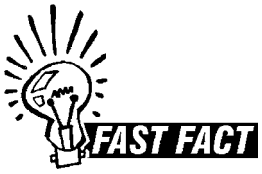
A substance, such as nuclear waste, or an industrial by-product that is potentially damaging to the environment and harmful to humans and other living organisms, is known as hazardous waste. Industrial waste can be highly toxic in nature and may have the potential of contaminating other municipal waste, if dumped together. Therefore, such waste requires separate disposal and management. Hazardous Waste (Management and Handling) Rules 1989, (amended in 2000) for Industrial Wastes govern the collection and disposal of such wastes.



The Government has issued norms making it mandatory for hospitals to segregate infectious and non-infectious waste before disposal. To this effect, the Ministry of Environment and Forests formulated the Bio-medical Waste (Management and Handling) Rules, 1998, which are binding on all healthcare establishments in the country.

E-waste

The term e-waste is applied to all waste emanating from or caused by electronics items, which is often toxic waste. It is a major concern with respect to wireless technology and computers, which are readily discarded due to rapid technological changes, low initial costs and obsolescence. E-waste includes electronic products and appliances, components and accessories that, for one reason or the other, we have deemed obsolete and have therefore discarded. Though governed under the Hazardous Waste rules, it has emerged as a distinct category of waste requiring special attention.



Estimates show that, the world over, between 300-500 million tonnes of hazardous waste is generated annually, with 90 per cent originating in industrialised countries. Most of it finds its way into dumping yards or recycling industries of southern countries.

Need for solid waste management

Waste reflects an imperfect human system of production and consumption, which is increasing with the changing nature of economy and lifestyle. Environmental concerns warrant that we dispose of our wastes in environment-friendly and feasible ways, and technological development has given us many options to do so. However, first of all, we need to see what happens if this waste is dumped carelessly.

Impact of waste on environment

- Unsanitary conditions, created by improper disposal, can lead to environmental pollution.
- Indiscriminate dumping of wastes pollutes surface and ground water sources.
- Burning waste causes air pollution and often produces toxic fumes like Dioxins
- Decomposition of organic wastes in landfills generates greenhouse gases.

Impact of waste on public health

- Human fecal matter, often found in municipal waste, attracts insects and rodent vectors, which can spread diseases like cholera and dengue.
- Garbage may clog drains, which may result in insect breeding and flooding during the monsoons.
- Untreated leachate pollutes surrounding soil and water bodies. Consequently, contaminated water exposes individuals to diseases.
- Dioxins produced during incineration are carcinogenic.

The problem is compounded by increasing globalisation.

Global perspective of waste

Increasing globalization has meant increasing inter-dependence of economies. Production is no longer confined to geographical boundaries and producers, in order to cut costs, manufacture items in one location and then transport them to other countries. Consequently, the waste flow follows the consumption route. So, as the product life cycle is turning global, so is the trail of waste it leaves *en route*. Moreover, unlike earlier times when the wastes were disposed of within the borders of producing countries, the countries are diverting their own wastes to other countries as well. For example, a lot of ship and automobile scrap is sent to India annually to take advantage of costs in recycling of these materials. Similarly, estimates show that the world over between 300-500 million tonnes of hazardous waste is generated annually, with 90 per cent originating in industrialized countries and most of it finds its way into the dumping yards or recycling industries of southern countries.

Increasing environmental consciousness in the North and relaxed environmental and health standards in the South are facilitating this trade in waste. These relaxed standards are often the result of linking of the issue with the livelihood of poor people. However, in the longer run this trade in waste puts poor communities at the receiving end:

- Poorly run production and recycling bases pollute the environment
- Loss of livelihood of farmers caused due to siting of new production bases
- Loss of livelihood of recycling workers due to waste corporatisation.
- Magnified health hazards for people involved in waste scavenging and recycling, especially the poor and marginalised.
- Environmental degradation due to dumping of waste.
- Dumping of low cost, polluting and obsolete technology.
- Displacement of community waste management by corporates.

Some forms of waste globalisation are explained by Bindas on the following page.

Regulating the trade in waste

Realizing the dangers of environmentally unsustainable productions, several Multilateral Environmental Agreements (MEAs) have been signed by many countries. Basel Convention and Kyoto Protocol are prime examples of this. Some of them even aim at making environmentally viable technologies available to the developing countries. However, this has not deterred many to introduce changes in the production process. For example, the US is not party to Basel Convention and uses the opportunity to flout its provisions routinely. A big generator of waste, the US alone exports over 10 million tonnes of waste annually.

The need is to view waste in a broader environmental and public health perspective rather than taking a myopic way of simply finding ways to dispose of the waste in our locality. The related issues need to be taken up at the policy level, as they have repercussions at the international level. Countries in the South have to tackle the challenge of 'Not in My Backyard' attitude of the North. For example, restriction on trade on certain items, if not regulated, may be taken to the World Trade Organization (WTO) on the grounds of discrimination. However, there are enough safeguards available to any country to safeguard itself from becoming a dumping yard for others.

Bindas, does waste travel? Does it need a visa?

The globalisation of waste has made it a big international business. There are several routes through which waste travels across borders, often in violation of regulations.

Direct Waste Dumping

Regulations in various countries are strict about disposal of certain items. Companies find it more convenient to export these wastes in guises. For example, a chlor-alkali plant in the US attempted to export 118 tonnes of mercury stockpile to India disguising it as 'raw material'.

Export of Dirty Products

Extremely hazardous or difficult to recycle products are exported to developing countries to avoid costs of higher safety standards in the home countries. For example, asbestos, banned for use in many countries, is exported to India in massive quantities. Similarly, e-waste in the guise of second hand computers is exported to India.

Export of Waste Technologies

Many technologies that have either been banned or being discouraged in many developed countries are finding ways in the developing countries. For example, incinerators are being discouraged in many countries, but the Royal Dutch government funded two incinerators in Pakistan in 2000.

New Markets for International Waste Companies

Growing urbanization makes the solid waste management sector lucrative to the international waste industry, which can use environmentally hazardous technologies due to lower safety and environmental standards for their profits.

Shifting Production Base

Toxic products like chemicals, electronics and plastics are increasingly being manufactured in Asian countries, which are emerging as major production centers for the North. The waste generated is dumped locally, though the production is for international markets.

Recycling in Developing Countries

Workers earning less than subsistence wages bear the brunt of toxicity of imported electronic waste, plastics, used syringes, etc. apart from the long-term health impacts they suffer from regular injuries at work place and risks of disease transmission. Women and children are worst sufferers.

Some useful concepts

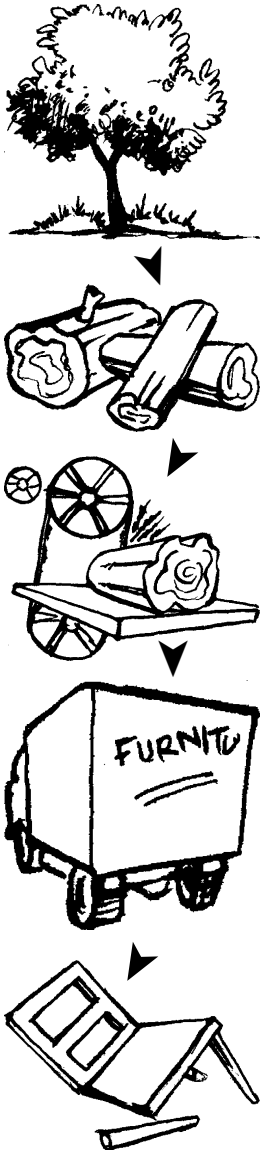
So, there is a serious need to include everybody – from municipal officials to individuals to civil society organizations, not forgetting numerous other invisible hands for whom garbage provides a source of livelihood – in the task of solid waste management. Instead of treating each activity associated with waste management separately, we need to devise an integrated approach, whereby each activity supplements the other. Responsibilities need to be fixed for each stakeholder, be it manufacturer of a product or the consumer of that product or the government. Some concepts mentioned on this and the following pages – Product life cycle, Extended Producer Responsibility (EPR) and The 3 R's – are important in this context.

Product life cycle

To understand how much waste we can produce and its financial and environmental costs, we need to understand all the phases of a consumer product, and not just the phase when the product is useful to us. If we see a product only from purchase to disposal, we may miss the fact that it uses energy and resources before we buy it and continues to do so long after we dispose of it. We should consider all these phases while making consumption choices.

Life cycle steps

Product life cycle can be analysed in five steps:



Step 1: All consumer products require resources from the natural environment. Some form of energy is always required to extract the natural resources from the earth or its atmosphere. For example, paper is manufactured from wood, hence trees need to be grown or petroleum products need to be extracted for production of plastic materials.

Step 2: Raw materials are processed or refined. Though there can be more than one technology for doing this, one could be cheaper, while the other could be more environment-friendly.

Step 3: Additional energy is required for processing or refining materials when they move through the manufacturing and assembly processes.

Step 4: When the product is ready, it is transported to stores consuming additional energy. Products remain at this stage as long as they are usable or repairable.

Step 5: Product is discarded, as it is no longer of use.

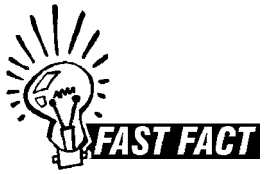
Life Cycle Analysis (LCA)

Industry has traditionally focussed on production rather than waste management. Life cycle analysis emerged in response to increased environmental awareness on the part of the general public, industry and governments. It enables manufacturers to quantify how much energy and raw materials are used and how much solid, liquid and gaseous waste is generated at each stage of the product's life. LCA involves making detailed assessment during the manufacture of the product, from the procurement of raw materials used in its production and distribution, through its use, possible reuse or recycling, to its eventual disposal. This is done in two stages. The first is the collection of data and the second is the interpretation of that data. Collection of data, done through life cycle inventory, reveals the resources used for producing one unit of output. This assessment helps in finding the product's impact on the environment and the likely quantum of waste to be generated.

Problems: Scientific reasons may not always form the basis for decisions. For example, it becomes quite subjective whether one tonne of emitted sulphur is more or less harmful than the emission of just a few kilos of a more toxic pollutant.

Reliable methods for aggregating figures generated by LCA and using them to compare the life cycle impacts of different products, do not yet exist. Often, there have been contradictory conclusions about similar products.

Opportunities: Despite these problems and contradictions, the benefits of LCA cannot be ignored, especially in view of the fast degrading environment quality and increasing problem of waste. The opportunities for waste reduction may be considered through all phases of product life cycle, as given below:



Life cycle analysis (LCA) emerged in response to increased environmental awareness on the part of the general public, industry and governments. It enables manufacturers to quantify how much energy and raw materials are used and how much solid, liquid and gaseous waste is generated at each stage of the product's life.

WHAT YOU CAN DO

Producers can contribute in many ways to reducing waste generation

Pre-manufacture

- Minimize material both in volume and weight.
- Incorporate recovered material.
- Design for disassembly, remanufacture, reuse and recycle, including minimization of different materials, interchangeable parts, etc.
- Use low energy materials and processes.
- Avoid use of hazardous or toxic materials and constituents.
- Consider transport implications of supplies and raw materials.

Product manufacture

- Minimize toxic chemicals and waste.
- Avoid chemicals linked to global warming.
- Minimize energy and water consumption.
- Minimize water and process discharge.
- Recover water and energy.
- Minimise and/or reuse scrap.

Distribution and packaging

- Use and specify environmentally preferable packaging materials.
- Minimize volume and weight.
- Consider reusable packaging.

Product use and maintenance

- Enhance durability.
- Design without need for oil, battery, chemicals and other consumables.
- Minimize energy/water consumption for product use.

End of life

- Make different components and materials easily identifiable.
- Maximize recovery and remanufacturing opportunities.

Product life cycle analysis entrusts the responsibility of minimizing wastes both on the manufacturer and the user, but producers are expected to take into consideration all the stages of PLC. In this context, the concept of Extended Producer Responsibility becomes pronounced.

Extended Producer Responsibility (EPR)

EPR means that the responsibility of producers for their products is extended to the post-consumer stage. In other words, EPR means that a company must be responsible not only with making the product and with how it functions, but also with what will become of it at the end of its useful life. The concept of the impact of the product extends beyond the emissions and effluents generated by the extraction or manufacturing processes, to include those after it is discarded. In 1990, the Swedish Ministry of the Environment defined EPR as "an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life cycle of the product and especially for the take-back, recycling and final disposal of the product".

Goals of EPR

The ultimate goal of EPR is sustainable development through environmentally responsible product development and product recovery. Implicitly, producers pay for the waste and pollution they create and thus have incentive to incorporate a broader range of environmental considerations into both their product design and choice of materials. This subsequently helps cleaner production and waste prevention.

Types of producer responsibility

Thomas Lindquist (referred to as the father of EPR) has identified five basic types of producer responsibility.

- **Liability**: The producer of a product is responsible for any environmental damage caused by its production or use.
- **Economic responsibility**: Producers assume the responsibility for paying of all or part of costs of collection, recycling or final disposal of products. Though, sometimes they may charge a fee for doing so. However, these costs get reflected in the pricing of the product.
- **Physical responsibility**: Physical management of a product or its effects is also the responsibility of the producer. This can range from merely developing the necessary technology, to managing the total "take-back" system for collecting or disposing of the product. However, they may charge a fee for that.
- **Ownership**: Producers assume both physical as well as economic responsibilities.
- **Informative responsibility**: Informing users about the product and its effects at various stages of its life cycle is the responsibility of the producers.

Operationalising EPR

EPR programmes aim at increasing recycling and provide the missing link between product design and recycling – a link that is key for making recycling efficient and economic. In many countries, industry has responded by designing for disassembly, developing reverse logistical systems and demanufacturing.

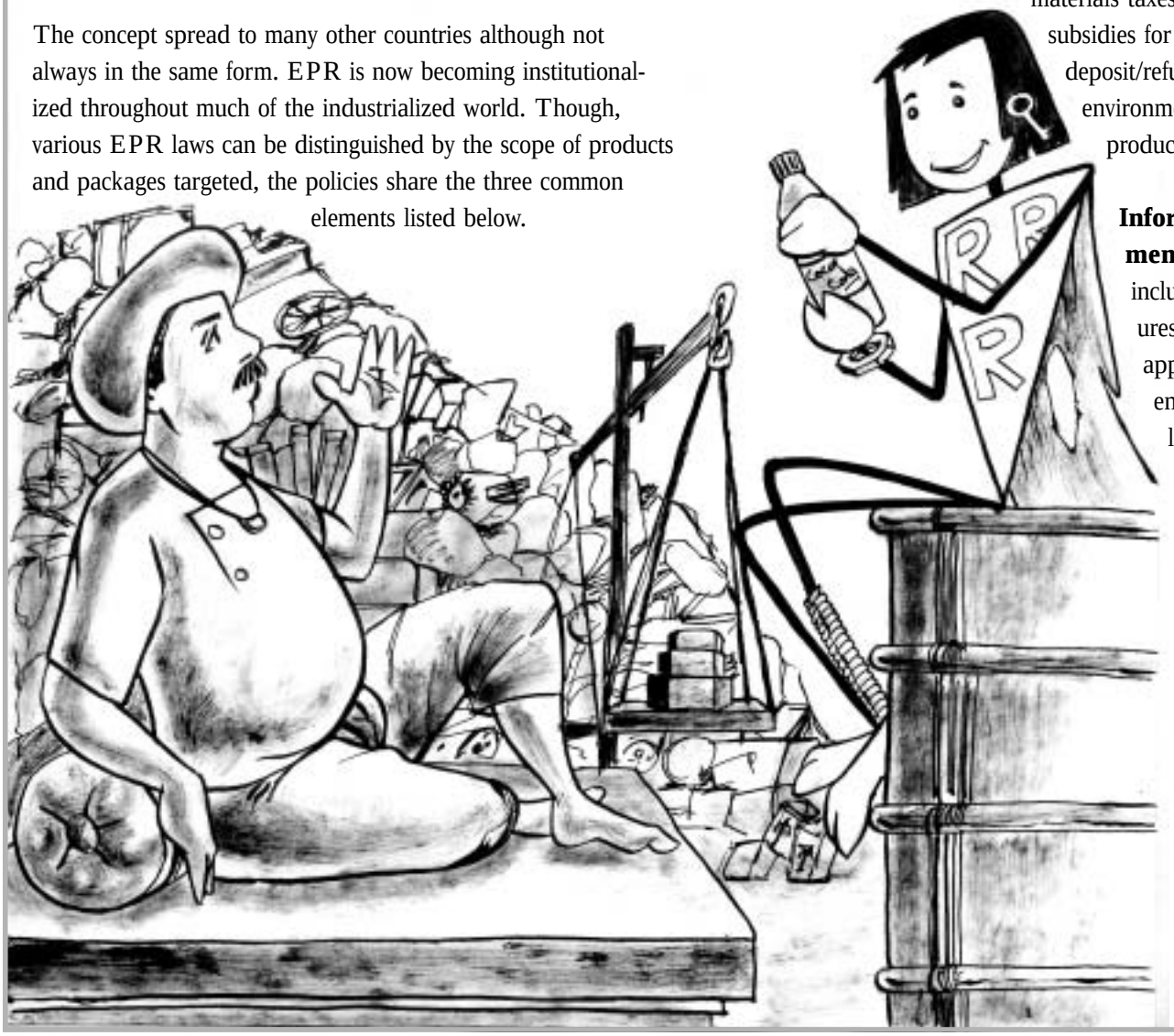
What is this EPR? Isn't it bad for my recycling business?

EPR in practice: The concept of EPR was developed in Sweden, but was first implemented in Germany in 1991. The country was experiencing a severe waste management crisis, with a scarcity of disposal capacity. German packaging ordinance targeted packaging, as it accounted for 50 percent by volume of the waste stream. Industry responded by adopting the 'Green Dot' system. It is a label that appears on the packaging of participating companies. Under the programme, producers of package products are required to take back their packaging. Most of them joined the Duales System Deutschland (DSD), a third party, industry-funded producer responsibility organization that overseas management of member companies' packaging wastes. DSD licenses its logo – the green dot, for a fee.

The concept spread to many other countries although not always in the same form. EPR is now becoming institutionalized throughout much of the industrialized world. Though, various EPR laws can be distinguished by the scope of products and packages targeted, the policies share the three common elements listed below.

Regulatory instruments: These focus on post consumer waste and/or design changes to phase out toxic constituents. This is reflected in mandatory take back; minimum recycled content standards; secondary materials utilization rate requirements; rates and dates; energy efficiency standards; disposable bans and restrictions; material bans and restrictions; and product bans and restrictions.

Economic instruments: These are established with the idea of placing greater physical and financial responsibility for product waste management on procedures, setting rate and date requirements for waste reduction and increasing recycling efforts. They are reflected in advance disposal fees; virgin materials taxes; removing subsidies for virgin materials; deposit/refund systems; and environmentally preferable products procurement.



Informative instruments: These include such measures as seal of approval of types of environmental labeling (Green seal, Blue Angel); environmental information labeling (energy efficiency, CFC use, recycled content); product hazard warnings; product durability labeling.

Four examples of how responsibility for product and packaging waste shifts from government and taxpayers to producers and consumers, are mentioned below:

- **Deposit refund systems:** The system provides monetary incentives to the consumer to return the product or package to the producers, which subsequently helps in creating infrastructure for collection and recycling. Many European nations and some states in U.S. and Canada have enacted beverage container deposit laws.

- **Product charges:** Product charges influence the choice of materials used. An eco-tax levied in Belgium reduced consumption of PVC.

- **Advanced disposal fees:** They are sometimes refunded to consumers. The objective of this fee is to influence the choice of materials used, which can subsequently generate substantial funds to be used for environmental projects. Austria has implemented such a fee for refrigeration.

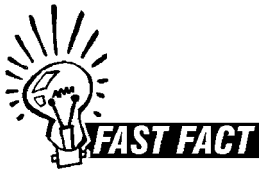
- **Voluntary agreements tied to mandatory regulations:** These agreements are aimed at phasing out undesirable materials, encouraging design for recyclability and ensuring greater reuse or recycling. Voluntary deposit system for Aluminium cans in Sweden has enabled the industry there in achieving government mandated recycling rate.

EPR in India

Take back or deposit refund system has existed in India for several years, especially with glass bottles, but that has been there more for economic reasons for the industry than for adhering to any regulatory instrument. In fact, a comprehensive policy on the subject is yet to crystallize. Presently, an effort is being made to make take back of PET bottles mandatory. During several meetings of the Task Force of the Ministry of Environment and the CPCB, the industries were asked to come up with an outline scheme of take back for PET bottles. The discussions have moved to voluntary take-back from a mandatory one. The industry expressed inability in setting up a system citing the reason that PET consumption in India is at a minimal stage in comparison to that in developed countries and the policy would increase production costs.

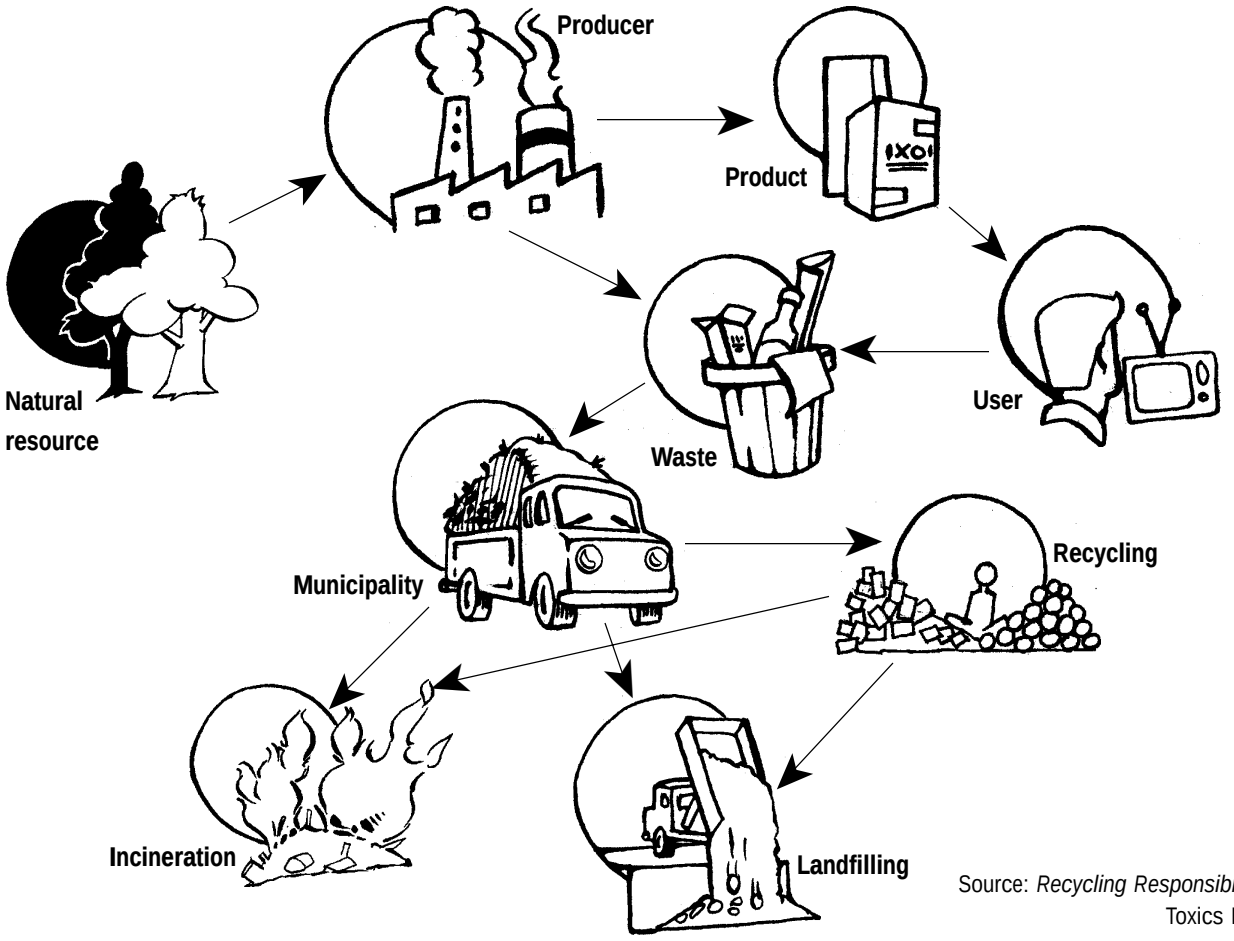
However, the Ranganath Mishra Committee on Plastic Waste Disposal constituted by Ministry of Environment and Forests, Govt. of India has recommended introduction of a Deposit Return Scheme on PET bottles. It recommended refund of 25 paise per bottle to consumers who returned these bottles. However, the proposal is yet to be implemented.

By and large the system is still linear, where the waste is generated at every stage of the PLC, but there is no connection between waste generation and its disposal or processing. It implies that the recovered materials are not fed into the production process.



The Ranganath Mishra Committee on Plastic Waste Disposal recommended a refund of 25 paise per bottle to consumers who returned used PET bottles. The recommendation is yet to see the light of day.

Linear system



Source: *Recycling Responsibility*, Toxics Link

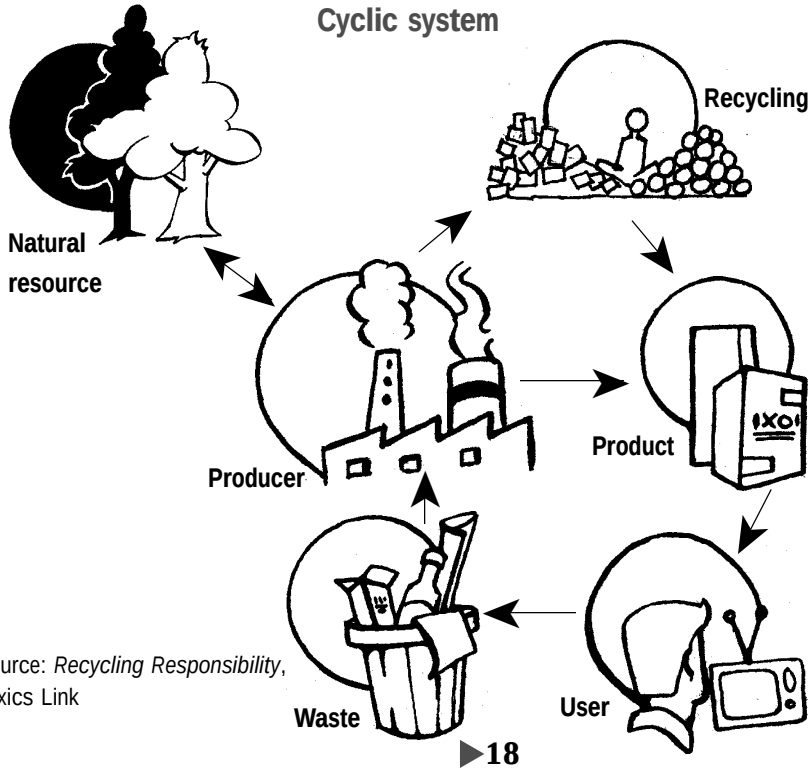
The figure above explains the current system.

Earlier, due to environmental concerns and pressure from international markets, the Govt. of India had launched a scheme of 'ecomark' in 1991 for the labeling of eco-friendly products, which incorporated life cycle perspectives. Studies reveal that no single product in the market bears the ecomark, largely due to the lack of incentives for the industry.

While efforts are made to increase the responsibility of producers in minimizing wastes, it is also important that consumers behave responsibly and help in this endeavour. The challenge is to make recycling part of a sustainable process where the recovered material can be fed into the production process, so that the natural resources can be conserved to the maximum extent possible.

The figure alongside depicts such a cyclic system.

Cyclic system



Source: *Recycling Responsibility*, Toxics Link

The 3 Rs: Reduce - Reuse - Recycle

Reduce what you do need

Reuse what you cannot reduce

Recycle what you cannot reuse

The 3 'R's are the most viable alternatives in the manner in which we can help in managing waste.

Reduce

Reducing the waste stream is the most significant of all the options to manage waste. The problem of waste management is reduced to the extent we are able to reduce the generation of wastes. Thus, we can conserve our resources and reduce disposal costs and pollution. We can start by analyzing what we throw away at home. This will include thinking about the goods and services we buy and the activities we support, and in what ways do they contribute to the solid waste problem.

WHAT YOU CAN DO

The choices you make can drastically reduce generation of waste

- Buy goods in retainable or recyclable packages. Select products that are not wasteful in their packaging.
- Try not to purchase items which have harmful ingredients.
- Select durable items that are easy to repair, have good warranties, are energy efficient, non-polluting in both manufacture and use.
- Avoid buying disposable items like plastic plates, polystyrene cups, etc. as they all end up in the landfill.
- Even while gifting others, think of items which can reduce their waste, like cloth napkins with matching tablecloths.
- Repair old clothes, appliances, furniture, etc. instead of discarding them.

Reuse

The process of reusing is started with the assumption that the used materials that flow through our lives can be a resource rather than refuse. We can 'reuse' many materials in their original form, instead of throwing them away, or pass them on to others who can use them. Once we have our minds set on the fact that we can use trash positively, we can begin to brainstorm and generate ideas. For this, we need to analyze our activities very closely and pick out things that can be reused. Reusing products or materials also helps in generating less waste, which again reduces the cost of managing solid waste and conserves natural resources.

WHAT YOU CAN DO

Following these steps will go a long way in reducing the quantity of waste generated

- Using washable cups instead of disposables.
- Using cloth napkins, sponges and dusters, as they can be reused by washing.
- Purchasing items in refillable containers.
- Reusing wrapping paper, plastic bags, boxes, etc.
- Buying returnable containers for beverages, etc.
- Using both sides of the paper for writing or typing.
- Washing and reusing empty glasses, plastic jars and containers for storing household items like buttons, nails, etc.
- Thinking of innovative ways of reusing other junk material.

Recycle

Recycle is a stage where the reusable material is remade into either the same or new product. So, it is a resource recovery method involving separating, collecting, processing, marketing and using material that would have otherwise been thrown away. However, recycling must be based in the overall production and consumption cycle. It should not be looked upon as an activity that can exist on its own merely as an alternative disposal means. In fact, it is one component of integrated waste management.

The entire recycling process is a dynamic mechanism in itself. With increase in supply of materials, manufacturing facilities, in both organized and unorganized sectors, have emerged to find uses for recyclable materials. This subsequently has created jobs or livelihood for a number of persons. This also helps in reducing the quantity of wastes going to landfills.

WHAT YOU CAN DO

You can contribute your bit to recycling in the following ways

- Stacking newspaper in manageable bundles and keeping them clean and dry and sell them to the *kabariwalas* (people who collect waste materials). This is also monetarily beneficial.
- Other kinds of materials, like glass or scrap metals, can also be sold to the *kabariwalas*.
- Separating our dry and wet waste at the household level.
- Not throwing wastes all over, but giving it to garbage collectors, who can be municipality workers or any other organization agreed to by the community where we live.

Two more 'R's: Refuse and Responsibility

Two more steps, in addition to Reduce, Reuse and Recycle, have emerged in view of the burgeoning waste situation, which can be useful in the management of wastes.

Refuse

Refuse what you don't need. This encourages people to consider use and disposal of all the components of the item they are purchasing, including the packaging. This helps us in buying products that use less of the earth's resources, create less solid waste and conserve valuable landfill space. Instead of buying new containers from the market, use the ones that are in the house. Similarly, we can carry our grocery bags while going for shopping. We can refuse buying new items, even though they may appear prettier than the ones we have at home. This stage can also be referred to as pre-cycling.

Responsibility

Specific responsibilities need to be fixed by society. The state should make policies and encourage or make it mandatory for industry to minimize waste and make products that are recyclable. Products could have built in costs for waste minimization and recycling, which would help generate finances for investment in the waste management sector. Finally, all of us need to behave 'responsibly' within the overall framework of Refuse, Reduce, Reuse and Recycle.

A brief list of recyclable items is given in Annexure 1 at the end of this book.

CHAPTER 2

A close look at the the informal sector

The primary responsibility of solid waste management in a town is that of its municipal body. However, municipalities across the country, by and large, have not been able to cope with this mammoth task. The two reasons attributed for this are the lack of budgetary support to undertake necessary activities over the entire town areas and the lack of proper understanding of the problem by the municipality officials. Traditionally, the job of municipalities has been to collect the garbage and dump it in landfill sites or low-lying areas on the outskirts of the town.

It is common knowledge that our household garbage includes many materials or items that can either be reused or recycled to produce items that can enter the market again. The inability of municipalities to handle this responsibility has thrown up a new economic opportunity for a significant number of persons, who make a living out of waste. This traditional recycling sector is highly informal, but operates under a high degree of organization, with a clear-cut chain of actors. We need to understand the entire dynamics of this informal sector to be able to plan for an integrated solid waste management system.

The actors

In India, over one million people find livelihood opportunities by engaging in waste collection, disposal and recycling through the informal system. We need to understand role of all the actors involved in the system, in order to have a clearer picture of the sector.

Waste pickers

At the bottom of the heap is the waste picker. He/she scavenges the municipal bin or the landfill sites, or collects waste from the street, market, home, offices, etc., and sells the items thus procured to others – usually the waste dealer or *kabariwalas*. Most of these people are those who come from rural to the cities in search of employment. Since the infrastructure in urban areas is not capable of providing employment or sustenance to this huge population, they resort to this self-employment opportunity, which requires no formal skills, education or financial investment. Concomitantly, they help the municipality in saving crores of rupees, which would have otherwise been spent on collection, transportation and disposal of these wastes. It is estimated that they reduce the work of the municipalities by 10 to 15 per cent.

Types of waste pickers

There are three categories of waste pickers:

- **Self-employed individuals:** These pickers pick the waste and sell it independently to waste dealers. Some pick selective items and some pick a variety of waste and sell them to different dealers.

- **Privately employed:** These pickers are employed by waste dealers who deal in specific items. Pickers sell all their collections to the particular dealer.

- **Organisational pickers:** This is a rather new category and has emerged since private organizations have started interventions in some areas.

Modes of collection

Waste is picked in three ways:

In a sack carried on the back to collect all the useful items

In a huge partitioned sack slung across a bicycle rod, where pickers keep items separately while collecting

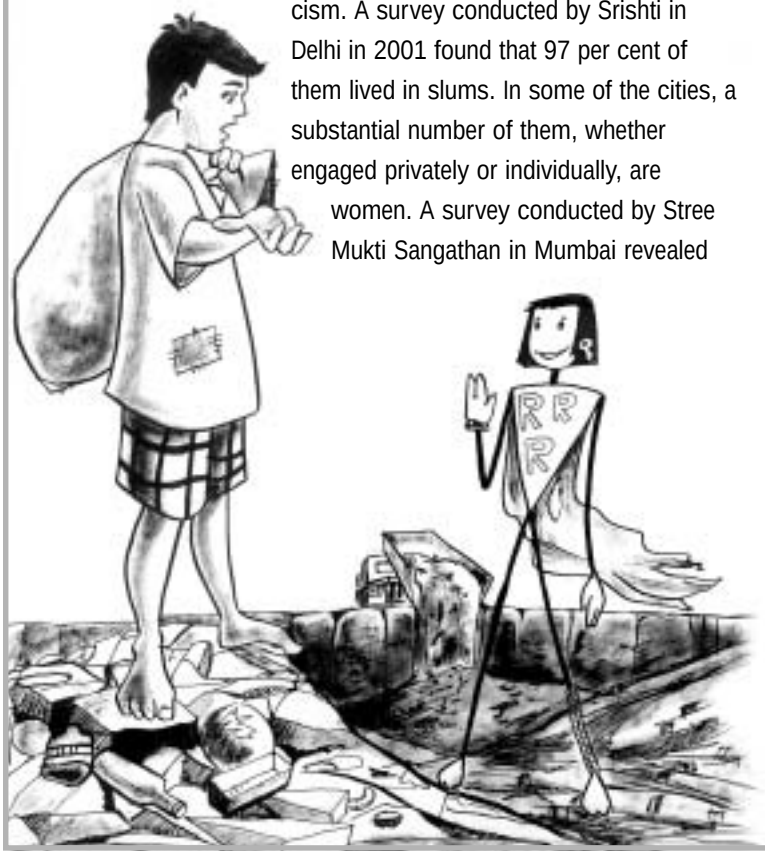
In a tricycles which can collect more than 50 kg. of waste on a good day

On an average each picker collects 15 to 25 kg of waste per day.

Does anyone know or care about our contribution?

Social and demographic profile of waste pickers

While waste pickers provide the residents a cleaner city and better environment, they themselves live in sub-human conditions of filth, deprivation and social ostracism. A survey conducted by Srishti in Delhi in 2001 found that 97 per cent of them lived in slums. In some of the cities, a substantial number of them, whether engaged privately or individually, are women. A survey conducted by Stree Mukti Sangathan in Mumbai revealed that 80 per cent of waste pickers were women. In Bangalore, community waste management systems have employed more women than men. Similarly, the survey conducted by Srishti found that 24 per cent of the pickers were female. The significant number of women waste pickers can be attributed to their subordinate position in our social system, which restricts their access to other employment opportunities.



Children also constitute a significant proportion of this workforce. The survey by Srishti revealed that in Delhi 24 per cent pickers were children below the age of 16 years. In fact, some of them started this work at an early age of 6 years and supplement the family income. A study conducted by the V.V. Giri National Labour Institute in 1992 found waste picking to be the fourth largest occupation for street children in Delhi. Similarly, it was the third largest occupation for them in Chennai and single largest in Hyderabad and Bangalore.

Income of waste pickers

The daily income of waste pickers depends on the place of their operation. Income levels are higher in bigger cities like Delhi or Mumbai, as compared to small towns. The income also depends on the nature of the work. In Delhi, waste pickers who collect wastes in a sack are able to earn between Rs. 45 and 80 a day. Those who collect wastes on bicycle earn something between Rs. 50 and 80, and those on tricycle earn between Rs. 150 to 200 per day. However, women pickers earn less. Meanwhile, a child waste picker earns Rs.10 to 15, if he/she accompanies his/her mother and Rs.20 to 30, if he/she is moving independently[1]. Privately engaged waste pickers earn monthly wages, which range between Rs. 1200 and Rs. 1500. However, there are also instances where they do not get paid for their services, but are given share in the sale of recyclable products. For example, Muskan Jyoti Samiti in Lucknow does not pay any remuneration to its pickers.

Waste sorters

This actor is the one who sorts items from the collected waste, usually at the premises of the waste dealer. Often referred to as invisible hands they sort the items at all the levels of waste dealing. Comparatively speaking, this is a specialized job, as they need to know what types of items are useful for them. However, no training is required for this, the sorters learn from experience. Often the waste dealer himself guides them. Most of the sorters start as waste pickers, so they are acquainted with the material. Some waste pickers leave the job of picking to work as sorters, because they find it easier and free from professional hazards, such as harassment from police or municipal officials.

Social and demographic profile of waste sorters

Like the waste pickers, sorters too move from rural to urban areas in search of livelihood opportunities. Their living conditions are as abysmal as those of the pickers. In fact, a lot of them who collect waste in the daytime do the sorting in their spare time to supplement their income. Most of them stay in slums or near the waste dealer's house. Often, they are given place to stay in lieu of their services. Sometimes they, especially children, are given food as well.

More women seem to be engaged in sorting than they are in picking. The reason is that it enables them to work and look after their household and children simultaneously, as they live near their places of work. Moreover, they do not have to face harassment from the police or the municipality officials.

How do they sort?

Sorting is normally done in open spaces. Usually, these are government lands that have been encroached upon by waste dealers, especially by the small or medium dealers. Large dealers may have their own spaces. Here, sorters learn the techniques of separating different materials and their usefulness, aided by their own experience and with guidance from senior sorters and dealers. However, there is no question of being provided with any protective gear while sorting. This exposes them to dangers of contracting infections or other diseases.

About 24 per cent of waste pickers are children below 16 years of age. Some of them start picking waste as early as 6 years.

Income of waste sorters

The income level is lower for sorters, as compared to that of pickers. There are two systems of payment – daily wages and monthly payments. In Delhi, a sorter on daily wages earns on average between Rs. 30 and 70. Children who do the primary sorting earn between Rs. 20 and 30 a day. Monthly payments to the sorters are in the range of Rs. 1200 to 1800. For this, they have to work for 8 to 10 hours. Payment also depends on the experience of the sorter.

There are instances where sorters, especially children, are not given any money for their work. Instead, the dealers give them food and a place to stay, and occasionally some money for expenses such as movies.

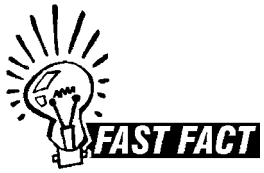
Waste dealers

They act as an intermediary between the waste picker and the owner of a recycling facility. A waste dealer buys the recyclable materials from the waste pickers, gets them sorted to sell them to different buyers. Dealers can be divided into three categories, on the basis of the quantities they buy and the storage and holding capacities they possess:

- **Small waste dealer:** This type of dealers normally buy all kinds of recyclable materials from the pickers or the itinerant dealers (popularly known as *ferriwalas*). But they do not buy in large quantities, as they do not have big storage capacities. Their holding capacity is also low. They have their links with the bigger dealers as well as with the owners of recycling facilities, to whom they sell their wares. Supply is done after preliminary sorting, for which they encroach upon government lands and employ sorters on daily wages or on a monthly basis.

- **Medium waste dealer:** These dealers mostly buy specific items either from the pickers directly or the small dealers. Some sorting is done at this level too. They also undertake certain activities like baling, crushing or granulating, so that the materials qualify for a specific category. Thereafter, they sell these materials either to large waste dealers or supply them to recycling units directly. One interesting aspect is that these dealers may often switch to materials in which they were not dealing earlier, depending on the demand and seasonality of a particular material.

- **Large waste dealer:** Large waste dealers buy a few specific items, mostly from small or medium dealers. Sometimes they could be dealing in only one or two items. They own bigger places where they get the sorting done and store the materials. They sell the items to recycling units in bulk. Sometimes they also provide processing services, which add value to the waste. In small towns, there may not be any large dealers at all.



In Delhi, a sorter on daily wages earns on average between Rs. 30 and 70. Children who do the primary sorting earn between Rs. 20 and 30 a day.

Agents

There are people who do not buy any item directly. They actually facilitate transaction between dealers and the recycling units. Apparently, they don't need any storage or holding capacity. They arrange for shipment of materials from one location to another on commission basis. They are particularly useful in small towns, where there may not be recycling units. In such situations, they save the dealers the trouble of locating the buyers. They get a commission, either from the dealer or the buyer, but sometimes from both sides. These intermediaries make the jobs of dealers and recyclers easy by helping them locate the buyers and suppliers respectively. Some work full-time as agents and others may take it up to supplement their income from other sources.

Recycling unit owners

Recycling units are places where the waste materials are processed and new items are produced for the market. Owners of these units employ workers to carry out activities associated with the processing. There are two types of recycling units – one where marketable goods are produced, and the other where recovered materials are altered such that they can be used by industry. For example, cullets are sent to glass factories.

Sizes of these units vary, depending on the materials to be processed and goods to be manufactured. Often small units are located in slums, while the big units are located in the industrial areas.

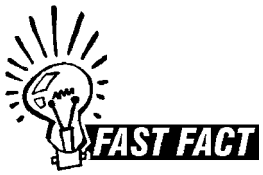
Workers in recycling units

Unskilled male female and child labour is employed in the recycling units. However, the proportion of males is higher than females or children. The strength of manpower in each unit depends on its capacity. It varies from four in a small unit in the unorganized sector to 120 in a large PET recycling unit.

Most of the employed labour is casual and is paid on the basis of capacity of the unit in handling the waste. Consequently, the workers are underpaid except in bigger units, which are covered under the Factories Act, 1948. Some units have permanent and contractual workers also.

Working conditions

Workers in these units work in very unhygienic conditions. They work on machines like grinders, sinks, water removing centrifuge, mixer, extruder, without any protective gear whatsoever. Thus, they are exposed to toxic fumes,



Most of the employed labour in recycling units is casual and is paid on the basis of the capacity of the unit to handle waste. The workers are usually underpaid except in bigger units, which are covered under the Factories Act, 1948.

dust, etc. For example, during grinding, Respirable Particulate Matter (RPM) and Suspended Particulate Matter (SPM) are produced. Smoke arising during the grinding process comprises dust and ash, which may cause cough and asthma. Similarly, powdered colour may cause fibrosis, fever and oedema in workers.[2]

Working hours are also long. Most of the workers work for 10-12 hours, that too with inadequate breaks, sometimes with minimal access to food and water.

Except for the large waste dealers, there is hardly any evidence that the various players have any kind of workers' association.

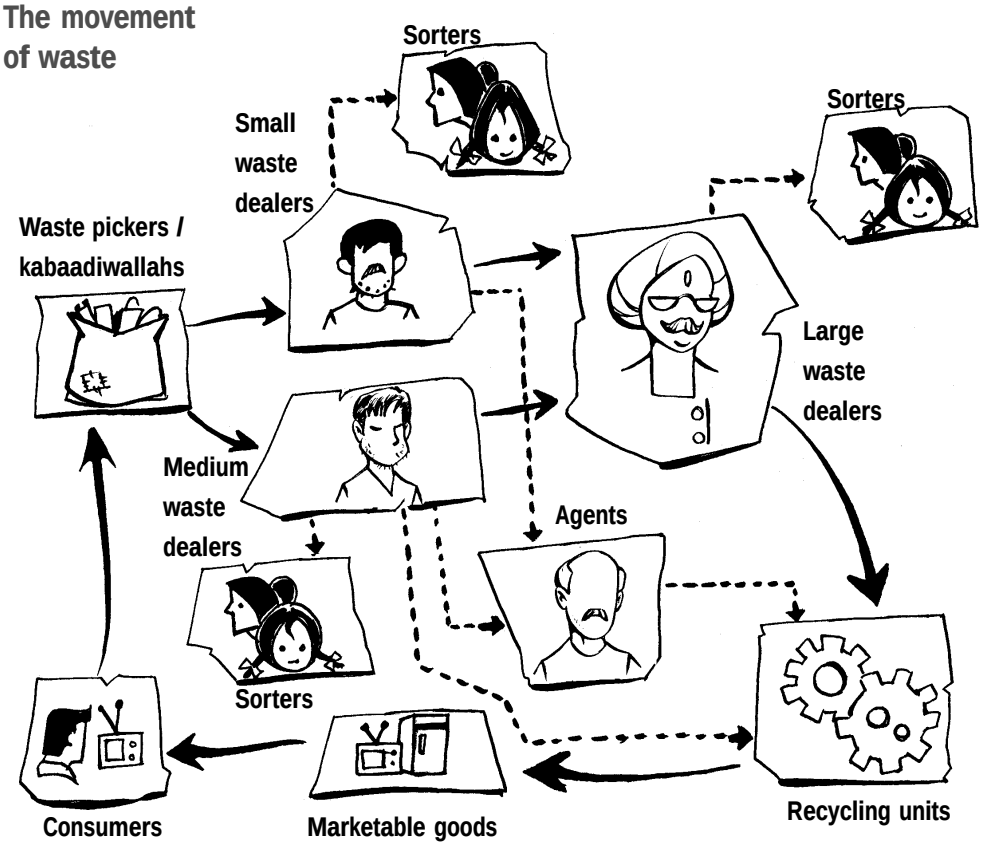
Recycling units

These units turn wastes into reusable and marketable products. But it is important to see whether or not these units are worthy of operation or would be viable in the long run from the sustainable recycling point of view.

(i) Technology options – Often the recycling technologies being used in the units are obsolete. This may be due to two reasons – the cost of new technology and a lack of awareness about new technology. Consequently, machines being used in these units are in poor shape. They are by and large fabricated in local workshops and, in all possibility, with bare minimum second-hand or discarded machinery parts. These machines are dangerous to operate and chances of accidents are high.

(ii) Viability – Recycling will be viable only if the cost of production of recycled items, which includes costs on collecting, sorting, transporting and manufacturing, is substantially recovered and is competitive in the market. Being competitive is also important if we keep the fact in mind that usually the recycled materials tend to be of lower grade, which can be readily substituted by low priced, better quality virgin material. Here governmental support is important. While the virgin items may get various kinds of concessions like subsidy, bank loans, etc., recycling having no legal status is deprived of such facilities.

The movement of waste



Sector dynamics

The entire chain can be understood from the diagram alongside, which shows the movement of waste. It can be seen that waste moves in a linear direction, which may not be homogeneous. It differs from place to place and depends on the quantity and nature of materials. At each level, some value is added to the waste through sorting and processing.

An interesting feature of the sector dynamics is the incentives provided to waste pickers, waste dealers. Dealers give advance money to pickers and itinerant waste dealers, as they need money to buy wastes from households, on the promise that they will sell their materials to him. This assures continuous supply of waste to dealers. The waste pickers use this advance as an assurance that the dealer will buy the wastes from them. Additional incentive in the form of shelter is given by medium and large dealers. Some dealers also protect the pickers from harassment from police or the municipality.

Why doesn't all this stuff get recycled?

Market dynamics

Recycling can be sustainable only when there is a market for the recycled products. Unless people are ready to buy such material, recycling would not make economic sense. Another factor that influences recycling decisions is the cost of producing such items. If the costs are higher, which could be either due to the technology adopted or due to the economies of scale, the material would not be recycled.

Related to recycling decisions is the pricing mechanism. The price of a particular waste material depends on how much is it in demand. Besides that, monopolistic situations may push the price of a particular material. However, it can be safely assumed that the market influences pricing decisions, and the range within which the actors play is limited. For example, if a new item can be bought for Rs.3 in the market, the price of the recycled one will have to be pegged at this level.

Another factor that is important for the stability of the market is that recovered materials be available to the recycling units, even if suppliers have to lower the price of their materials. Some suppliers may be lured by the higher prices being offered by some unit owners, though in the long run, this may be detrimental to his/her interest.

While there is no simple way to determine the best market situation, a dealer may adopt a four-step process:

❶ **Identifying buyers:** Dealers must identify the potential buyers who would be willing to buy their materials on a long-term basis. Buyers may not be there in small towns or cities, where agents can be of great help in locating these buyers.

❷ **Contacting buyers:** Since each buyer has his specifications for making a purchase, he should be contacted for soliciting information about the form in which the material should be supplied. How the material is to be transported should also be discussed, so that prices of the materials are not affected adversely.

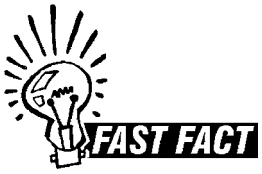
❸ **Selecting buyers:** Once the dealer is satisfied that quantity and quality of his materials are appropriate for a particular buyer, he may select him. If he has surplus capacity, then he may opt for another identified buyer in addition.

❹ **Contracting with buyers:** Once the buyer has been selected, it is in the interest of the dealer that he enters into a contract with that buyer, so that a long-term relationship is forged, and there is stability in the market.

Recycling through EPR

A crucial feature of Extended Producer Responsibility (EPR) is that the producer is obliged to take back his product for recycling or disposal. Since EPR has not been regulated in India so far, producers can at least make arrangements so that the supplied materials are recyclable. The least they can do is to design their products in a manner that facilitates recycling.

Relationship with government



The entire informal sector has day-to-day problems in dealing with government agencies, such as municipal bodies, weight and measures department and local police, in carrying out their business.

The people involved in the informal sector – rag pickers, waste dealers and recycling unit owners, etc – while engaged in the process of recycling have day-to-day problems in dealing with government agencies, such as municipal bodies, weight and measures department and local police, in carrying out their business. It is only in a few places in India where the municipal bodies have accepted the necessity of involving private players in the task of waste management. By and large, the municipalities have been insensitive towards the entire sector, due to an inadequate understanding of the staff. In the survey carried out by Srishti, it was found that waste-pickers faced problems from municipal officials.

As they carry out their business in slums and small dwelling units, they use some of the land near these units. This use of land is termed as land encroachment by the municipal units, and the dealers have to pay bribe in order to continue. Moreover, dealers do not have any license and are not even aware that they require one to carry out the trade.

Sometimes, they are also accused of trading in stolen goods. Waste dealers may also face problems from the weight and measures department, if their weighing scales are not calibrated. While the government has issued a policy paper to facilitate private sector intervention in urban waste collection, disposal and processing, little thought has been given to the issue of supporting the traditional recycling sector. If legitimacy is given to the existing informal chain, it may make the system more competitive to produce higher quality products at lower costs and reduce the exploitation of the weakest of all the actors, i.e. the waste pickers and sorters. Such a step may further improve the technological interventions and make them more environment-friendly.

Unfortunately, since, the sector is informal and the players unorganized, they are unable to put any pressure on the government to address their problems or to formalize and sustain this useful system .

References

[1] Recycling Responsibility, Srishti 2002

[2] Murdoch. C.M., Toxicity of Gases, 1993.

CHAPTER 3

The many forms of waste

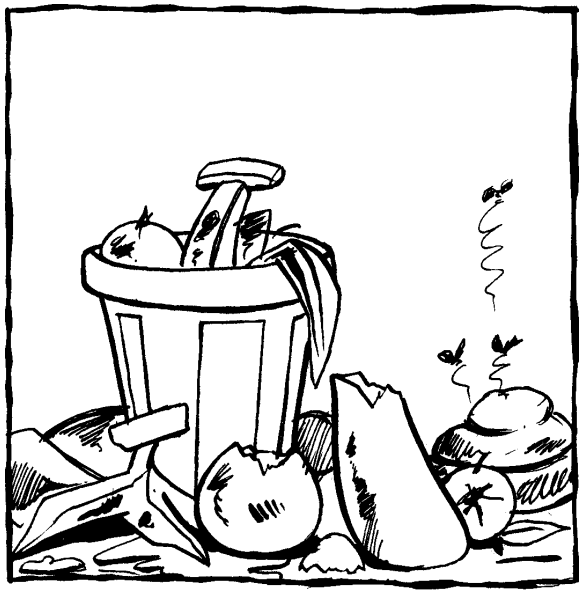
Effective management of solid waste and planning for their disposal requires understanding of the materials that are likely to be part of the waste. The quantity and quality of solid waste generated vary from country to country. Factors like climate, income levels, kind of industrial production, population and consumption behavior determine the composition of waste. For example, density and moisture contents of waste are much higher in developing countries. Similarly, paper constitutes about 40% of the volume of residential waste in the U.S. Indian urban waste is a complex mixture of household, construction, infectious, commercial and toxic industrial elements. It is estimated that in 2001, urban India produced almost 40 million tonnes of waste[1].

Material types

Waste is not a homogenous entity. However, we can broadly classify it as wet waste (biodegradable) and dry waste (non-biodegradable).

Wet waste

The decomposition of organic matter by biological action has been taking place in nature since life first appeared on our planet. In recent times, man has attempted to control and directly utilize the process for sanitary recycling and reclamation of organic waste material. Such materials as vegetable matter, animal manure and other organic refuse, otherwise wasted materials, can be converted into a more stable form for use as a soil amendment, by a process called



composting. The final product of the composting process is called compost. Generally speaking, there are two kinds of decomposition of material that yield compost – aerobic and anaerobic. The decomposition of wet waste into forming compost typically takes place in a composting unit.

Composting facilities are relatively cheap and easy to operate. They can reduce the total amount of municipal solid waste by 40 per cent, thus reducing the amount of garbage to be disposed of in landfills[2]. Composting can be carried out individually or commercially in units that may be centralized or decentralized. There are many techniques that are used for composting. Various research studies reveal that Indian waste is expected to grow substantially in its organic content. Projections are that it will go up from 40 per cent to 60 per cent. It is interesting to note that in large cities, it has already crossed those limits and is as much as 80 per cent in some instances.

WHAT YOU CAN DO

Responsible behaviour on the part of each person goes a long way

- ▲ Do not throw garbage out on the streets.
- ▲ Segregate wet waste and give it to the collector at the stipulated time.
- ▲ Exhort others to do the same.

Dry waste

Dry waste can be either recyclable or non-recyclable. Recyclable waste can be sold in the market and non-recyclable waste has to be sent to a landfill. Communities are increasingly adopting recycling as a method of managing municipal waste. Whether publicly or privately operated, the process diverts a significant percentage of municipal solid waste from being disposed.

The list of potentially recyclable materials is long, and it continues to grow as technological developments enable more materials to be recycled. However, keeping in mind the nature of Indian waste, these materials can be grouped into five major categories of post-consumer recyclables – paper, plastic, glass, aluminium and other metals.

Paper

Paper is made from cellulose fibre, which is primarily sourced form wood. Other sources for paper manufacturing are rags, cotton, grasses, sugar cane and straw. Paper is both biodegradable and recyclable. Most kinds of paper can be recycled and made into new paper products. Saving paper is saving trees and subsequently

helping in enhancing environmental quality. Recycling paper benefits the environment, because it requires at least 50 per cent less energy and up to 75 per cent less water than making it from virgin fibre. It also produces up to 90 per cent less aqueous effluent.

▲ Recycling 1 tonne of newspaper conserves the equivalent of 19 pine trees.

▲ If each child saves 1 sheet of paper a day, then 40,000 trees can be saved per year, by Delhi students alone.

Moreover, recycling of paper:

▲ Reduces paper waste to be dumped in landfill.

▲ Creates jobs in collection, sorting and reprocessing.

▲ Helps in protecting the environment.

Projections are that paper-waste in India will increase substantially from 5 per cent at present to 15 per cent.

Recycling paper

Waste paper are bought and sold through a well-established network of ragpickers, *kabariwalas* and paper mills. Though, the estimate regarding recovery rate is not available, it is pretty low. Even in a country like US, the recovery rate was only 40 per cent in the last decade. The recovered papers are sorted into different grades – high grade, cardboard and mixed waste paper. Paper mills are the most common end users of recovered paper. The high-grade paper is recycled to make tissues, paper toweling etc. the cardboard and mixed paper are recycled to produce packaging paper. However, introducing virgin fibre continuously into the recycling process is necessary as every time a fibre is recycled, it loses some of its strength. After being reused about 6 times, it is no longer strong enough for papermaking.

Main types of recyclable papers are:
- Office white paper.
- Newspapers, magazines, pamphlets, etc.
- Cardboard.
- Mixed or coloured paper.
- Computer print-out paper.

We can help in paper waste reduction by:
- ▲ Trying not to use as much in the first place.
- ▲ Using the back of sheets of paper as well as the front.
- ▲ Buying recycled paper products wherever possible.
- ▲ Reusing envelopes.
- ▲ Choosing packaging that can be sent locally for recycling.

Closing the loop

The future of recycling ultimately depends on there being a market for recycled produces. Paper mills cannot continue to produce recycled paper if people do not buy items made from it. Recycled paper in many cases, is more expensive than virgin paper, but this is only because not many people use it. However, increasing environmental consciousness is driving people to buy such items now. For example, today we can find many greeting cards made of recycled paper in stationery shops.

Plastic

This 'wonder' material has pushed traditional substances like jute, cotton, wood, coir, paper, cardboard, rubber and glass to obsolescence, primarily because of convenience and cost. Plastic is made of long chains of a variety of compounds (chemically called polymers). These are compounds of carbon, synthesized from petroleum and natural gases, with one or more of the elements: Hydrogen, Chlorine, Oxygen, Nitrogen or Fluorine.

However, it has become a hazard today to the environment, especially because of its longevity. Plastics do not degrade easily and persist in the environment for a long time. Almost all types of plastic involve highly flammable aromatic petrochemicals in their manufacture. Polyvinyl chloride uses phthalates, uses

toxic heavy metals to add colour and uses toxic chlorine, which is the precursor for another deadly compound Dioxin. Polycarbonate uses toxic phosgene and polyurethane uses hazardous intermediates and creates by-products like phosgene. Polystyrene uses carcinogenic benzene, and Polyethelene Terephthalate uses heavy metals as catalysts. Polyethelene and Polypropylene, considered least toxic, use environmentally damaging flame-retardants as additives[3].

India's per capita consumption of plastic increased to 2.4 kg during 1998-99. It is estimated that yearly plastic consumption will touch the 5-million tonne mark very soon. Consequently, the waste will go up from 4 per cent to 6 per cent of the total waste stream.

Dioxin

Dioxin is the name given to a class of 75 chemicals. They are classified under Persistent Organic Pollutants (POPs). When burnt along with other MSW, chlorinated plastics like PVC, plastic and other chlorine release dioxins. Dioxins:

- Are considered the most toxic substance known to science.
- Have been identified as a carcinogenic (cancer causing) substance. The cancer risk due to dioxins is 1000 to 10000 times higher than the generally accepted levels.
- Settle on soil, water and plants and enter the food chain and finally reach human body, primarily through foods such as meat, dairy products and eggs.
- Can affect fertility.
- Cause hormonal changes.
- Cause birth defects.
- Reduce sperm count and cause abnormal testes, and
- Damage the nervous system.

Source: Breaking the Plastics Mould*, Toxics Link, 2003*

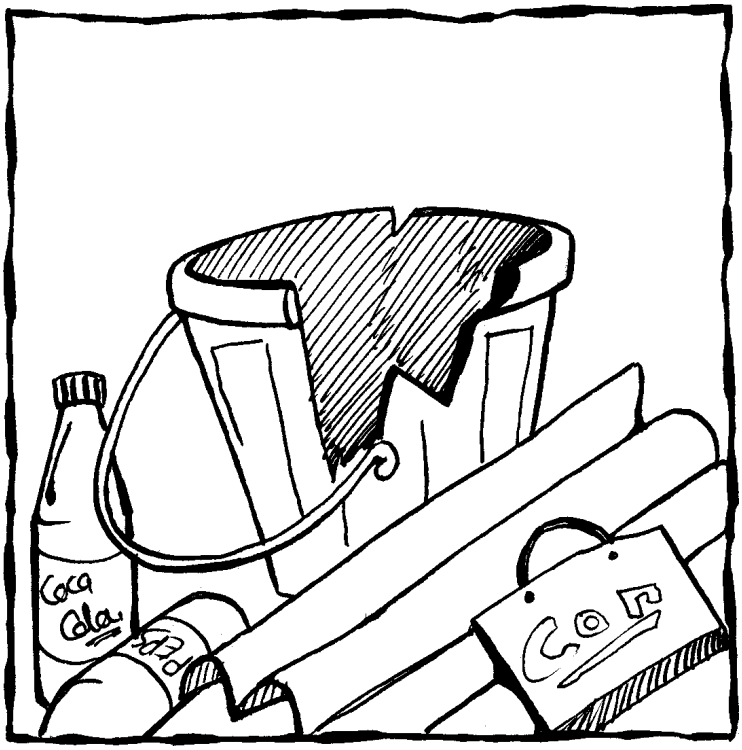


Table 1. Plastic waste generation in India

(figures are in thousands of tonnes)

	1995-96	2001-02	2006-07
Total plastic consumption	1,889	4,374	8,054
Process waste (2%)	38	87	161
Post-consumer waste*	870	1,966	3,624
	(46%)	(45%)	(45%)
Waste available for recycling	800	2,000	NA

**Reprocessable mixed plastic waste*

Source: National Plastics Waste Management Task Force, MoEF, Government of India, 1997.

Broadly, plastics are classified under two categories:

- **Thermoset plastics:** This undergoes an irreversible chemical reaction with combination of resins of phenol/urea/melamine and formaldehyde. The most common thermosets are celluloid bakelite, and they are predominantly used in electrical appliances.

- **Thermoplastics:** These are processed by melting and softening and can be moulded into different shapes. The process is reversible, and hence these plastics can be melted and reshaped. As these are recyclable, they are much in demand in the market.

Some uses of various plastics are given in Table 2.

Table 2. Uses of different varieties of plastics

Plastics	Uses
Polypropylene (PP)	Packing of fertilizers, powdered chemicals, soft goods, foodstuffs and textiles, domestic appliances and cement. Injection-moulded into containers, house wares including crockery, schoolbags, briefcases, combs, furniture, toys, etc.
Low-density polyethylene (LDPE)	Damp proofing to lining ponds and canals to prevent seepage, lamination of paper, coating milk and other food cartons, etc.
High density polyethylene (HDPE)	Making buckets, cups, plates and bowls and packing of foodstuffs.
Polyvinyl chloride (PVC)	Carry bags, shoe soles, sheets, etc.
Engineering thermoplastics (ETP)	Cellular phones, CDs and CD-ROMS, optic fibre cables, automobile parts, etc.
Polystyrene	Packaging and encasing audiocassettes, CDs, etc.

Disposal of plastic waste

Earlier, dumping at the landfill was the main solution. But technological developments have diverted some of the plastic waste to the recycling industry. In fact, there is greater emphasis on recycling today. This is because of the environmental problems they pose due to the release of toxic fumes when certain resins are incinerated.

Types of recyclable plastics

Only 12 years ago, HDPE and Polyethelene Terephthalate (PET) were vaguely considered recyclable. But post-consumer plastic-resins recycling technology has developed more rapidly than technologies for any other recovered material. Today, primarily all varieties of Polyolefins i.e. LDPE, HDPE, Linear Low Density Polyethelene (LLDPE), High Molecular Polyethelene (HMPE), PP, PVC and PET are recycled in India. While most of the recycling is done in the informal sector, there are a few big recyclers as well. For example, the recycling capacity of PET in the organized sector is given in Table 3.

Table 3. Present recycling capacity of PET

Recycler	Location	State	Capacity (MT/Yr)
Daga Fibres	Silvassa	Dadar & Nagar Haveli	NA
IOCL	Chennai	Tamil Nadu	36,000
Viral Filaments	Bharuch	Gujarat	20,000
Sharc Star	Coimbatore	Tamil Nadu	12,000
Maskara Fibres	Nasik	Maharashtra	6,000
Arora Fibres	Silvassa	Dadar & Nagar Haveli	6,000
Ganesh Polytex	Kanpur	Uttar Pradesh	6,000
Gareware	Mumbai	Maharashtra	4,000
Padmini Polimers	Sahibabad	Uttar Pradesh	3,000
Nirmal Fibres	Moradabad	Uttar Pradesh	2,000
Total			**91,000**

Source: Recycling Responsibility, Srishti, 2002.

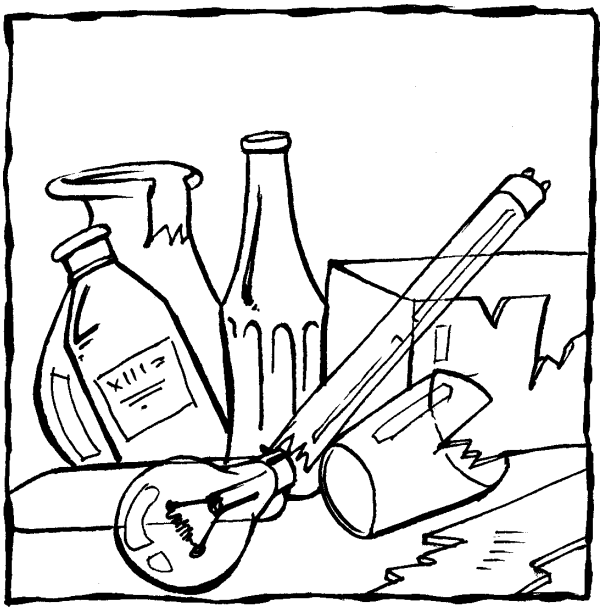
WHAT YOU CAN DO

Refuse, Reduce, Reuse and Recycle – managing plastic waste is our responsibility too

- Carry your own bags to shopping.
- Refuse to accept plastic carry bags, wherever possible.
- Avoid flimsy and dark-coloured plastic carry bags, as they may transfer toxic materials to the body.
- Urge vendors and shopkeepers to hand out items in paper bags.
- Prevent the burning of plastics.
- Refuse to buy over-packaged products.

Glass

Glass is made from abundant and cheap materials – sand, limestone, soda ash and other additives. These additives include iron for colour (brown or green), chromium and cobalt for colour (green and blue respectively), lead for altering the refractive index, alumina for durability and boron to improve the thermal options. Glass is used as a packaging material in addition to its use in door, windows and other applications.



Advantage of glass products is that it can remain in use till it is broken or becomes useless and joins the waste stream. Returning bottles to the retailer and receiving the deposit in return used to be a common practice. However, the practice is on the decline due to consumer preference towards the convenience of non-returnable bottles. Despite the extra weight required to withstand wear and tear and the costs of cleaning, returning bottles can still be the best option when they are recovered and refilled locally. There is also the option of reusing bottles and jars as storage containers for home-made wine, beer or jam.

Glass constitutes 2 per cent of our wastes, which is likely to go up to 3 per cent. It is the least finite of the non-renewable natural resources targeted by recycling programmes. However, glass can be recycled indefinitely as part of a simple but hugely beneficial process, as its structure does not deteriorate when reprocessed. Glass bottle makers provide a strong market for recycled glass containers.

Benefits of glass recycling[4]

- Making glass from recycled cullet (broken glass) uses half the energy of what it takes to make it from sand, limestone and potash.
- The energy saved by recycling one glass container can light a 100-watt bulb for four hours.
- Making glass from recycled cullet reduces air pollution by 20 per cent and water pollution by 50 per cent.
- Recycling also means less mining, and therefore less mine waste. Each tonne of recycled glass reduces mining waste by 500 pounds
- Since, recycled cullet melts at a lower temperature and is less corrosive than the raw materials that make glass, glass recycling also prolongs the life of melting furnaces.

EPR in glass recycling

While many countries have regulations for industry to recover and recycle glass, Indian Government is yet to come out with any such mechanism. For example, Britain targeted 50 per cent of packaging under The Producer Responsibility Obligations (Packaging Waste) Regulations, 1997. European Law aims at achieving recycling at least 70 per cent of glass in the packaging waste stream.

WHAT YOU CAN DO

Remember, glass waste needs careful handling

- If a bottle is returnable, it is usually preferable to return it, rather than to recycle it. This is economically beneficial too.
- Rinse bottles or jars after use.
- Wherever possible, remove metal or plastic tops, corks and rings from bottles or jars, as they can cause damage to furnaces if they get through.
- Recycle all glass containers, not just drinks bottles.
- Separate light bulbs or cookware, as these have different properties and can contaminate a load, resulting in sub-standard finished bottle products.
- Flat glass, such as window glass, whole or broken, should not be put with bottles.

Aluminium

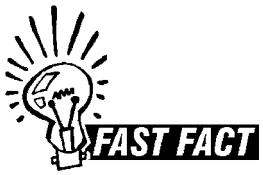
Aluminium occurs naturally and makes up about 8 per cent of the surface of the earth. It is used in manufacturing cooking utensils, containers such as beverage cans, foils, appliances and building materials. It is also used in paints and fireworks; to produce glass, rubber and ceramics and in consumer products such as medicines, preservatives and cosmetics.

The advantage with Aluminium products is that they can be recycled repeatedly without any deterioration in quality or in the metal's intrinsic value. Recycling Aluminium requires only about 5 per cent of the energy required to produce the primary metal. This is the reason behind the huge success of the industry of recovery and recycling of Aluminium. While recycling in the developed countries is a medium to large-scale (25,000-2,00,000 tpa) industry, in India it constitutes small, highly polluted units operating under hazardous conditions to produce degraded metal of poor quality.

Therefore, the issue is serious, especially in view of the increasing demand of Aluminium. The Working Group on non-ferrous metals for the IXth Five Year Plan has strongly recommended encouragement of recycling as it is estimated that about 25,000 tonnes of sheet applications and 40,000 tonnes of extrusion applications can be better served by recycled Aluminium metal.

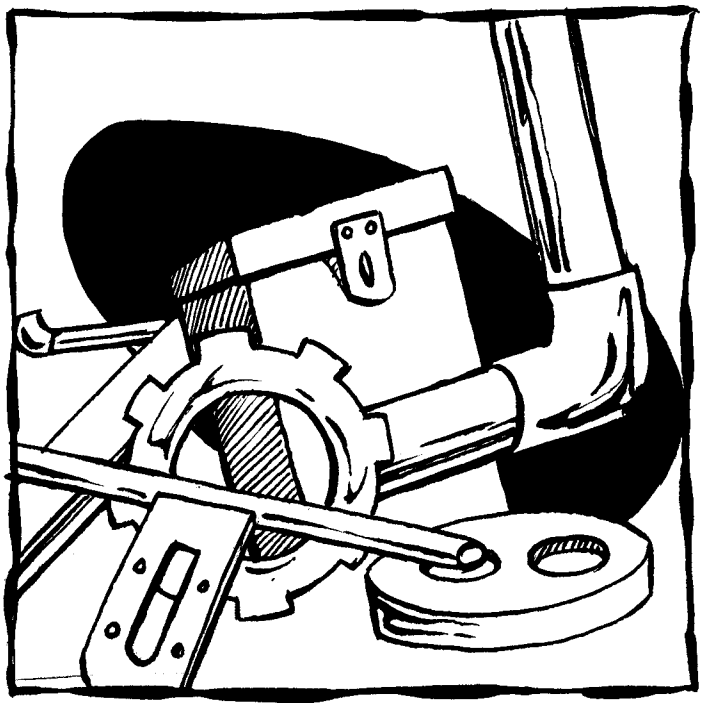
Other metals

Metals can be categorized as ferrous and non-ferrous. The reusable nature of metals contributes to their sustainability. While the primary sources of metals are ore deposits, the secondary sources are recycled materials. Once a product completes its useful product life, it becomes old scrap. Both ferrous and non-ferrous metals can be prepared for sale to markets by processing it through a combination of flattening, baling and shredding. Metals from discarded home appliances, like refrigerator, music system, food processor, used batteries, are recyclable. Though most of the recycling of scrap metals is undertaken by industry, the informal sector is also engaged in it. One even hears about how junk dealers disassemble computers to extract useful metals.



Metals from discarded home appliances such as refrigerators, music systems, food processors and used batteries are recyclable.

The nature of these products is such that very little waste is generated at the household level. Major contributor of scrap metals is industry. Presently,



metals constitute about 1 per cent of the total waste stream. However, with changing lifestyles, their share is likely to go up to 4 per cent. Their effective recycling is important because improper disposal of these materials can be hazardous.

Types of metals

While many metals come into the waste stream, some predominant metals are:

- **Copper and copper alloy scrap:** Major source of this metal at the household level is electrical wires.
- **Iron and steel scrap:** Iron, including its refined products steel, is the most widely used of all the metals and its recycling is an important activity worldwide. The largest source of obsolete scrap is junk automobiles and home appliances.
- **Cadmium:** The easiest forms of Cadmium scrap to recycle are spent Nickel-Cadmium (Ni-Cd) batteries and some alloys. All other applications of Cadmium are in low concentration and therefore difficult to recycle. Consequently, much of the Cadmium is dissipated.

WHAT YOU CAN DO

Managing waste made of aluminium and other metals

- ▲ Separate aluminium cans from other wastes. They can be sold for a price to the *kabariwala*.
- ▲ Taking care while disposing of items like used batteries. They should be kept with dry waste, so that the waste-collector can take them to proper disposal centers.

References

[1] Manual on Solid Waste Management (1st ed.), prepared by the Expert Committee constituted by the Ministry of Urban Development, Government of India, January 2000.

[2] No Fire Without Smoke, A Critical Look at Municipal and Hazardous Waste Incineration, Srishti, 1996.

[3] Robert Edward and Rachel Kellet; Life in Plastic: The Other India Press; 2000.

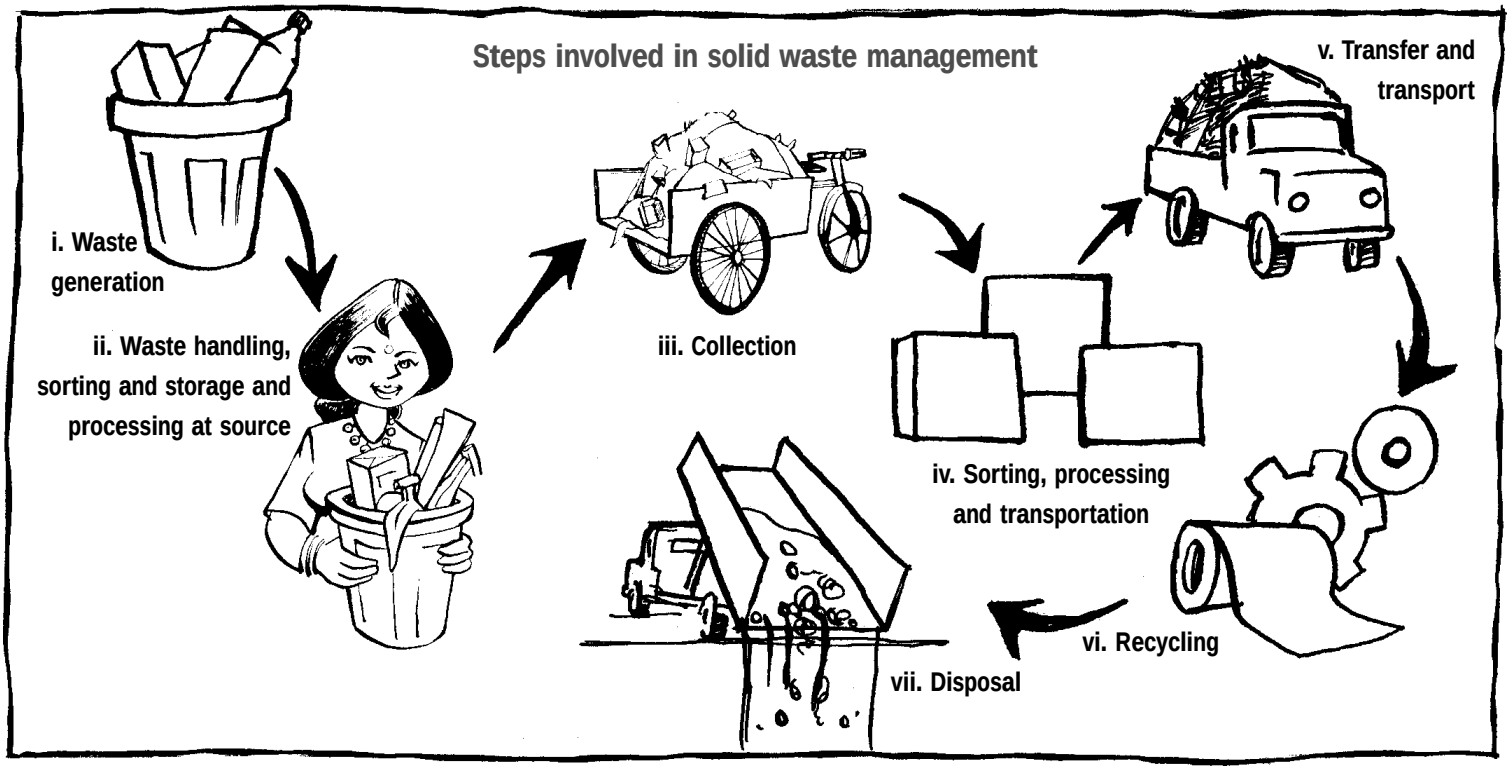
[4] Ryan Grindel, Candace Snover and Keith Hopkins, 20.1.97. Position Paper P.I.G.

CHAPTER 4

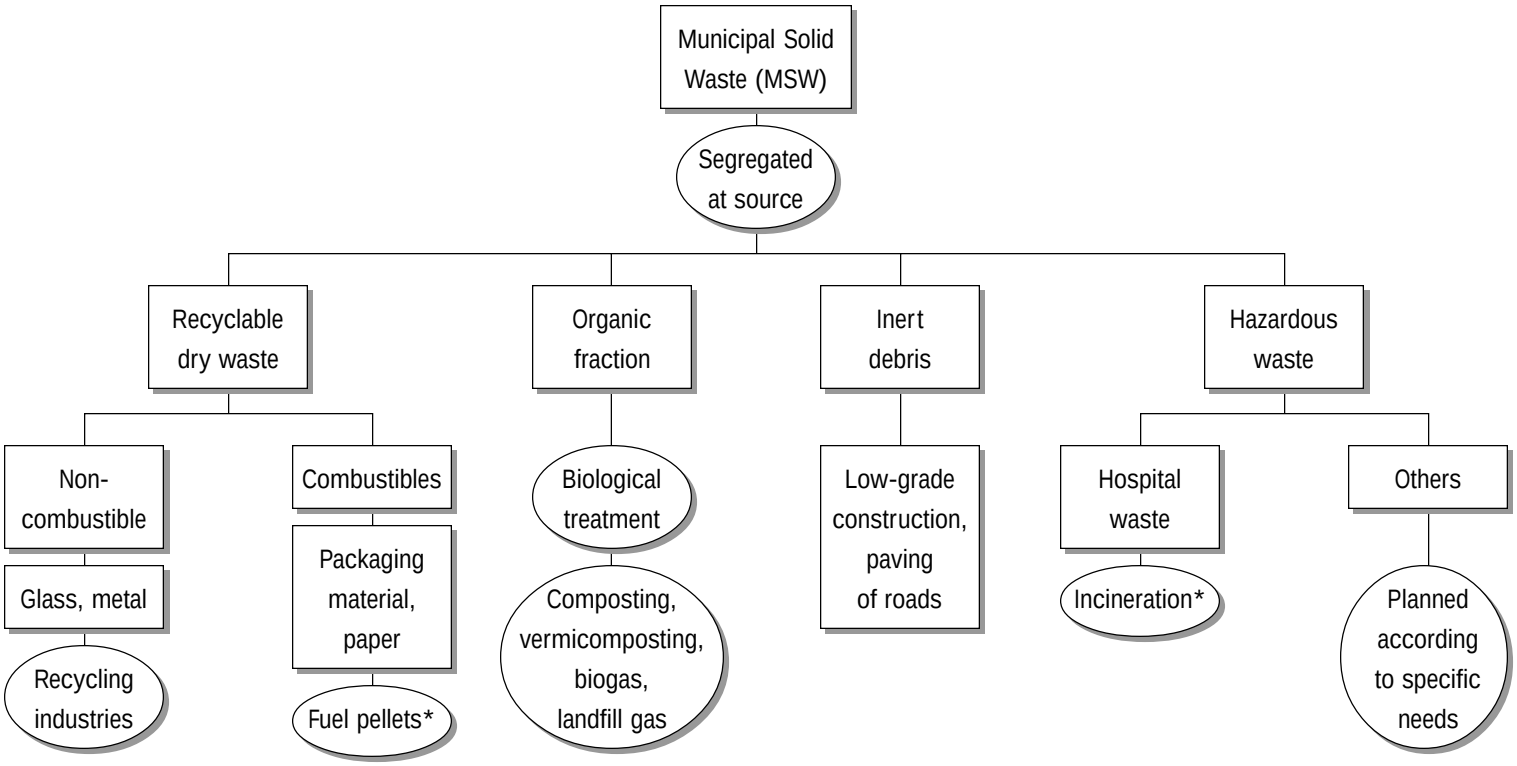
Effective practices for managing waste

A large part of the total waste generated in India is simply dumped in open dump-yards giving rise to unhygienic surroundings, health hazards, contamination of ground water and an unclean look to the city. A proper municipal solid waste management system is a major challenge in the protection of local and global environment.

There are a number of technological options to minimise and manage municipal solid waste. The municipal managers and all others involved in the endeavour need to be given adequate exposure and training to these technological options for application of Integrated Solid Waste Management (ISWM) in their municipalities or areas as the case may be. There is a chain of activities in Solid Waste Management (SWM), which includes the steps shown below.



A typical MSW management approach can be understood from the following diagram:

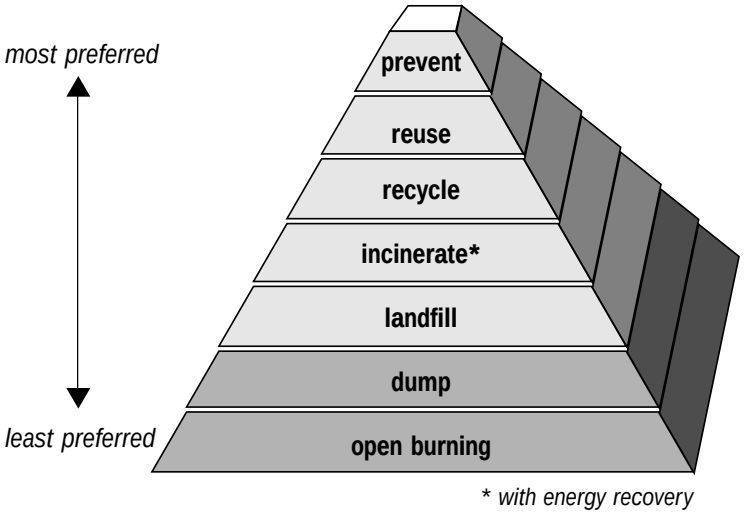


* technology that has negative consequences for the environment

Source: Management of Solid Waste, CPCB, MoEF, GoI.

The ISWM hierarchy

The waste hierarchy is accepted as a key element in integrated SWM, and is based on environmental principles that propose that waste should be handled by different methods according to its characteristics. However, experts have maintained that the options should not be ranked in a particular order, but should be considered as a menu of alternatives. The figure alongside can give an idea of this basket of options, or hierarchy.



Source: Analysing Urban Solid Waste in Developing Countries: a Perspective on Bangalore, India *by Pieter van Beukering, Madhushree Sehker, Reyer Gerlagh and Vijay Kumar. Working Paper No 24. CREED*

The first priority in the ISWM is waste minimisation or reduction at source, which involves reducing the amount of wastes produced. Reduction at source is the first in the hierarchy, because it is the most effective way to take care of all the issues related to solid waste and its management, the environmental impact and the cost associated with its handling.

The second priority is recycling, which involves (a) separation and sorting of waste materials; (b) preparation of these materials for reuse or reprocessing; and (c) reuse and reprocessing of these materials. Recycling is an important factor that helps to reduce the demand of resources and the amount of waste requiring disposal by landfilling.

The third in rank is waste processing, which involves alteration of wastes to recover conversion products (e.g. compost and energy). The processing of waste materials usually results in the reduced use of landfill capacity. Shredding, compaction may also be undertaken to reduce waste volume. Moreover, such an ISWM has other associated benefits that also include reduced public health hazards, reduced surface and ground water pollution, air pollution, and production of compost material for use as fertilizer, etc.

Landfilling/dumping is the last in the hierarchy and involves controlled disposal of MSWs on or in the earth's surface.

Segregation of waste and resource recovery

A stage between the collection of garbage and its disposal is that of resource recovery. The municipality in any city in India does not do segregation of garbage into biodegradable and non-biodegradable waste. Since the volumes of garbage handled by the municipality is very large, it would be a very labour-intensive job. Segregation, however, does happen in an informal way before the garbage is disposed. In door-to-door collection of garbage, the workers involved remove all recyclable items that have a resale value like plastic items, unsoiled paper, metal, glass, etc. Waste pickers in every city, of course, most efficiently perform segregation.

In India, paper, plastic, glass, rubber, ferrous and non-ferrous metals – the materials that can be recycled – are salvaged from the waste to produce low-cost products. Of the wide array of recyclable materials present in the Indian household waste, paper and plastic get maximum attention, because the two together form the single largest component of household waste. The reusable materials are sold off in waste recycling centres, which are small-scale industries.

The municipalities, however, are unable to take up any projects on segregation and recycling due to the high costs involved. Segregation of waste into biodegradable and non-biodegradable is done more efficiently in programmes run by NGOs. There are many initiatives by NGOs to involve households in separating the garbage into bio and non-biodegradable waste. However, these efforts need to be augmented by other support systems to be viable.

Secondary transportation of garbage

The situation of secondary transportation of garbage is very dismal. On average, 20 to 30 per cent of the total waste generated remains uncollected, creating environmental hazards in urban settlements. The collection, transportation and disposal of waste are labour-intensive activities. In large metros like Mumbai, some of the Municipal wards have started using modern, automated systems of collection, thereby increasing efficiency. However, in cities like Hyderabad and Ahmedabad, in many areas when the municipality does not collect garbage, sweepers resort to burning the garbage on the spot, thus creating an air pollution problem locally and unknowingly generating very toxic pollutants like dioxins and furans. Very often, the garbage is swept into the open gutters/drains, causing problems of choking and stagnation, which leads to unhygienic conditions.

Solid waste is usually transported in open trucks, compaction vehicles, tractor-trailers or carrier-containers. The vehicles are normally owned and maintained by municipal authorities. Lately, however, a few corporations have resorted to hiring vehicles from private contractors. Hired vehicles have been found to work more effectively and efficiently, if monitored and held accountable for the services rendered by them. In smaller (rural) towns, bullock carts, tractor-trailers, power tillers, tricycles etc. are mainly used for the transportation of waste. These vehicles are being used for the primary collection of waste from the streets, as well as for the collection of waste from dustbins.

Some of the problems faced in transporting MSW in large towns and cities are:

- The number of vehicles is inadequate and the percentage of vehicles remaining off the road is large.
- The fleet of vehicles is not optimally utilised.
- Transportation fleet does not synchronise with the types of dustbins provided.
- Hydraulic vehicles need proper maintenance and well-trained staff in the workshops.
- Double handling of waste becomes inevitably necessary.
- Waste handling is done manually and loading and unloading is time consuming. This reduces the productivity of manpower and vehicles.
- The system is a potential health hazard for the workers, as all type of waste including hospital infectious waste, human excreta etc., are disposed of in the common dustbin.
- Arrangement for collection of infectious hospital waste separately is practically non-existent.
- Dustbins are not cleared on a day-to-day basis. Many bins are cleaned once or twice in a week or even later. The backlog thus built up gives rise to unsanitary conditions

Where does all the waste go?

The prevailing technological options being followed for Municipal Solid Waste (MSW) disposal in our country are (unscientific) land filling, burning in open and composting. The wastes are normally brought to a designated landfill site, normally a low-lying area on the outskirt of a city. The choice of a site is more a matter of what is available than what is suitable. Only a few cities follow such good practices as organised tipping of wastes, using mechanised equipment for leveling and compacting the wastes, and covering the top layer with earth before compacting it further. In small towns and cities very often the garbage is dumped in ponds or banks of a river. In hill towns, the garbage is dumped along the hillside on the outskirts of the town, which attracts monkeys and various other animals. Collection of recyclable items like plastic, paper, etc. and transporting it to large towns for recycling is not an economically sound option. Efforts are required to organise the collection of these recyclable material from hill towns, or else these towns will be enveloped by waste.

There are a variety of methods for the disposal of the refuse collected from different collection points of the municipality. As per CPCB guidelines, the prevailing technological options for municipal solid waste disposal include:

- Sanitary landfill
- Incineration
- Composting
- Fuel pelletisation

It is necessary to mention here that some of the options mentioned above have serious environmental and health repercussions. We can also discuss each of the practices by types of waste, i.e wet and dry (dry waste may be recyclable or non-recyclable).

Wet waste

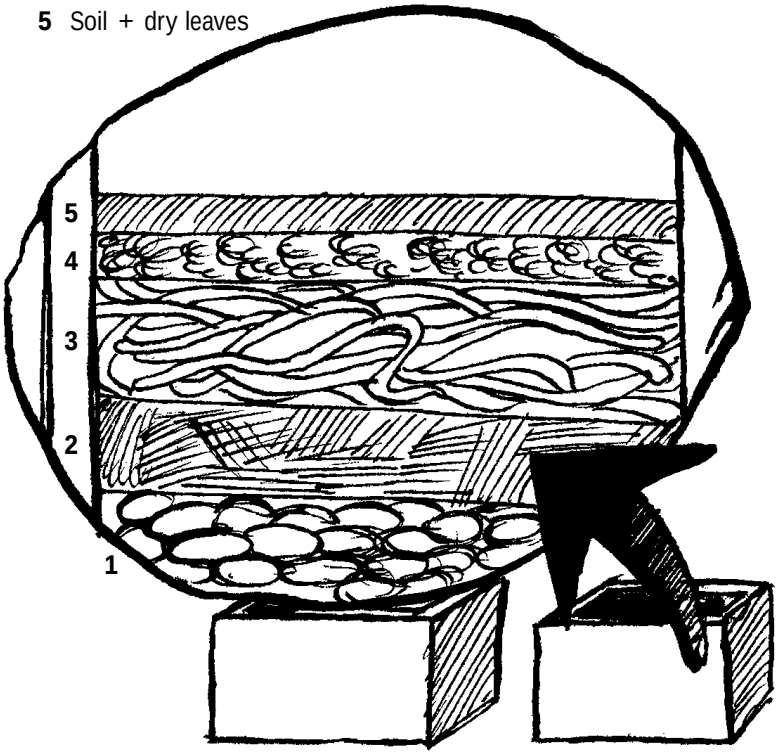
The organic component of our waste is often called wet waste. Some useful technologies are described below which can provide us resources from these wastes.

Composting

Composting can be defined as the biological decomposition of the organic constituents of wastes under controlled conditions. This process can take place in the presence or absence of oxygen, that is, aerobic or anaerobic composting. Aerobic composting, if efficiently carried out, can rapidly produce a pathogen free product, whereas anaerobic composting requires more time and is seldom free of pathogen or odour problems and hence needs greater controls. The micro-ogranisms convert organic wastes into humus, which has significant value to agriculture.

Layers (in ascending order, from bottom to top)

1. Broken bricks or pebbles
2. Sand or loamy soil
3. Cowdung + earthworms
4. Organic waste
5. Soil + dry leaves



Merits of composting

- ▲ Foul smell is quickly eliminated.
- ▲ Processing site is made hygienic for workers.
- ▲ Harmful pathogens are killed by exothermic heat.
- ▲ Waste becomes free from flies and vultures.
- ▲ Chances of smoke and fire hazards are minimized.
- ▲ Weed seeds, fruit nuts are made viable.
- ▲ Waste material becomes safe for re-transportation, etc.
- ▲ The end product, organic manure has a very good acceptability among farmers for agriculture as well as horticulture. Organic manure improves soil fertility, soil texture and water retention capacity of soil, thereby increasing production.
- ▲ Recyclable products like glass, metal, plastics are recovered at the end of the process.
- ▲ Minimizes production and release of gases like methane, ammonia, hydrogen sulphide etc. in the environment.

Anaerobic decomposition (fermentation): Anaerobic decomposition takes place in nature. Organic compounds break down by the action of living organisms that do not require air from the atmosphere. These organisms use nitrogen, phosphorus, and other nutrients to live and to develop cell protoplasm, but they reduce the organic nitrogen to organic acids and ammonia. The carbon from the organic compounds, which is not utilized in the cell protein, is liberated mainly in the reduced form of methane (CH_4). A small portion of carbon may be respired as carbon dioxide (CO_2).

Since anaerobic destruction of organic matter is a reduction process, the final product, humus may appear to decompose further after being exposed to air. This oxidation is minor, takes place rapidly, and is of no consequence in the utilization of the material on the soil. In other words, much less heat is generated in anaerobic decomposition than in aerobic decomposition.

The lack of heat generation in the anaerobic destruction of organic matter is a definite disadvantage if contaminated materials are used for composting. High temperatures are needed for the destruction of pathogens and parasites, though the pathogenic organisms do eventually disappear in the organic mass, as a result of the unfavorable environment and biological antagonisms. The disappearance is slow, and the material must be held for periods of six months to a year to ensure relatively complete destruction of pathogens. Therefore, compost may be used only after a year.

Main characteristics of anaerobic composting

- ▼ The process is a lengthy one, extending over a period of 4 to 12 months.
- ▲ It is a low temperature process and the destruction of pathogens is accomplished by their exposure to an unfavourable environment over a long period.
- ▼ The gaseous products of reduction are methane, hydrogen sulphide and other gases with offensive odour.

Aerobic decomposition: When organic materials decompose in the presence of oxygen, the process is called "aerobic." The aerobic process is most common in nature. For example, it takes place on ground surfaces such as the forest floor, where droppings from trees and animals are converted into relatively stable humus.

In the process, living organisms, which use oxygen, feed upon the organic matter. They use the nitrogen, phosphorus, some of the carbon, and other required nutrients. Much of the carbon serves as a source of energy for the organisms and is burned up and respired as carbon dioxide (CO_2). Since carbon serves both as a source of energy and as an element in the cell protoplasm, much more carbon than nitrogen is needed. Generally about two-thirds of carbon is respired as CO_2, while the other third is combined with nitrogen in the living cells.

When some of the organisms die, their stored nitrogen and carbon become available to other organisms. As other organisms use the nitrogen from the dead cells to form new cell material, once more excess carbon is converted to CO_2. During composting, a great deal of energy is released in the form of heat in the oxidation of the carbon to CO_2. For example, if a gram-molecule of glucose is dissimilated under aerobic conditions, 484 to 674 kilogram calories (kcal) of heat may be released. If the organic material is in a pile or is otherwise arranged to provide some insulation, the temperature of the material during decomposition will rise to over 170°F. If the temperature exceeds 162°F to 172°F, however, the bacterial activity is decreased and stabilization is slowed down.

Aerobic oxidation of organic matter produces no objectionable odor. If odors are noticeable, either the process is not entirely aerobic, or there are some special conditions or materials present, which are creating the odour. Aerobic decomposition or composting can be accomplished in pits, bins, stacks, or piles, if adequate oxygen is provided. Turning the material at intervals or other techniques for adding oxygen is useful in maintaining aerobic conditions.

In its modern sense, aerobic composting can be defined as a process in which, under suitable environmental conditions, aerobic organisms, principally thermophilic, utilize considerable amounts of oxygen in decomposing organic matter to fairly stable humus.

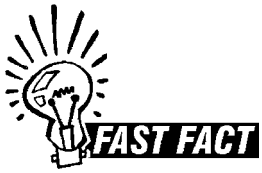
Main characteristics of aerobic composting

- ▲ Rapid decomposing, normally completed within 4-6 weeks.
- ▲ During the composting period high temperatures are attained, leading to speedy destruction of pathogens, insect eggs and weed seeds.

Vermiculture

As an aspect of biotechnology, Vermicomposting makes use of earthworms, which are natural and versatile bio-reactors for cleaning up the environment. It is a simple low-cost waste management technique. By providing earthworms with optimum conditions for rapid multiplication and conversion of farm wastes and biodegradable urban waste into bio-fertilizers, it can preserve and improve soil fertility. Worms eat the organic waste and turn it into an excellent fertiliser – worm compost, otherwise known as worm castings or vermicompost. Worm composting, or vermiculture, requires very little work, produces no offensive odours, and helps plants thrive. Only a few things are needed to make good worm compost: a bin, bedding, worms, and worm food.

Certain specific species of earthworms can consume organic residue very rapidly and fragment them into much finer particles. For vermicomposting, the most significant aspect is the selection of earthworms. There are broadly three



During composting, a great deal of energy is released in the form of heat due to the oxidation of carbon into carbon dioxide.

varieties of earthworms – surface, subsoil and deep burrowing. For vermicomposting, the best variety is the surface variety, because they feed on the surface. Some of the species of earthworms that aid in vermicomposting are *Eudrilus eugeniae*, *Eisenia foetida*, *Perionyx excavatus*, etc. The following products can be obtained from the process of vermicomposting:

- **Vermicompost (**end product), is the castings (excreta) of the earthworms. This is rich in plant nutrients.
- **Vermiwash** (bye product), is a solution of nutrients obtained from the percolation of water through the vermicastings.
- The **earthworms** themselves, are very good sources of proteins and can be used as feed for fish, poultry and pigs.

Vermicomposting has immense potential and has been very successful at the community level, at a small scale. There are no examples of vermicomposting at a large scale. However, the present techniques may be modified and tried on large amounts of waste to significantly address the solid waste management issue.

Dry waste

We know that dry waste is of two types – recyclable and non-recyclable. Recyclable material reaches the processing industries, while the non-recyclable materials are sent to landfill sites for dumping. We need to know how the recyclable items are processed in terms of technology and scope.

Recycling of paper

The recovered paper is first sorted into different grades – high grade, cardboard and mixed waste paper – and then taken to the paper mill. At the mill, the paper is "slushed" into pulp, and large contaminants, such as staples, plastic, glass, etc., are removed. Fibres are progressively cleaned. The pulp is then filtered and screened through a number of cycles to make it more suitable for papermaking. For certain uses (e.g. for the production of graphic and hygienic papers) the fibres also have to be de-inked. The pulp is then ready to be made into paper. Depending on the grade of paper being produced, quantities of virgin pulp from sustainable sources may be added. Some papers, such as newsprint and corrugated materials, can be made from 100% recycled paper. Once the paper is used, it can be recycled and the process started again.

Sometimes the ink is not removed from the paper when it is reprocessed, which then disperses into the pulp, discolouring it slightly. This is why recycled paper often has a greyish tinge. If the paper is to be de-inked, this can be done by either washing or flotation.

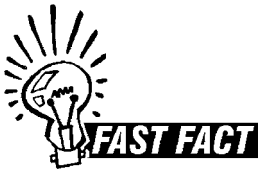
Worm composting, or vermi-composting, requires very little work, produces no offensive odours, and helps plants thrive. Only a few things are needed to make a good worm compost: a bin, bedding, worms, and worm food.

Washing: As the paper is pulped, chemicals can be added, which separate the ink from the paper and allow it to be washed away in the large amounts of water used. (The water can then be cleaned and re-used.)

Flotation: Air can be passed through the pulp, producing foam, which will hold at least half of the ink and can be skimmed off.

Sometimes, the pulp is also bleached. Hydrogen peroxide and chlorine are commonly used bleaches, though the former is more acceptable, as it breaks down into water and oxygen on disposal. Chlorine can, however, combine with organic matter under certain conditions to produce organo-carbons, including dioxins, which are very toxic pollutants. Although the de-inking process uses water and chemicals, it is still less harmful to the environment than the manufacturing process of new paper.

Different processes are used for some other papers. For example, cartons are not made from paper alone, but are comprised of about 75% paper, 20% plastic (polyethylene) and 5% aluminium foil. As they are an amalgam of materials, they cannot be recycled along with ordinary paper. They have to be reprocessed into other items or incinerated to produce energy, or landfilled, again posing serious threat to environment and health.



Products recycled from mixed post-consumer plastic waste are generally used in agriculture, recreation, gardening and horticulture, construction and industry.

Recycling of plastic

Incineration technology, as mentioned previously, produces a variety of very toxic fumes, which are extremely harmful for health. Hence, it is better to use alternative technologies. Different processes are used to recycle different types of plastic waste, though it may be remembered that plastics can not be recycled endlessly. Some of these processes are:

Mechanical recycling: Mechanical recycling is a viable option for most of the thermoplastic products. The process involves processing of plastic material by sorting, cleaning and recycling into pellets, ready for production of new products. However, this technique has its limitations, as material is grossly polluted or burnt, absorbs moisture from air, and may be of composite nature.

The process followed is described below:

Sorting – Sorting of waste plastic is essential, as there are some plastics that can be mixed and extruded, while others cannot because their material and melting characteristics are different. The initial sorting of plastic is done by visual-method by the employees of the waste dealers. The sorters use their experience to identify the plastic type by seeing. Sometimes, the flotation method is used to determine the type from its density. In case of any confusion, the plastic is either broken and identified on the basis of the strength of the polymer, or burnt to determine by odour.

Size reduction – Uniform variety of sorted plastic scrap is manually fed into the shredder/grinder/cutter and is subsequently shredded into flakes or ground or cut to reduce the size of the waste.

Machine	Raw material
Shredder	Films, sheets, foams
Grinder	Lumps, injection moulded items, large blow moulded items
Cutter	Big lumps

Washing – Once the waste is sorted and reduced in size, it is then washed to remove all visible contaminations and dirt. Washing is done with caustic soda and some type of detergents. Sometimes, it is difficult to remove contamination from waste plastic, as it may consist of metals or ceramic, which, if not removed properly, may have undesired effects on the recycling process or the recycled product.

The flakes or chips are soaked in soap solution for a few hours to few days in drums or cemented tanks. The non-polymeric contaminations sink to the bottom due to gravity. The plastic is then hand-washed and rinsed with clean water. This operation requires the workers to soak their hands in soap water for long hours.

The equipment required for the process is:

Centrifuge – Centrifuge is a cylindrical vessel, inside which is a perforated vessel that rotates with the help of a motor at high speed. These are used to dry the material.

Blower – In a blower, ambient air is heated up with the help of heaters, by using LPG gas. The plastic is dried in the blower and passed on to the mixer.

Mixer – The uniform variety of plastic scrap is put in the mixer. If the plastic waste is clean, then it is directly put after shredding and grinding. Pigment in the form of master-batch is mixed at this stage.

Extruder – In this step, plastic scrap is fed into an extruder. This is primarily used in polymer processing. The test of a good recycling line is the extruder, and most of the operation involves extrusion. The choice of the extruder depends on the process task and raw materials. The extruder process requires close monitoring of the composition, morphology, characteristics of final products, etc. The contaminants that remain in the waste, even after washing, are filtered by breakers plate during the extrusion process. This waste is removed by burning at least once, depending on the quality of the waste and the quantity of the material extruded.

Pelletiser – The pelletiser is the last component of the recycling process. The materials, after being filtered by the breaker plate during the extrusion process, flow in the form of strings, which are finally cut into granules or *danas*. Before being cut, the strings pass through a water bath. This cools the strings, which are then cut into small granules with the help of blades that rotate continuously on the die plate.

Mixed plastic waste recycling: The contents of mixed plastic waste are – LDPE, HDPE, LLDPE, HMHDPE, PP, PVC, PS PC, ABC, Polyamide, etc. This plastic is contaminated with paper, soft metal, dirt or thermoset plastic. Due to contaminants, its recycling generates lot of toxicity and hence is not recommended owing to concerns about emissions. Products from mixed post consumer plastic waste are generally used in agriculture, recreation, gardening and horticulture, construction and industry. Such kind of waste is mixed thoroughly and then extruded or moulded directly into linear shaped pieces known as plastic lumber.

Problems related to the technology: The problems related to the extrusion process are:

- The presence of moisture in the extrudate in extreme condition may lead to explosion. The moisture present in polymers can lead to degradation and clogging of the screw channel.

- Overheating due to lack of automatic temperature control may lead to degradation and clogging of delivery channel and subsequent release of volatile matter.

- As most of the machines used in the extruding process are fabricated in local workshops, there is a high risk of short circuit. Usually, heaters and electrical wiring connected with barrel are exposed without any casing.

- Heated barrel without protective casing may cause accidents, particularly at the time of changing the wire mesh, as the wire mesh is attached with a breaker plate to remove contaminations. There is invariably a fair amount of impurities in the shredded material loaded into the extruder, and in normal operation the mesh get heated very fast and may need replacement.

- There is a problem of degradation of the matter inside the extruder, at times of unscheduled power shut down. PVC, in

particular, emits Hydrogen Chloride and other products of degradation when removed from the extruder, once power is restored.

Polyethylene terephthalate (PET) recycling: PET recycling operations are usually designed based on the bottle (soft drink) specifications i.e., one piece bottle having higher intrinsic viscosity for its production using blow molding as compared to two-piece bottle with a HDPE cap. Apart from resin specifications, the nature of bottle closure also varies. In some bottles Aluminium metal roll on closures having weight around 1.5g are used. All PET bottles use labels that are made of either paper or have a plastic base.

The process: First, the bales of PET bottles are separated and individual bottles are subjected to hot water treatment, by which they regain their original size and are then sent for manual separation. On the conveyor system, uncleaned (oil stained, fluids remaining inside the bottles etc.) bottles are separated and are sent back for cleaning.

Next, the clean bottles are crushed. After crushing, a simple flotation process is employed to separate the bottle caps, neck and other polyethylene material, as well as external brand labels if any. Based on the level of contamination of the batch, either caustic soda or detergent is used to clean and disinfect. Further washing, both manual and mechanical, is undertaken and then magnetic separation is used to separate the foreign particles. The batch is then finally crushed into raw flakes.

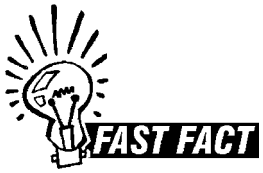
Recycling of EPS: As EPS waste is voluminous, it occupies a lot of space and proves to be a problem. Some quantities of the EPS waste are grounded by the manufacturers into small pieces and mixed with the fresh EPS as a partial or direct substitute for the virgin polymer for the production of loose fill packing or for new EPS moulding.

In the recycling units, EPS wastes are cut into straight slabs of a fixed dimension in a cutting machine. In the process, the cut pieces that are produced are then taken away by the *kabariwalas* to be sold mostly to brick kilns. In this manner, these small pieces are mixed with other combustible waste and burnt to produce energy. Heavily soiled packaging are collected by rag pickers and sold to brick making factories directly. The molten EPS in the form of a mass comes out from the bottom of the kiln. The molten EPS mass is of three qualities: white, brown and black, which are then ground into small bits and sold to plastic recycling units. The best quality is the white, followed by brown and black. The plastic recycling unit owners on their part reuse the molten EPS in the production of non-foam applications, by mixing it with plastic waste to make plastic stationary products, video and CD cases, coat hangers etc.

The heat release value of EPS waste is 9,600 kcal/kg, which is thermally equivalent to 1.2-1.4 litres of fuel oil, depending on the density and calorific value of oil.

Recycling of glass

Glass has the unique ability to be infinitely recycled, without its quality being compromised and creates a compelling case for recycling. The manufacture of glass uses energy in the extraction and transportation of the raw materials and during processing, as materials have to be heated together to a very high temperature. Large amounts of fuel are used and the combustion of these fossil fuels produces carbon dioxide – a greenhouse gas. If recycled glass is used to make new bottles and jars, the energy needed in the furnace is greatly reduced. After accounting for the transport and processing, 315 kg of CO_2 is saved per tonne of glass melted. Thus, glass recycling is a hugely beneficial process, as its structure does not deteriorate when reprocessed.



Glass has the unique ability to be infinitely recycled, without its quality being compromised.

Clean flint **cullet** is usually the most desirable form of recycled glass scrap. Mixed color broken glass with ceramics or stones mixed in it is the least desirable grade of cullet, bringing the lowest price. Most recyclers sort it colour-wise and break or crush and screen bottles before selling their product. When glass cullet reaches the plant it is monitored for

purity, contaminants are removed and it is crushed and added to the raw material mix in the melting furnace. It is then moulded or mechanically blown into new bottles or jars.

In the case of bottles and jars, up to 80% of the total mixture can be made from reclaimed scrap glass, called "cullet". Cullets from a factory have a known composition and are recognised as domestic cullet. Glass cullet can also be used for aggregate in the construction industry, and the new road laying material glasphalt.

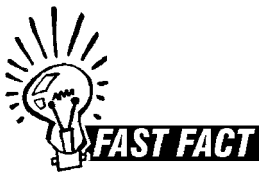
Glass that we are familiar with is divided into different streams based on its particular composition and use. Modern, high production bottle manufacturing requires very clean and uniform feedstock. Over the past decade, there has been a growth in the glass benefaction sector. These are intermediate processors that receive glass from recycling programs and run it through a series of steps to remove any contaminants (rocks, ceramics, metal caps, etc.) and provide a uniform feedstock to the bottle manufacturers. These preprocessors provide an excellent market for recycling programs that do not have the volume or ability to produce glass for direct mill delivery.

Glass beneficiation plants use sophisticated optical sorting machines to separate the glass into the three color-types. They may also x-ray the glass to detect any rocks or ceramics, which are then removed. Magnets and eddy current separators are used to remove magnetic and non-magnetic metal contamination from caps and lids. The end product is a uniformly sized load of ground glass that is free of contaminants readily acceptable by bottle manufacturers.

Problems in glass recycling: *Colour imbalance* – The main barrier to recycling glass is the shortage of clear cullet, which is essential for making usable products.
Rate – Though the exact figures are not available, the rate of glass recycling in India is very low. The primary reason for this is that the collection is largely handled by the informal sector. In contrast, the western countries have banks for bottles, etc. Switzerland and Finland recycle more than 90% of their container waste, and a recycling figure of more than 50% is the norm.

Aluminium recycling

Aluminium, as we have seen, is the most recyclable material and helps in energy conservation. Aluminium cans are the most valuable component in the consumer waste stream that can be recycled successfully. However, often labelling on aluminium packaging or cans is done by paints, which can give rise to harmful emissions when smelted. Apart from cans, Aluminium dust from factories and dust of Aluminium utensils are also recycled using the same technology as for cans.



Aluminium cans are the most valuable component in the consumer waste stream that can be recycled successfully. However, often labelling on aluminium packaging or cans is done by paints, which can give rise to harmful emissions when smelted.

Aluminium is recycled in a furnace or *bhatti*. There are three types of furnaces – coal, oil and electric.

In the coal furnace, at a time 10-15 kgs of Aluminium waste is melted, with the molten material remaining in the furnace. The time taken to melt is one hour. In the oil furnace 300 kgs of Aluminium waste is melted at a time in two to three hours. The oil furnace has certain advantages over the coal furnace, like it takes less time to melt, less smoke

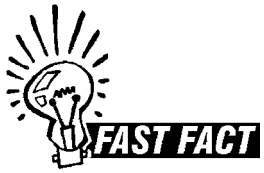
emission and more quantity of waste can be melted.

Once the aluminium is melted, it is checked for proper chemistry (usually depends on the knowledge of the workers who have learnt it through experience) and then scooped out with the help of long iron spoons and put inside moulds that cat sheet ingots. ammonium chloride/zinc dust is added which acts as a grain refiner or flux to clean the molten aluminium by separating out any oxides that are skimmed off. The molten aluminium cools to form ingots. In some units, only ingots are manufactured while in some others the slabs are made into sheets. These slabs are then put into a hot rolling machine. They are taken out with the help of pincers and put into a cold rolling machine. Then they are put in shearing machines and flattened into sheets.

Recycling of other metals

Most of the other metals are reprocessed in medium- or large-scale factories. The recovered metals are sorted and then the large waste dealers sell them to factory owners. This does not mean that new industries are coming up, but the current plants are either expanding or adding capacity. For example, India's stainless steel mills are upgrading existing plants rather than building new ones. In fact, India has emerged as a big buyer of scrap metals in the international market, which implies that recovery of such materials is low in India.

However, some sort of local processing is undertaken to separate the material from other matters. Disassembly of computers is a case in point.



In India, 91 per cent of waste is dumped in low-lying areas. These improper landfills can pollute water and air.

Disposing of the non-recyclable

The non-recyclable dry waste and that portion of dry waste that is discarded after making use of the recyclable material, is finally disposed of in the following manners:

Sanitary landfilling: Sanitary landfilling is an engineered method of disposing solid waste on land in a manner that minimises environmental hazards and nuisances. It is a controlled disposal of solid wastes on or in the upper layer of the earth's mantle.

A sanitary landfill site should be carefully selected, designed and prepared. The wastes are to be spread in thin layers, compacted to the smallest practical volume and at least at the end of each operating day, covered with earth, which is also compacted. In India, however, there is no sanitary landfill; here the waste is simply dumped in low-lying areas. 91% of the waste meets this fate in these so-called 'landfills'. These improper landfill sites are a constant threat for water and air pollution. In future, local bodies will find it difficult to get landfill sites not only because of scarcity of land, but also due to public alertness.

Proper planning and site selection, combined with good engineering design and operation of a sanitary landfill, can minimise the possibility of surface and ground water pollution. The landfill sites in India suffer from the following deficiencies:

- Lack of proper drainage to prevent flow of rainwater into and out of the site
- Non- application of cover material on garbage on a daily basis
- Lack of proper gas venting facility
- Absence of overall environmental management plan for solving pollution problems

According to NEERI, June 1996, examination of the water environment in major landfill sites indicates a high concentration of TDS in contiguous ground water sources. Solid waste samples from various depths of the landfills contained high values of faecal coliforms and faecal streptococci.

Landfill gas recovery: The waste deposited in a landfill gets subjected, over a period of time, to anaerobic conditions and its organic fraction gets slowly volatilised and decomposed, leading to production of landfill gas, which contains a high percentage of methane (about 50 per cent). Typically, the production of landfill gas starts within a few months after disposal of wastes and generally lasts for 10 years or even more, depending on the composition of wastes and the availability of moisture.

This gas can be recovered through an active system of vertical or horizontal wells, which are placed/drilled into the wastes where methane is being produced. A main collection header connects the wells and a blower pumps the gas out under negative pressure. The gas is passed through a moisture trap, gas-cleaning unit, a flame arrester, a non-return valve and a gate valve before being connected to the compressor. As the gas has a calorific value of around 4500 Kcal/m^3, it can be used as a source of energy either for direct heating/cooking applications or to generate motive power or electricity.

Degradation of MSW: Anaerobic decomposition of MSW in landfills starts sometime after the dumping of the waste. This process consists of several phases:

Aerobic phase – In this phase, the oxygen present in the landfill is consumed in the (aerobic) degradation of organic compounds. This phase is relatively short (several days to several weeks), since the quantity of oxygen present is limited.

Hydrolysis phase – In this phase, the large organic molecules are converted into small soluble molecule such as lower fatty acids, simple sugars and amino acids.

Acidogenic phase – Under anaerobic conditions (absence of oxygen), hydrolised compounds are degraded by bacteria into fatty acids. In this way, the acidity level (pH) is reduced. The gases that are formed in this phase are mainly hydrogen (H_2) and carbon dioxide (CO_2).

Methanogenic phase – During the methanogenesis phase, the fatty acids formed in the acidogenic phase are decomposed mainly into methane (CH_4) and carbon dioxide (CO_2). The methanogenesis can sometimes take several months or years before methane is formed. In contrast to the microorganisms in the acidification phase, the methane forming bacteria are sensitive to sudden changes in the environmental condition. It is, therefore, important that during the methanogenic phase the landfill remains under anaerobic conditions.

Since, a landfill is highly heterogeneous, the stages described above occur simultaneously in a landfill. Until some years ago, landfill had been the accepted system of waste disposal in most developed countries. Now, there is a general trend worldwide to discourage disposal of combustible and organic wastes into landfills. Some of the countries like Austria, Belgium, Canada, Denmark, Finland, France, Germany, Netherlands, Norway and Sweden have already banned landfills or have decided to reduce reliance on landfills.

Resource recovery through waste processing

Processing of MSW may provide us energy (electricity) or rich compost, depending upon the technology adopted. It has been estimated that there is a potential of generating about 1000 MW of power from urban and municipal wastes and about 700 MW from industrial wastes in the country. The total Indian market for Municipal Solid Waste treatment and disposal technologies (excluding collection and transportation) in 1997 was estimated at US $ 270 million[1]. The market was projected to grow at an average annual growth rate of 20 per cent during the next 3 years. Composting technology, due to its simplicity and low capital requirements, accounts for almost 50 per cent of the market.

Waste-to-energy initiatives worldwide

The Ministry of Non Conventional Energy Sources (MNES), Govt. of India identified "Energy from Waste" as one of the thrust areas of its activities and initiated a 'National Programme from Urban and Industry Waste'. The programme was intended to promote 'waste to energy' projects, by creating a conducive environment by providing suitable financial/fiscal incentives. Improvement of waste management practices (with special emphasis on generation of energy from waste, wherever possible) using latest and clean technologies is another important objective of the programme. But most of these projects are based on industrial wastes. It may be mentioned here that many technologies being supported under the programme are suspect, and there are evidences of their being environmentally unsustainable and hazardous for health.

Constraints in setting up of waste-to-energy project using MSW

In spite of a major initiative taken by the Govt. of India and attractive financial and fiscal incentives being made available by international agencies, not many MSW based Waste to Energy (WTE) projects have come up in the country so far. The following are the major constraints in setting up such projects:

- High capital cost of a waste-to-energy project
- A potential developer/entrepreneur is not keen to take up such a project, as there is a risk factor involved due to the lack of success stories/ground experiences available in the country on successful MSW projects.
- Due to a deficiency in the legislation, there is no compulsion on the Urban Local Bodies to take up such projects, techno-economical viability and sustainability of which are not guaranteed.
- Most of the technologies were developed in other countries and may not be suitable for Indian conditions.
- Lack of adequate financial resources of Urban Local Bodies and State Govts. to meet even a part of the project cost.
- Lack of concrete/long-term strategy at the level of State Governments, as also the absence of clear-cut and conducive policy on waste to energy projects, such as supply of wastes, availability of land and sale/purchase of power generated from such projects.
- General lack of awareness about hygiene and protection of environment.

Disadvantages of waste-to-energy projects

WTE technologies are being abandoned in the west because governments and communities have realised problems with them. For example, plastics are good source of producing high energy and are therefore preferred, but they also produce extremely toxic fumes that are harmful for both human beings and the environment.[2] Toxics Link has strong opposition to this option, because besides being detrimental to environment it promotes unfettered consumerism, wasteful and irresponsible use of resources.

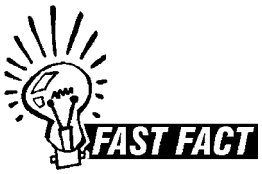
Technologies used in WTE

Some technologies used in WTE projects are mentioned below:

Physico-chemical options

Pelletisation: Pelletisation is the production of fuel pellets from solid waste. The process is essentially a method that condenses the waste or changes its physical form and enriches its organic content through removal of inorganic materials and moisture. Pellets can be used for heating plant boilers and for the generation of electricity. They are pitched as a perfect substitute for coal/ wood used in home/industry, but they lead to undesired toxicity from burning.

Pelletisation of MSW involves the processes of segregating, crushing, and mixing high and low heat value organic waste material and solidifying the same to produce fuel pellets or briquettes, also referred to as Refuse Derived Fuel (RDF). This is stored and transported and used as a supplementary fuel for combustion processes and utility boilers. The calorific value of RDF is about 4,000 kcal / kg, and it depends upon the content of combustible organic materials in the waste, additives and binder materials, if any, used in the process.



Waste-to-energy technologies are being abandoned in the West as governments and communities have realised problems with them. Toxics Link strongly opposes this option, because besides being detrimental to the environment, it promotes unfettered consumerism and irresponsible use of resources.

Table 4. Evaluation of pelletisation

Merits	Demerits
The process results in production of high calorific value pellets	The garbage processing unit cannot be operated during rainy season , as the garbage is too wet.
Pellets can be conveniently stored and transported	High moisture content of Indian MSW increases the cost of drying
Pellets can be used as a supplementary fuel for combustion process and boilers	The process consumes more energy than the biological process, such as composting
	Uncontrolled burning of pellets may lead to harmful emissions
	Even a trace amount of plastic content in the pellets can be extremely harmful

Source: Management of Solid Waste. CPCB, MoEF, GoI.

Gasification: Gasification is the process involving partial combustion of a carbonaceous fuel to generate a combustible fuel gas rich in carbon monoxide and hydrogen. A gasifier is actually an incinerator operating under reduced conditions. Heat to sustain the process is derived from the exothermic reactions, while the combustible components of the low-energy gas are primarily generated by the endothermic reactions. The kinetics of the gasification process is quite complex and a subject of considerable debate.

When a gasifier is operated at atmospheric pressure with air as oxidant, the end products are a low-energy gas, typically containing 10% CO_2, 20% CO, 15% H_2 and 2% CH_4 (by volume), the balance being N_2 and a carbon-rich char. Because of the diluting effect of nitrogen in the input air, the low-energy gas has an energy content in the range of 5.2 to 6.0 MJ/m^3. When pure oxygen is used as the oxidant, a medium-energy gas with energy content in the range of 12.9 to 13.8 MJ/m^3 is produced.

The gasification process converts solid waste materials into clean useable energy in the form of a high calorific value gas. The system uses a thermal conversion reactor, which operates, at a high temperature in an oxygen deficient environment. The waste stream is pre-treated to remove materials that are recycled, including glass, metals and other non-combustibles. It can then be dried, utilising waste heat from the process and finally shredded to increase the surface area and maximise the gasification reaction.

Immediately prior to being introduced into the reactor, the feedstock is purged with an inert gas such as carbon dioxide in order to remove the entrained air. The reactor operates at a very high temperature and the feedstock is gasified. Any solid carbon or ash produced during the reaction is removed by the separator system.

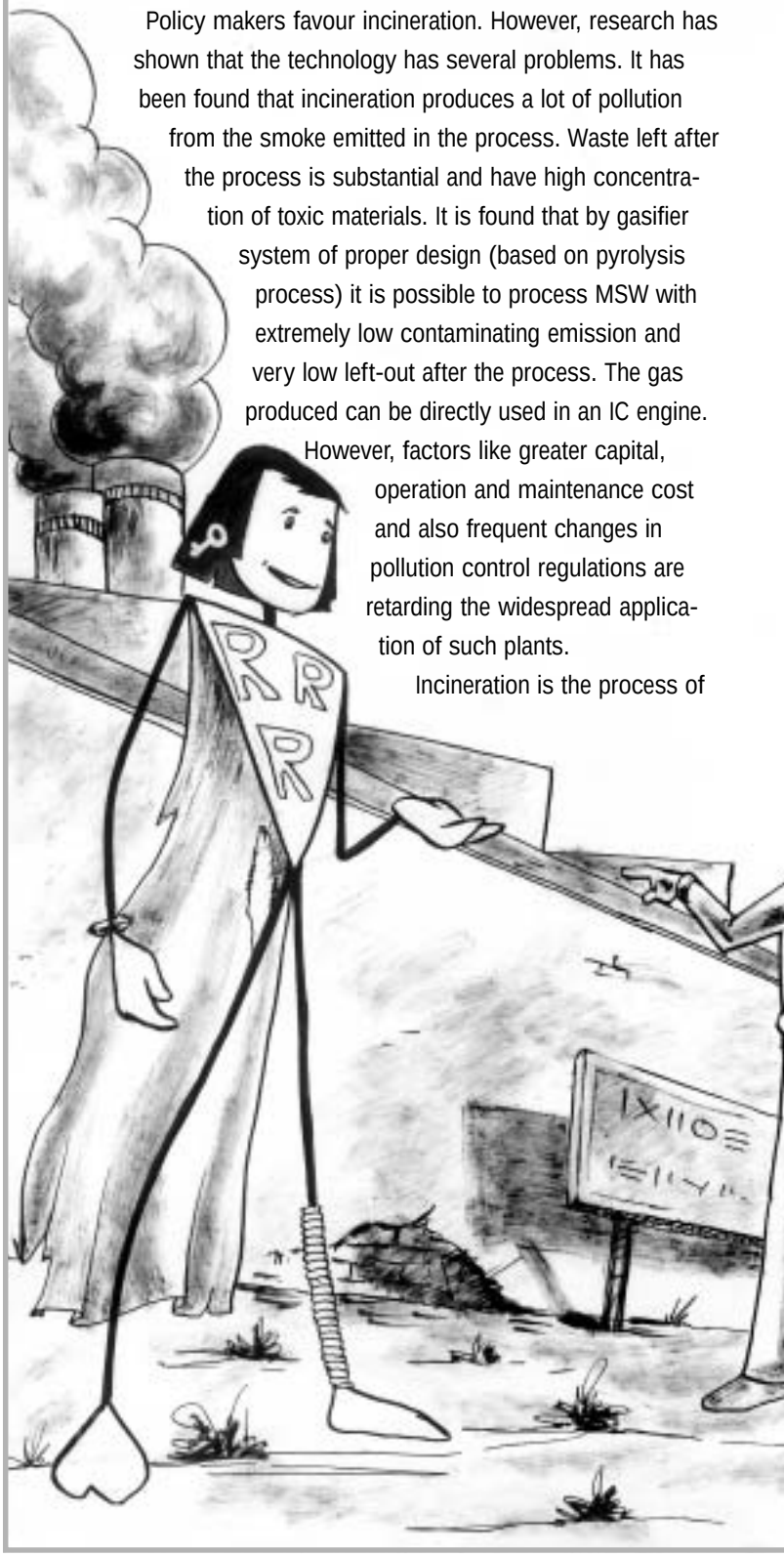
The produced gas is quenched to ambient temperature immediately, as it leaves the reactor by direct injection and further cleaned by a wet gas scrubber utilising sodium hydroxide. The gas thus produced is suitable for being fed into a boiler or another prime mover for power generation.

Burning waste to generate electricity sounds great. What's wrong with that?

Incineration: a burning issue

Policy makers favour incineration. However, research has shown that the technology has several problems. It has been found that incineration produces a lot of pollution from the smoke emitted in the process. Waste left after the process is substantial and have high concentration of toxic materials. It is found that by gasifier system of proper design (based on pyrolysis process) it is possible to process MSW with extremely low contaminating emission and very low left-out after the process. The gas produced can be directly used in an IC engine. However, factors like greater capital, operation and maintenance cost and also frequent changes in pollution control regulations are retarding the widespread application of such plants.

Incineration is the process of



direct burning of wastes in the presence of excess air (oxygen) at high temperatures (about 800^{0}C) liberating heat energy, inert gases and ash. Net energy yield depends upon the density and composition of waste, percentage of moisture and inert materials, which add to the heat loss, ignition temperature, size and shape of the organic matter into hot air, steam and hot water.

Incineration is a thermal process for burning the waste at a very high temperature. It requires high calorific value waste, which can burn without any external fuels. Indian waste contains only 3-7% of combustible material like plastics, paper by the time the waste reaches the disposal site. This is principally because most of the material that can be burned; is recovered by the ragpickers from the waste lying on the streets, dustbins and dump yards. Thus calorific value of Indian waste at dump yards is found to range from 800-1000 Kcal/kg, which is very low.

The combustion temperature of conventional incinerators fuelled only by wastes is about 760^{0}C in the furnace (insufficient to burn or even melt glass) and in the excess of 870^{0}C in the secondary combustion chamber. These temperatures are needed to avoid odour from incomplete combustion. Temperatures up to 1650^{0}C, which would reduce volume by 97% and convert metal, and glass to ash are possible with supplementary fuel. Wastes burned solely for volume reduction may not need any auxiliary fuel except for start-up.

The incineration technology is not exactly suited for Indian MSW, because of the high ash and dust contents of Indian wastes. Excessive moisture and inert content in waste affects net energy recovery; auxiliary fuel may be necessary to sustain combustion. There are chances of toxic metal concentration in the ash. In addition to particulate, SO_x and NO_x emissions, chlorinated compounds ranging from HCl to dioxins, and heavy metals are a cause for concern, due to which elaborate pollution control equipment are required. Additionally, it involves high operation and maintenance costs as well as a lot of money for training the personnel to handle the incinerators effectively. Incineration of MSW thus results in a lot of air emissions and for adequate control of such emissions, a lot of pollution control equipment needs to be installed. All this adds up to the cost.

Not in my backyard

❧ In September 1999, the *New York Times* reported that Mr. James Wolfenson, President of the World Bank, had made a personal contribution of US $ 50,000 to an effort to prevent the construction of a mixed hazardous waste incinerator near his vacation home in the US state of Wyoming. He did not respond to requests to stop the World Bank lending to other countries for similar purposes.

❧ In 1998, when one World Bank task manager was asked about plans to incinerate medical waste in Pakistan, he replied, "I think the dioxin problem would be the last on their list. This is the sort of luxury we can only afford here [in Washington D.C.].

The truth about incineration

- Destroys resources, as it closes down the option of reusing the material in any other form.
- Demands creation of waste, by removing the responsibility of the waste collector to collect, reduce and recycle.
- Requires landfills, as it is not the final disposal. At the same time, the ash from incineration is very toxic, as it contains heavy metals (lead, mercury, cadmium) and organochlorines (dioxin and furans), and can contaminate air, soil and water.
- Needs huge investments, as it is a costly technology. For example, it takes Rs. 8 crore to convert 150 tonnes of waste into 1 MW power, while 500 tonnes of waste can be turned into compost with Rs. 3 crore.
- Needs waste having calorific value at least between 1200-1400 k cal/kg, but calorific value of Indian waste is normally between 600-800 k cal/kg.
- Attacks at the livelihood option of many, as a lot of people in the informal sector earn their livelihood from waste.
- Extracts energy mostly from recyclable materials thus destroying non-renewable sources.
- Burns only part of the waste due to the problems in design and operation.

Source: Putting out the Flames, *Toxics Link.*

Table 5. Various waste disposal methods and their merits/demerits

Method of disposal	Demerits	Merits
Landfilling	▼ Restricted site availability; cannot last long ▼ Contaminates water sources ▼ Anaerobic gas production explosions	▲ Easy operation ▲ Land gets levelled
Open land dumping	▼ Environmental pollution ▼ Costly large area occupied ▼ Increasing maintenance of open dumps ▼ Ugly look to the cities and surroundings ▼ Smoke and fire ▼ Shifting of locations due to space becoming full	▲ Lower initial costs ▲ Easy for ragpickers ▲ Non-skilled job
Burning/incineration	▼ Smoke and gaseous contamination ▼ Temperature rise ▼ Diesel costs higher ▼ Capacity for incineration is a constraint	▲ Incineration is a standard ▲ Hygienic operation ▲ Easy operation
Bio-conversion into organic manure	▼ Technological constraints ▼ Higher capital costs ▼ Requires government support	▲ Highly useful product for agriculture ▲ Sustainable approach

Source: Management of Solid Waste, *CPCB, MoEF, GoI*

Conclusion

Keeping in view the ever-growing problem of solid waste generation, its management and associated impacts, the Ministry of Environment and Forests has brought out a set of guidelines for the municipalities for Management and Handling of Municipal Solid Wastes. The notification makes it obligatory for the municipalities to restrict landfilling to non-biodegradable inert waste, and other wastes that are not suitable either for recycling or for biological processing.

However, favouring one form of disposal, namely incineration, is actually contentious. Several points against it have been discussed above. Further, Toxics Link has launched a campaign against a few technologies, like RDF incineration. Starting with the Delhi Campaign for Safe Environment (DCSE), Toxics Link intends to cover the entire country under this campaign. The point to be made is that adoption of technologies should be based on scientific grounds and not on the pressure politics observed in the international arena.

References

[1] Field Survey, Ministry of Non-conventional Energy Sources, New Delhi, 1998

[2] *Indian Garbage – Should Energy be the Driving Concern?*, Toxics Link Factsheet, March 2002.

CHAPTER 5

The waste situation in India

Municipal Solid Waste (MSW) collected from any area depends on a number of factors, such as food habits, cultural traditions of inhabitants, lifestyles, climate, etc. When a person moves from a rural to an urban area, or from a small urban area to a big urban area, a certain change in his consumption pattern can be noticed, which, among other things, includes generation of more wastes. It may also be noted that increasing urbanization, coupled with rising GDP and income levels, has a multiplier effect on the amount of waste produced in the cities. Thus, the basis of calculation of waste generation are the population and the town size. To get an idea of current waste generation and to assess future projections, it is important for us to see the urbanization pattern.

Urbanisation in India

In recent decades, there has been significant growth in the urban population, paving enough space for related problems to confront with. As per Census 2001, 285 million out of 1027 million people of India live in urban areas. This accounts for 27.78% of the Indian population.. The decadal growth of the urban population is as high as 31.2%. The present trend is likely to continue and the urban population is expected to grow to 45% of total from the prevailing 28% (The World Bank). As per Census 2001, the number of metropolitan cities in India having a million plus population stands at 35. The details about other urban areas are given in Table 6 (following page).

Table 6. Urban agglomerations/towns of India by class/category

Class	Population Size	Number of UAs/Towns
Class I	1,00,000 and above	393
Class II	50,000-99,999	401
Class III	20,000-49,999	1,151
Class IV	10,000-19,999	1,344
Class V	5,000-9,999	888
Class VI	Less than 5,000	191
Unclassified		10*
All Classes		**4,378**

Data: Population Census, 2001.
**Towns in which the Census was not held.*

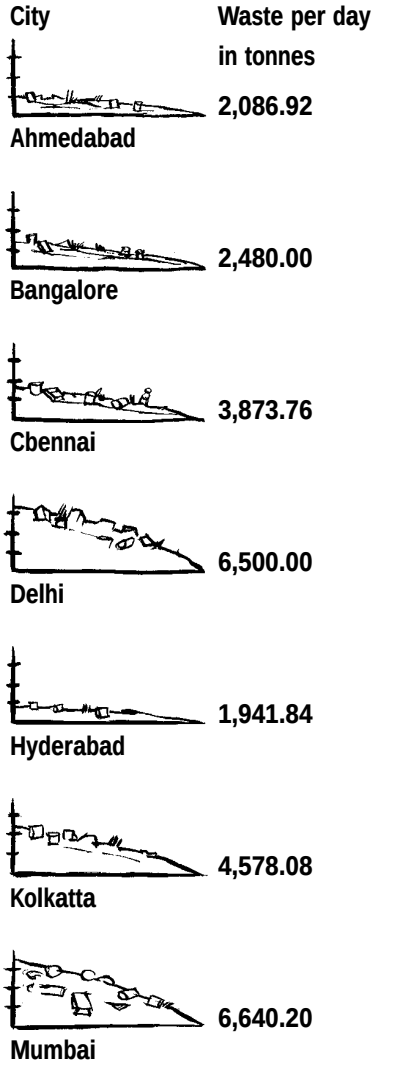
Increasing urbanization has brought with it a number of problems due to weak infrastructural capacity and financial constraints of urban local bodies. One such problem is solid waste management. Before we go on to analyse the framework of MSWM, let us take a look at the current waste generation and future projections.

Waste generation in India

There is a lack of comprehensive national level data on generation, collection, storage, transportation and disposal of MSW. National level policies and other interventions are largely based on the estimates derived on the basis of some studies by organizations like NEERI, TERI, NIUA, CPHEEO or CPCB. According to the Manual on Municipal Solid Waste, about 100,000 metric tonnes of waste is generated in India, which means that the average waste generated comes to about 490 grams per capita per day. In 2001, urban India produced almost 40 million tonnes of waste.[1] Waste generation in 1991 was 23.86 million tonnes per year with 217 million people living in the area (Burman Committee Report).

The typical rate of increase of waste generation in Indian cities has been estimated at around 1.3% annually (TERI). However, this suggests that population increase is not proportional to the waste generation, but that is due to inclusion of wastes from commercial establishments etc. The expected generation of MSW in 2025 will therefore be around 700 grams per capita per day. An idea about the proposition of converting waste to a resource can be had from Figure 1.

Figure 1. Waste generated per day in different cities



Source: CPCB.

FAST FACT

About 100,000 metric tonnes of waste is generated in India. This means that the average waste generated is about 490 grams per capita, per day.

Waste generation profile

However, as mentioned earlier, the generation of waste is also linked to the size of the town. How much difference does it make can be gauged from Table 7. This information may also be handy for planning ISWM in your area.

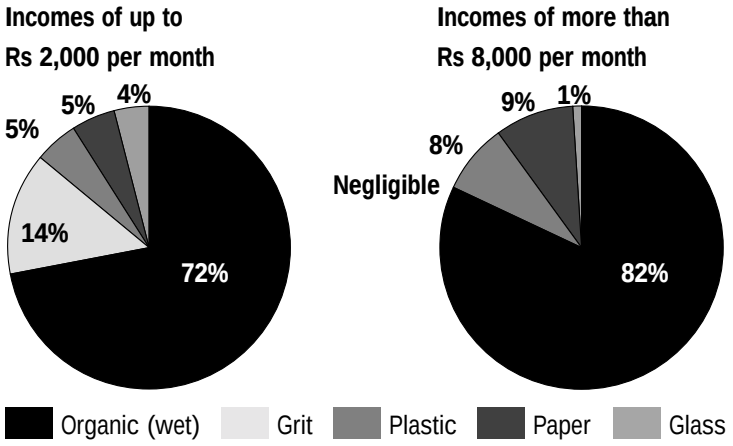
Table 7. Waste generated per capita

Population range (in lakh)	Average per capita waste generation (gm/capita/day)
1-5	210
5-10	250
10-20	270
20-50	350
50 lakh plus	500

Source: NEERI Strategy Paper on SWM in India, 1996.

By extending the logic of waste generation being linked with income levels further, we can also assume that people earning less will be generating less waste. This assumption is borne by the study conducted by Srishti and TERI in Delhi. According to the study, people in higher income brackets, having a monthly income of Rs. 8000 and above generate about 800 gms. of waste per capita per day. Whereas, the corresponding figure for people earning less than Rs. 2000 per month is just 200. Figure 2 reveals the picture.

Figure 2. Variation in types of waste generated



Composition of waste

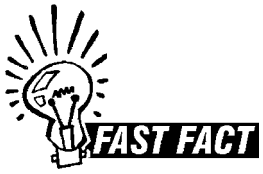
We have seen earlier that waste is not a homogeneous entity and that it is made up of a wide variety of materials. In Indian waste, there is a small percentage of recyclable material and more of compostable and inert materials. An indicative assessment is given in Table 8.

Table 8. Characteristics of Indian solid waste

Population range (in millions)	Cities surveyed	Paper	Rubber/ leather	Glass	Metals	Total compostable matter	Inert
0.1 to 0.5	12	2.91	0.78	0.56	0.33	44.57	43.59
0.5 to 1.0	15	2.95	0.73	0.35	0.32	40.04	48.38
1.0 to 2.0	9	4.71	0.71	0.46	0.49	38.95	44.73
2.0 to 5.0	3	3.00	3.18	0.48	0.59	56.67	49.07
> 5	4	6.43	0.28	0.94	0.80	30.84	53.90

All values are in percentage.

Source: Manual on Social Waste Management, CPCB.



People with a monthly income of Rs. 8,000 and above generate about 800 gm of waste per capita per day. For people earning less than Rs. 2,000 per month, this figure is just 200 gm.

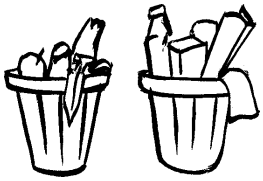
Municipal solid waste management

Experts have noted that the solid waste management practices have continued to remain inefficient and outdated. The objective of MSWM is to reduce the quantity of solid waste disposed of on land, by recovery of materials and energy from solid waste in a cost-effective and environment-friendly manner.

The cities are attempting to create a framework so that disposing of solid wastes can be free from hazard and is cost-effective as well. Two leading mechanisms of waste disposal having been adopted in India – composting (aerobic composting, anaerobic, vermi-composting, etc.), and waste-to-energy (bio-methanation, pelletisation, incineration, pyrolysis/gasification).

Waste management efficiency

Despite many good practices from around the world being available, most ULBs in India select inappropriate technologies. There is a need to understand these good practices and identify the local context that led to their success as well as identify major constraints faced during project preparation and implementation.



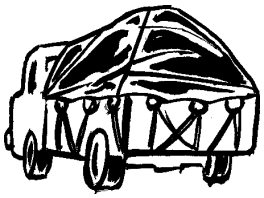
Segregation

Segregation at source is yet to become a reality in most of the municipalities. Some of the attempts made in this direction failed except probably in one or two places. Most of these cities lack the infrastructure, resources and technical expertise to make optimum utilisation of segregated wastes. The quality of segregation at source also is poor due to lack of awareness and enforcement.

Collection and storage

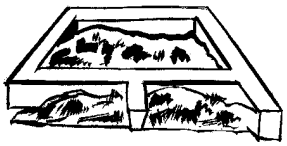
Similarly, until 10 years ago, waste collection was not done on a day-to-day basis, and the entire quantity of waste produced was not collected in most of the municipalities. The efficiency ranged from 19% to 97%. The situation has however improved after the plague in Surat in 1994. CPCB has estimated that the average collection ranges from 50% to 90% of the total solid waste generated, while 94% of the wastes are disposed unscientifically.

Municipalities lack in the storage capacities as well. Waste is mostly littered on the roads and streets from where it is swept into municipal bins, which are generally open.



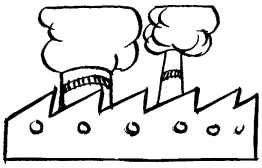
Transportation

Transportation of waste in the cities and towns is being done in various ways. In smaller (Rural) Towns bullock carts, tractor trailers, power tillers, tricycles etc. are mainly used for the transportation of waste. These vehicles are being used for the primary collection of waste from the streets, as well as for the collection of waste from dustbins. They are also used to transport the waste either to the compost yard or to the landfill site, popularly known as dumping ground. Moreover, poor vehicle routing, inadequate fleet and their maintenance adversely affect costs.



Composting of solid waste

By far, about 35 composting projects have either emerged or have been finalised in different cities in the country. The installed capacity of these projects ranges from 80-700 tonnes per day. Funds required for such projects vary from Rs. 30 million to Rs. 75 million. Most of the compost plants have come up with private sector participation on different formats of privatisation.

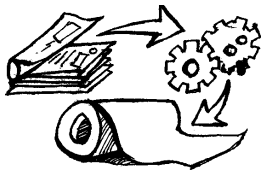


Waste-to-energy projects

Waste-to-energy (WTE) projects for disposal of solid waste are a relatively new concept in India. These are yet to get off the ground, largely because of the fact that their financial viability and sustainability is still on test. Many environmentalists argue that environmental costs incurred in these projects are far higher than the returns. While a number of cities have opted for WTE plants, such as Hyderabad, Vijaywada, Lucknow, etc., most of these have been unsuccessful experiments till now, primarily due to the composition of waste in India and the lack of a market for end products.

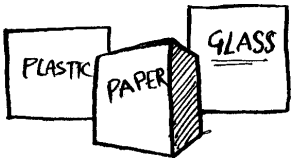
Recent WTE plants have involved the private sector in their installation and O&M, though most of them are heavily dependent on subsidies provided by the Ministry of Non-Conventional Energy Sources (MNES) and financing institutions such as HUDCO. The MNES has taken steps in this direction by preparing a Master Plan on Waste-to-Energy for India, which is currently being finalised.

Recycling



A very large network exists in the informal sector towards re-use and recycling of wastes in almost all cities. A large number of waste pickers pick waste from the streets, dustbins, dumping sites, etc. It is estimated that they pick up about 10% of the total waste produced in large urban areas and pass it on to the recycling industries. They generally pick up papers, plastic, metal, glass, rags, etc. Besides the waste pickers, there are several itinerant dealers who move from house to house for buying the reusable materials.

Disposal



Land filling is the commonest method used in the country for the disposal of waste. Crude dumping of waste is being done at almost all the places, without following the principles of sanitary land filling. As there is no segregation of waste at source, all wastes, including infectious wastes from hospitals, find their way to the disposal site. Quite often, industrial waste is also deposited at the landfill sites meant for domestic waste.

Community involvement

It is only at a few places that community has shown willingness to engage in the ISWM. A study by Toxics Link shows that community initiatives are successful at places where they have got some sort of support from the municipality concerned. The basic characteristic that makes these initiatives successful is the willingness of the community to pay 'user fee'. However, the communities are yet to internalize the necessity of segregation at source, probably due to a lack of awareness. The support from municipality comes in the form of provision of land for segregation and composting, or issue of identity kits to waste collectors who are actually not the employees of the municipality.

However, at the moment, the community interventions have only a marginal presence and most of them have focused on middle-income localities. The willingness of the people to pay in low-income areas or slums is doubtful. The study found that people are paying user fee from Rs. 10 to Rs. 100, depending on the socio-economic profile of the locality. Upscaling of the initiatives has also been noticed at most of the places covered under the study, which implies efforts if made in the right directions can be sustainable.

Financial requirements for MSWM

The urban areas are not able to generate adequate sources of income for the provision of the essential services and for maintaining the same. According to a study by National Institute of Public Finance and Policy for Twelfth Finance Commission, municipalities generated approximately Rs.12,750 crore, or 3.07 per cent of the total publicly-raised resources in India in 2001/02. It formed 0.63 per cent of the country's gross domestic product (GDP). In a study conducted by NIUA in 1986 and 1992, it was found that on average, 80% of total revenue expenditure of municipalities is spent on account of salaries and wages.[2] The Planning Commission estimates that around 75 to 80 per cent costs are incurred on staff salaries.[3]

Consequently, there is an evident deterioration in physical environment and quality of life in the urban areas aggravated by the widening gap between demand and supply of essential services and infrastructure and increasing population pressure on urban centers. The worst sufferers are the poor, whose access to basic services like drinking water, sanitation, education and basic health services is shrinking.

Though, exclusive needs of the sector have not been calculated, huge investments are required for the purpose. Some inclusive estimates have been worked out:

- The India Infrastructure Report (1996) estimated the investment requirement to the tune of Rs. 28,035 crore for the next 10 years for urban water supply, sanitation and roads.

- Central Public Health and Engineering Organization has estimated that by the year 2021, Rs. 172,905 crore will be required to provide safe water and sanitation services to urban population.

- Ministry of Urban Affairs and Poverty Alleviation (MUA&PA) has projected the financial requirements for MSWM by 2025 as Rs. 5,203 crore.

Regulatory framework

Solid waste management in India is a part of public health and sanitation, and falls in the State List of the Indian Constitution. The activity being of local nature, is entrusted to the ULBs. Till the 1980s, solid waste management attracted limited response from policy makers. Growing waste generation, especially the toxicity of the materials and consequent unhygienic conditions, necessitated state intervention. However, a significant development that pushed the process, was filing of a Public Interest Litigation (PIL) by Almitra H. Patel in 1996 on the issue.

We can say, there are three categories that define the regulatory framework of MSWM in India today:

Judicial response

The courts have influenced the activities in the sector a lot. In response to the PIL of Ms. Patel, the Hon'ble Supreme Court asked the central government to submit a report on the status of the MSWM. Subsequently, the Asim Burman Committee was constituted. The Committee examined the existing practices in Class I cities and suggested hygienic processing and waste disposal practices. The recommendations were of two types: mandatory and obligatory, which applied to all stakeholders – citizens, municipalities and state governments. These recommendations formed the basis for Municipal Solid Wastes (Management and Handling) Rules, 2000.

Recently, under directions from the Hon'ble Supreme Court, a Technology Advisory Group (TAG) has been set up to improve SWM in the country and oversee implementation of innovative technologies of waste management in the country. Courts at the state level have also shown activism and have often directed state governments to follow hygienic and appropriate practices.

Legislative response

Recycled Plastics Manufacture and Usage Rules, 1999

Under the rules, the recycling of plastics is to be undertaken strictly in accordance with the Bureau of Indian Standards Specification IS 14534:1998 entitled 'The Guidelines for Recycling of Plastics'. Marking as 'virgin' or 'recycled' on the product was made necessary. Its efficacy is doubtful, as the recycling sector is largely in the informal sector.

Aren't there any rules that can ensure management of waste?

Municipal Solid Wastes (Management and Handling) Rule, 2000

Ministry of Environment and Forests, Government of India through the Gazette Notification of 25 September, 2000 has brought into force the Municipal Solid Wastes (Management and Handling) Rules, 2000, applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid wastes. As per the notification, the municipal authorities are required to furnish their annual compliance reports to the State Government or the District Magistrate on or before 30 June every year, and the State Boards and the Committees have to prepare and submit to the GoI an annual report with regard to the implementation of these rules by 15 September every year.

The rule stipulates detailed compliance criteria and procedures for the management of municipal solid waste by the municipalities in India. Under the provisions of management of MSW by the municipalities, detailed compliance criteria for (1) collection, (2) segregation, (3) storage, (4) transportation, (5) processing and (6) disposal of MSW have been notified under Schedule II of the notification. Under Schedule III, 'specification for landfill sites' have been brought out particularly under the 'site selection', 'facilities at the site', 'specification for landfilling', 'pollution prevention', 'water quality monitoring', 'ambient air quality monitoring', 'planting at landfill site', 'closure of landfill site and post-care' and 'special care for hilly areas'.

The notification stipulates compliance criteria for the municipalities as given below:

1 Setting up of waste processing and disposal facility **(by 31-12-2003).**
2 Monitoring the performance of waste processing and disposal facilities **(once in six months).**
3 Improvement of existing landfill sites as per provision of rules **(by 31-12-2001 or earlier).**
4 Identification of landfill sites for future use and making site (s) ready for operation **(by 31-12-2002).**

However, the field level impacts of the MSW rules are still limited. In 2004, three years after the MSW rules were notified, the picture that emerged was one of large-scale non-compliance. Few ULBs can claim to have met the deadlines that were set. Under the MSW rules, ULBs are required to apply for and be granted a state pollution control board authorization before setting up disposal and processing facilities. But, in an affidavit filed by CPCB in early 2004, before the Supreme Court of India, it mentioned that of the 3957 ULBs in India, only 813 (20.6%) had applied for permits, and of these only 403 (10.2%) had been granted authorisation.

Policy response

The initiatives of government of India (GoI) began as early as in the 1960s when the Ministry of Food and Agriculture offered soft loans to ULBs for SWM. Under the Fourth Five Year Plan, state governments were given support through grants and loans for setting up SW composting facilities.

In 1974, the GoI modified this scheme to support cities having population of above 30 lakh. In 1975, the government set up a high-level committee for review of problems of urban waste in India. The committee, in its report made 76 recommendations, covering eight important areas of waste management. Between 1975 and 1980, ten mechanical compost plants were set up in the country; though only one is operating presently. In 1990 GoI constituted the National Waste Management Council (NWMC). One of the objectives of NWMC was to improve MSW and it provided financial assistance to 22 municipalities to undertake surveys to assist them in improving SWM situation.

In 1995, The Ministry of Environment and Forests (MoEF) and the CPCB organized an interaction meet with municipal authorities and other concerned ministries to evolve a strategy for the management of MSW. Since 1995, over 50 waste treatment facilities have been set up across the country, mostly with private sector participation.

High Powered Committee on Urban Solid Waste Management in India

This committee was constituted in 1995 in the aftermath of the Surat plague, under the chairmanship of Prof. J.S. Bajaj. This committee gave a number of suggestions including the need for source segregation, community-based door-to-door collection and transportation to municipal *dhalaos*, charge of user-fees, standardisation of design for municipal vehicles for transportation, need for composting of waste as the most feasible alternative for disposal, and private sector participation in waste management.

National Plastic Waste Management Task Force

Constituted by the Ministry of Environment and Forest in 1997, the Committee formulated a strategy and prepared an action programme for management of plastic waste. It gave the following recommendations:

- Beyond Type II materials as per BIS Standards, recycling plastic wastes should be banned and should be used for energy recovery.
- Consumer items such as toys, water bottles, carry bags etc. should not be allowed to use recycled plastic waste beyond Type I material. Instead, a blend of 50:50 with virgin plastics should be encouraged without degrading the quality of end products.
- Industry should take lead in collecting and recycling of plastics.
- Financial and technical assistance should be provided to prevent indiscriminate plastic waste generation and to promote recycling.

Manual on Municipal Solid Waste Management

The Municipal Waste Rules of 1999 was complemented by a Manual on Municipal Solid Waste Management. The Manual was prepared by an Expert Committee, constituted by Ministry of Urban Development, Govt. of India, January 2000. It deals with quantity of solid waste, storage, primary collection, composting, energy recovery etc.

Waste as an energy policy promoted by the Ministry of Non-Conventional Energy Sources (MNES), 1995

This policy provides the following incentives for waste management:

- Financial assistance up to 50 per cent of the capital costs of the project, limited to Rs. 3 crore per Mega Watt for demonstration projects.
- ULBs receive financial incentives at Rs.15,00,000 per MW for providing garbage free cost to the project site and land on long-term basis on nominal rent.
- Financial institutions also get financial incentives to promote non-conventional energy sources.
- State Electricity Boards receive financial incentives on the cost of equipment and differential power tariff, if the energy generated is fed to the grid.

Ranganath Mishra Committee on Plastic Waste Disposal

The Ministry of Environment and Forest, GoI formed this Committee in 2001 to examine various environmental issues related to collection, segregation, recycling and disposal of plastic wastes. The significant aspect of recommendations of the committee is the attempt to enforce the concept of EPR. It suggested the Deposit Return Scheme, where whosoever returns PET bottles would be paid 25 paise. Though the industry is yet to reconcile to this, the negotiations are at advanced stages.

Opportunities and threats

The MSWM poses a lot of challenges. We need to make sure that we do not contribute in compromising the ability of our future generations in meeting their needs of sustainable environment. So, it is our responsibility that we handle our wastes in a responsible manner, especially when we know that there are not enough spaces for landfills and will certainly be a huge problem in future, if the current MSWM practices continue.

Waste can be a curse

Industrial processes were initially designed to take resources, make products, and turn them to waste. Two centuries of take-make-waste have begun to degrade the health of ecosystems. Waste, by definition, is a foregone opportunity, which is now placing a severe drag on the bioregional, national, and global economies. If not handled properly, waste can affect public health and the environment via pollution of surface and ground water, air pollution, generation of greenhouse gases, contamination of land, noise, odours and a deterioration of local amenity.

Institutional weaknesses

Despite various policy pronouncements and judicial interventions, there is a lack of accountability in the present MSWM system for discharging of these functions efficiently. The institutional arrangement for the SWM is extremely poor in most of the Urban Areas.

While the municipalities have collaborated with private sector in some places, there are insufficient attempts to involve other stakeholders in a meaningful way. The 74th Amendment Act of the Constitution of India redefines the role, powers, functions and financial authority of ULBs. A three-tier structure of urban local governance has been put in place in various states with the implementation of the Act, which can play a leadership role in MSWM.

Legal aspects

The laws governing the ULBs make it obligatory to ensure regular cleaning of public streets and disposal of wastes collected there from. In the absence of adequate legal provisions, even citizens do not organize themselves for the proper storage of wastes at source,

for its community collection and for its disposal into the municipal system. There is a gap in legislation, as it neither makes it mandatory for the people to have a domestic bin and community bin and to dispose of their wastes into municipal systems, nor does it make it compulsory for the urban local bodies to make door-step collection of wastes or community based collection, resulting in unsanitary conditions in the urban areas affecting the environment substantially. The laws generally provide for street sweeping, provision for dustbins and removal of waste therefrom, which are not adequate to handle the SWM situation effectively.

Laws do not give primitive power to local bodies to punish offenders. The local bodies have to file complaints in the courts where the legal process is very slow. The amount of fine that can be imposed is also very small. Thus, people are not afraid of punishments, and the law has no impact.

Financial aspects

Improvement in the SWM service necessitates large investments in the initial years to meet the capital costs, followed by provision of adequate funds for the maintenance of the services. The financial scenario of urban areas shows that most local bodies are experiencing acute shortage of funds even to maintain the existing services and are not in a position to undertake developmental activities.

Though the local bodies can levy certain taxes to raise their financial resources, the political will to impose adequate taxes on the people to meet with the cost of services is lacking resulting in deterioration of services. Financial discipline is not imposed to ensure that the service becomes self-sustaining. Moreover, the lack of efforts to engage the community deprives them from the possible user charges, which can augment resources.

Social aspects

People desire to have a better level of services, but when it comes to cost sharing, they shy away. Neither do they make adequate arrangements for the storage of domestic, trade and institutional wastes at source, nor create a facility of community bins for the disposal of the wastes generated at source for its onward transportation to the municipal system. Besides that, it is a common experience that even at places where the local body has made provision of dustbins, people continue to throw their waste outside the bin.

Recycling of waste

An effort to organise the waste pickers in the informal sector towards re-use and recycling of wastes, though a difficult task, needs to be attempted in view of the lack of capacity of municipalities in handling wastes as well as the potential in making waste a resource.

Waste can be a resource

Use of recovered waste materials and their recycling reduces demand for virgin resources and can reduce impact on the environment. More effective use and recovery of waste coupled with a greater focus on avoiding waste can significantly reduce the quantity of waste being generated by the community. On the other hand, waste as resource can be important contribution to local economies and sustainable materials cycles. With adequate support and facilitation from the government and the municipality it may create new skilled jobs, contributing to social equity.

Health implications of solid waste: Surat

- Soil/ground water contamination.
- Air pollution.
- Environmental degradation.
- Emission of greenhouse gases from landfills.

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[1] Manual on Solid Waste Management (1st ed.), prepared by Expert Committee constituted by the Ministry of Urban Development, GoI, 2001.

[2] NIUA/FIRE(D) Working Paper Series No., 1999: Norms and Standards of Infrastructure and Services in India: A Review and Methodological Assessment.

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CHAPTER 6

Cleaning up one's neighbourhood

We know that it is obligatory on the part of the local bodies to make arrangements for Municipal Solid Waste (MSW). However, we, as residents and generators of waste, have a responsibility as well. Given the resource constraints of municipalities, leaving the issue entirely to them would only worsen the situation. There are certain aspects of waste management, where we can be one of the most effective stakeholders. However, this is not to say that the municipalities will not have any role to play, whatsoever. In fact, all the stakeholders need to supplement each other's activities.

Community participation

Community Participation is the process by which individuals and families assume responsibility for their own health and welfare and that of the community and build the capacity to contribute to their own development as well as that of the community. They know their own situation and are motivated to solve their common problems. This enables them to become agents of their own development instead of being passive beneficiaries of development aid.

Why does the community need to participate?

Urban Solid Waste Management (USWM.) continues to remain one of the most neglected areas of urban development in India. The sheer immensity of the problem, the financial and infrastructural constraints, including non-availability of land for safe disposal of generated waste and the lack of awareness and apathy at all levels, have come in the way of efficient, safe management of urban solid waste. There has been a progressive decline in the standard of services with respect to collection and disposal of household, hospital and industrial wastes. This gives rise to unsanitary conditions, especially in densely populated slums, which in turn results in an increase in morbidity, especially due to microbial and parasitic infections and infestations, which consequently leads to periodic outbreaks of food, water and vector-borne diseases, and ground and subsoil contamination.

There has been no major effort to build informed community awareness, either about the likely perils due to poor waste management, or the simple steps that every citizen can take to reduce waste generation and promote its effective management. A certain degree of community sensitization and public awareness was generated recently because of the focal epidemics of malaria, Japanese encephalitis and the media attention on plague. It is imperative that community steps in to improve urban solid waste management, environmental hygiene and sanitation without further delay, in every possible way.

Community efforts

The task of collecting garbage from households and taking it to a collection point primarily is an activity best performed by the households themselves. In many cases, where the residents are economically better off and hygienically conscious with active resident welfare associations (RWAs), efforts are made to organise the collection of garbage from each household and transport it to the collection point. These efforts, though still nascent, are now visible in many cities of India.

In most of these cases, waste collectors are employed privately to collect garbage from every household and transport it to a common collection point from where the municipality picks it up. In fact, in Delhi, it is stipulated that the RWAs would provide these facilities, since neither the Delhi Development Authority (DDA) nor the Municipal Corporation provides the facility of door-to-door collection of garbage. In Mumbai, in many high-rise apartments, the garbage from all the flats is collected and placed in large bins at the entrance of each apartment. The municipality pick-up vehicles collect this garbage at a pre-decided time. A major nuisance is thus avoided since the humidity in the atmosphere causes the garbage to degrade very fast, leading to unhygienic conditions. The practice of garbage collection from households collapses in most of the unplanned and unauthorised settlements. As a result, the garbage is thrown anywhere along the road or in a vacant plot and sometimes even in parks.

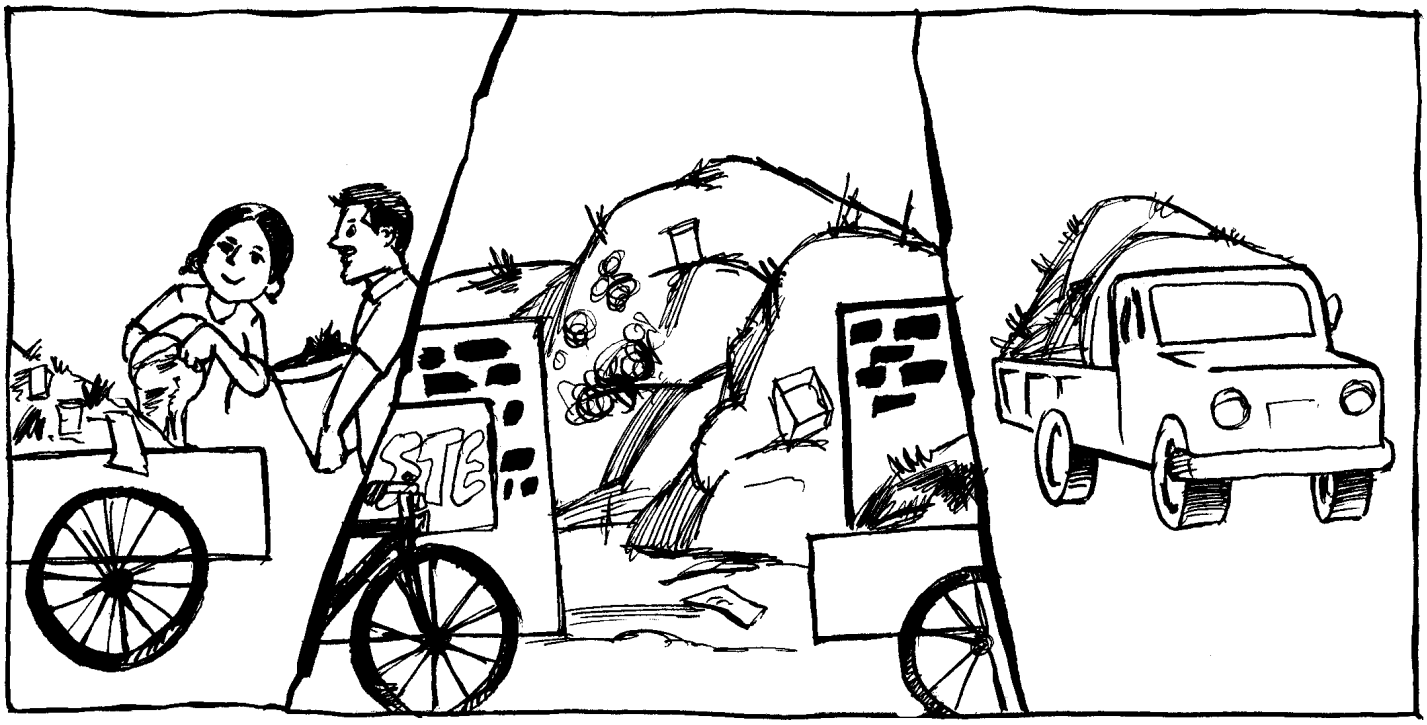
In Mumbai, in many high-rise apartments, the garbage from all the flats is collected and placed in large bins at the entrance of each apartment. The municipality vehicles collect this garbage at a pre-decided time.

Human resource development

Analysis of the present status of solid waste management in Indian cities and towns indicates that better sanitation standards could be achieved in most cities with moderate additional investment, provided availability of trained manpower at critical levels is ensured.

Awareness creation

The role and responsibility of the people in ensuring safe and sanitary management of urban solid waste needs to be communicated to the general public, opinion builders, industrialists, hospital personnel and policy makers, planners and civic administrators. Municipal authorities, NGOs and citizen organizations should be involved in a multimedia campaign to create awareness on the crucial role of the individual in promoting appropriate solid waste management.



The health consequences of poor urban solid waste management should be adequately documented and information disseminated to the public, the administrators and the decision makers. USWM can be introduced into school curricula. Stakeholders like NGOs may be encouraged to address important environmental issues including USWM.

Training

There is an acute shortage of requisite trained manpower in municipalities, particularly the small and medium ones. Appropriately designed training modules for different categories of professional staff in USWM need to be designed by institutes with adequate expertise in USWM. Apart from providing appropriate and adequate technical information, efforts should be made to utilize the multi-professional education approach in these training courses so that the persons not only acquire knowledge, but also learn to work as a team with related professionals from allied sectors.

Knowledge resource

Reliable country-wide data on the generation and management of urban solid waste, including its impact on health and environment, are not available. Existing institutes with experience and expertise in this area need to be supported, and entrusted with the task of generation of appropriate national database, and evaluation of ongoing and proposed R & D / pilot projects for USWM.

Efforts needed

What we need to do is guided by the shortcomings in the existing practices. Several studies, including the one by Toxics Link and by Aziz and others, have noted certain trends in MSWM from a community perspective. Some findings are mentioned below:

1. The impact of macro-level structural reform, economic liberalisation and reduction in the role of the public sector in infrastructure development is gradually trickling down to the grass-roots.

2. The conventional and traditional approach to 'public service' by the government at the urban local government level is slowly changing, and it is now being realised that community participation and private sector partnership are more appropriate to develop the urban local services.

3. Unfortunately, it is found that the initiatives are coming from the top (higher level government) in the form of policy advice, programme guidelines, recommendations and instructions through government orders. In very few instances are attempts being made to improve the standard of urban service management and delivery systems at the local government level.

4. It is observed that in all the case studies on SWM there are two common features:
   i. Partial privatization of garbage collection and transportation; and
   ii. Inviting private sector to install waste recycling plants or produce fertilizers from solid waste.

5. Even though partial private participation (contracting out some components of services) is in vogue in some municipalities, this was treated as a means of convenience rather than reducing the responsibilities of the municipality. Hiring of trucks or tractors by the municipality from private parties to transport solid waste is a case in point.

6. Any attempt to 'change' or 'modernize' or introduce advanced techniques is generally viewed as unnecessary and no better an alternative, involving additional risk, and resisted by a large section of elected representatives as well as the municipal staff.

7. It is observed that if the chief executives, administrators and elected chairpersons make a serious attempt to revamp the

traditional methods of SWM and decide to introduce new and innovative approaches, there is sufficient scope for success.

8. There are also a large number of legislative, legal and administrative hurdles to the introduction of new approaches. Every part of municipal functions is coded in the form of municipal Acts, Laws and bye-laws, which remain unchanged over the decades. For example, public health and sanitation rules, regulations and specifications restrict the appointment of the required sanitary staff, purchase of materials, revision of rates and charges.

9. Even though decentralization in all respects has been preached, in reality there has been no impact on the urban local bodies, as is evident from the fact that they do not administer as per the aspirations and needs of the local people.

10. Although solid waste management is the responsibility of the municipality, as enshrined in the Act, the latter has been seeking the support of non-governmental organizations like EXNORA, CBOs (Community Based Organizations) and workers' societies. This points to the emerging trend of networking between the municipality and other local organizations for managing solid waste.

11. Studies reveal that there are always some operational problems, financial and other constraints, lack of political support and a lack of wholehearted support from the citizens, which hinder the promotion of meaningful, effective and responsive waste management endeavours.

12. Discussions with the households indicate that the local organizations are willing to come together to shoulder the responsibility of waste collection and disposal, provided the municipality supports their initiatives.

13. The case studies developed on the workers of the informal sector show that their contribution to solid waste management is on an equal footing with the efforts of the formal sector. They, in a way, are responsible for the reuse and recycling of the waste generated, which is used by different establishments.

14. There is increasing public awareness of the need for collection and proper disposal of garbage. While solid waste management is becoming more and more an important function of the municipalities, the latter are constrained by the lack of funds to perform this function effectively.

15. Owing to financial constraints and ban on recruitment of sanitary workers, the municipalities have been forced to manage the existing personnel more economically and also evolve innovative methods of collecting and disposing garbage more effectively.

The trends indicate that we need to make certain efforts in certain key areas. Some steps are given below:

Consultations with community members

Informal meetings, separately for different areas, could be held throughout the community involvement project. These meetings may discuss general matters pertaining to community welfare and area cleaning, as well as the most appropriate communication methods, to enhance awareness in solid waste management among the community. It is necessary that the community accords high priority to solid waste. To gain the confidence of the community members, it may be part of the strategy to also address other community sensitive issues like welfare and health, which may not be directly related with solid waste management. Activities such as the "Celebration of the Cleanliness Week" and a vaccination campaign against the spread of Hepatitis B, may be promoted. During the rainy season, the community can be assisted in flood control by contacting authorities, such as the sewerage authority.

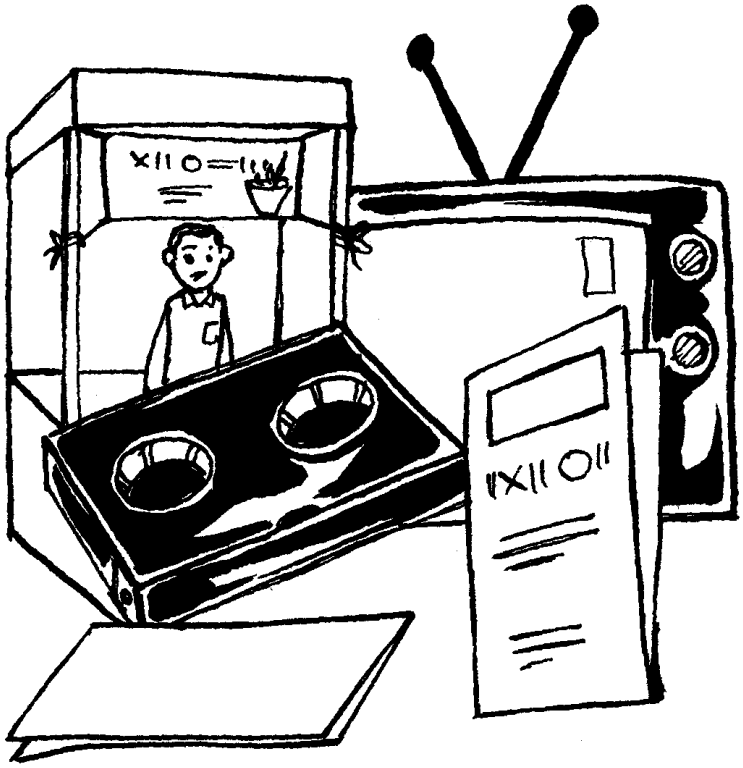
Designing a primary waste collection scheme

Technical design and organisational structure of a waste collection system can be discussed and finalized in informal community meetings. There is a need to promote segregation of inorganic recyclable materials like plastic, glass, metals, papers at the source, and every effort should be made to provide collection of these in separate containers or bags in each house. Use of garbage containers need to be promoted among residents, who may be urged to use waste containers with a lid, and refrain from using plastic bags.

The waste should be collected and transported from house to house every day. Private agencies/ NGOs, ragpickers or their cooperatives may be involved in primary collection of solid waste from households/community bins. Vehicles of an appropriate design should be promoted for house-to-house collection. Direct transfer of garbage from primary collection carts to the covered transportation vehicles may reduce vehicle's waiting time and make the system cost-effective.

Volunteers training

There may be a need for training of both male and female volunteers on health aspects of inappropriate solid waste handling and potential improvements of the existing system. This would ensure wide dissemination of knowledge. Self-help and use of community participation may, in many cases, be the only way of solving the waste collection problems in low-income areas. Volunteers can be helpful in this.



Communication strategy

The Inform-Educate-Motivate strategy developed by the communication professionals may be effective. The "informing" strategy familiarizes the community with the pollution hazards and the resulting public health and environmental impacts. During the 'educating' phase, the different segments of the community are targeted with specific material on SWM (video, handbills, etc). Motivation follows automatically, and the community actively participates. The main communication methods may comprise informal meetings with community members of different gender and ethnic/religious backgrounds, house visits and information campaigns at schools.

Community involvement

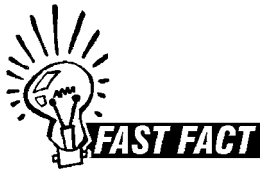
Many households now recognise the danger of poor solid waste management. They agree that the government alone cannot effectively handle solid waste management. Many SWM improvement projects have proved that once communities are involved in the implementation of a project, they will participate in managing the project. In addition, private participation in the provision of sanitation services can work if the community knows that it is properly regulated by an approved agency.

Important Issues to be addressed

Financing arrangements

Municipal government is still the traditional source of support for SWM. Expenses for collection to processing and disposal are still borne by the municipal government. However, households or neighborhood associations, very often pay for waste collection services directly. The municipal government then pays for transfer and disposal.

There are many examples of private players being integrated in the collection. Because, the private sector is better at keeping pace with rapid urban growth due to its ability to respond with flexibility given varying neighborhood needs and because of its small scale of operation.



Recycling of wastes collected often helps finance other parts of the SWM operation. Again, to varying degrees, the scavenging community has been the foundation of this reuse/recycling effort.

Community financing is not universal. It is generally limited to collection and even then the willingness to pay varies greatly. Low-income communities also pay for collection though in varying degrees. However, in very low-income situations, people are too poor to pay anything and burning of waste or dumping into waterways is common. Even in neighbourhoods where waste is collected by private micro-enterprises, coverage may be quite inefficient, leaving a high portion of wastes uncollected.

Recycling of wastes collected often helps finance other parts of the SWM operation. Again, to varying degrees, the scavenging community has been the foundation of this reuse/recycling effort. Linking SWM with other concerns such as job creation may help improve the odds and find financial and political support. Ultimately, fuller integration of the labor-intensive system may be required.

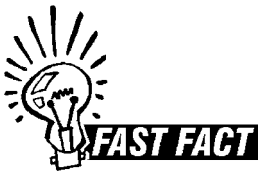
Governance and regulation

Although MSWM is a matter for implementation at the municipal level, enabling policy, regulatory and legislative frameworks are critical at the state and national levels. Local constraints should be reflected in enabling policies. Practical constraints on applying enabling policies at the local level must be taken into account, preferably before the policies are enacted.

Moving from one extreme (complete reliance on public sector delivery of urban services like waste management) to the opposite extreme (indiscriminate privatization) is unlikely to produce desirable results. Caution is required in privatization of SWM. Mechanisms for good governance need to be in place for privatization to benefit the population. Public Private Partnership (PPP) requires financial, administrative and managerial capacity to succeed, and it is the very lack of that capacity that, in part, drives the desire to establish PPPs.

Capacity building

Many people working in SWM lack the most basic technical and financial knowledge. All projects ideally should include training for staff on a continuous basis to build human resources capacity at local, regional and national levels. At the institutional level, the training is required in planning, accounting, and budgeting at the minimum. All organizations, including private companies, NGOs, political bodies as well as



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governmental entities should be targeted for capacity building.

One approach that has been effectively implemented by the International Solid Waste Association (ISWA) in Argentina, India and Croatia is to support the establishment of national professional solid waste management associations. This is helpful in facilitating the exchange of information among professionals in the field and lends credibility and a positive image to the profession. Such associations also help support motivated individuals, who are critical to the process of building capacity more broadly.

Community participation

Community should be involved not just as users, but as equal partners in planning, design, monitoring and project evaluation. For effective community participation, it is important to determine the right incentives to get people involved and also to stay involved. Some combination of inducements appears to be critical in promoting community participation. In Senegal, for example, children receive movie tickets for turning in recyclables, and in Curitiba, Brazil, people receive bus tickets and vegetables. These types of simple payment programs seem to be effective in achieving high rates of participation in recycling.

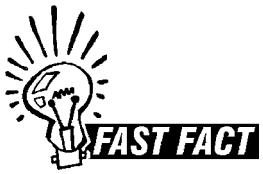
Attracting and maintaining community participation at a broader political level in the design of PPP may be more nuanced. One common problem is that external funders and agencies by-pass existing entities that might enable broad participation in projects because such bodies are considered corrupt and/or inefficient. Part of the problem may be that external funders expect efficient achievement of project goals and community participation in a short time frame, but guaranteeing more sustainable outcomes, requires more time.

Technology

Technology is needed to deal with the changing composition and quantity of waste. Many aspects of SWM technology are potentially relevant to improving solid waste services. The changing and growing waste stream in emerging economies may affect technology choices. For example, the proportion of plastics, hazardous materials and paper used is growing, altering the composition of materials in the waste stream.

The implications of these factors for formal and informal MSWM systems are huge. As systems expand to meet the needs of a growing population, the economies of scale achievable with large, capital-intensive approaches like waste-to-energy incineration may become attractive economically, forgetting their negative impacts on health and environment. The risks and expense of relying on large-scale technologies may not be desirable or appropriate, depending on the context.

It should be kept in mind, however, that poor technology approaches cannot divert the bulk of the waste stream, as most of it contains non-biodegradable and hazardous material. Therefore, environmentally acceptable transfer and disposal of the remainder after informal and market-based systems have reused, recycled and composted, remains critical. Whatever the waste management systems



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eventually identified and chosen, training and technical support for the technology transfer must be included for the initial implementation and for the long term.

Prospects of community participation in MSWM

Development of an effective municipal waste management system depends not only on local government, but also on NGOs, CBOs and citizens. Nevertheless, local governments need to clearly stipulate their ultimate responsibility and to actively improve their standards and facilities relating to the provision of proper waste management services. The future depends on the quality of the co-operation of all the stakeholders. There are cities in which such cooperation has been achieved. This success can be replicated if there is political will and community participation.

CHAPTER 7

Planning the system

Models of operation

The success of any innovative model of service delivery lies in its acceptance by all the stakeholders. This acceptance also helps in institutionalizing the process. In planning for a system for ourselves, it is always helpful to look at other similar and successful models. The enabling factors of these models can guide us to build our own. A study by Toxics Link has found five types of waste management models operating in the country, which have mainly focused on the decentralised waste management.

1. Partnership between NGOs and municipality – In this model NGOs/CBOs manage community interventions with some help from or in alliance with the concerned municipality. Organizations like Exnora Green Cross (Vellore) or Jana Chaithanya (Vishakhapatnam) are successful examples of this model.

2. NGOs/CBOs on their own – The service providing organizations do not get any support from the municipality. However, they may get support from other state agencies. For example, Muskan Jyoti Samiti in Lucknow got support from State Urban Development Agency (SUDA), District Collector of the city and other state agencies, but not from the municipality as such.

3. Municipalities on their own – In some places, the municipality has undertaken this responsibility on its own, which is due to the presence of reform-minded and conservation-conscious individuals in official positions. Suryapet, Kalyani or Panjim municipalities are prime examples of this model.

4. Outsourced to private contractors – In some places, municipalities have contracted out part of their solid waste functions to private operators. Municipalities in Chennai, Surat, Nasik etc. have privatized these functions.

5. Institutions/industrial houses on their own – Some institutions/industrial units have attempted to manage their solid waste problem with the help of expert agencies. Indian Institute of Technology and Jawaharlal Nehru University in Delhi and Indian Tobacco Corporation in Bhadrachalam have engaged local NGOs to carry out these activities.

Planning the system

Once we have seen the suitability of a particular model, we can plan for the system for our locality. However, it is not necessary that a model should be adopted in its exact form. It can be modified in accordance with needs in the area concerned.

The first step in the planning for Solid Integrated Waste Management is to collect information about each stage of waste management. Reliable information will help the community-based intervention to accurately assess the financial requirements and likely revenues, which are crucial for the sustainability of the proposed intervention.

We need to have an idea of the quantities of different waste materials and what optimal use they can be put to. Without an idea of the expected quantities, making decisions on equipment, space needs, facilities, markets and personnel would not be practical.

How do I start planning a system?

Surveying the situation

The first step is to determine the quantity of waste. There are two methods that can be adopted for this. The first is to multiply the population of the area to be covered with the average per capita waste generation for that town size category *(refer Table 7 on page 57)*. However, due consideration should be given to the unique local features while using this generic data. The second method is to conduct a pilot survey to make a direct assessment. The duration of this survey can be a week to ten days. Following this, the population to be covered can be multiplied with the average per capita waste generation.

The second step in the process is to assess the effectiveness of the existing waste disposal system adopted by the community or the Urban Local Bodies. This will help us in identifying the gaps in the existing system and making plan for filling up those gaps.

At the end of the exercise, we should know:

a. Which type of composting is appropriate.
b. What would be the size of decentralized composting plant.
c. How much quantity of wet waste would be needed to be sent to the centralized composting plant.
d. Which recyclable items would be available and in what quantity.
e. How much inert material exists and how it is to be got rid of.
f. What transportation system is available.
g. How many people need to be engaged for collecting waste.

Fostering linkages

No community-based intervention can be feasible without active participation or support from stakeholders. Therefore, an important step in planning for a sustainable system is to identify all possible stakeholders and find ways for them to participate. These stakeholders are:

Community involvement

ISWM requires effective participation of the community that the programme intends to serve. Economical and efficient operation of the programme needs cooperation from generators of the waste at the various stages of the product life cycle. This implies that we, as a community, generate less waste, ensure its segregation and proper collection, use recycled products as far as possible and contribute towards costs of SWM in the form of user charges.

Inducing the municipality

Municipalities have the legal mandate for MSWM in any area. So, the support of the municipality is crucial for many aspects of the operation, such as:

- Issuing identity cards to waste collectors, which would save them from harassment from municipal or police officials.
- Providing land for composting.
- Synchronising the activities of the operator with the operations of the municipality.
- Providing resources through contracting.

However, resistance to change in general may require some efforts on the part of operator or the community. Discussions with officials or presentation to elaborate the benefits accruing to the municipality in terms of savings in expenditure and reduction in workload, from the system may induce them to agree to proposal.

Involving facilitators

SWM is a complex matter. There may not be enough expertise available at the local levels to understand the various issues and their ramifications, which may hurt the environmentally sustainable waste management practices. In such circumstances, involving expert individuals or organizations may help not only in chalking out strategies that would be environmentally sensitive and financially viable, but also in mobilizing resources for the project/ intervention.

Attracting service providers

Though the responsibility of MSWM lies with the municipality, there are many interventions that have emerged to control chaotic situations, with the support of the community. Some of them have least interaction with the municipal authorities. At the same time, municipalities, upon realizing the significance of the matter, are increasingly engaging private service providers. In some cases the municipality has privatized the entire operation, and in others part of it.

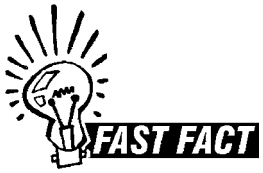
Non-governmental service providers can be attracted only if their returns on investments are adequate. In other words, they will come only if the project is financially viable. In some cases, the projects are so viable that the service provider does not need even the user fee. For example, Naya Savera in New Delhi is of the opinion that it can recover the entire financial cost of the project and earn profits too from the sale of recyclables alone. Muskan Jyoti Samiti does not pay any salary to its waste collectors. However, such issues can be addressed through proper assessment of expenditures and likely revenue positions. The need is to explore all possible solutions as per local conditions.

Political buy-in

The Corporator is the elected representative of the municipality and is responsible for looking into the matters, including MSWM, concerning the communities and the area he is representing. He can be of great help in resolving various issues with the municipality. However, he should not see the intervention as an erosion of his authority, which is important in the light of the prevailing political realities. Field experiences suggest that the local political structure plays a crucial role in the sustainability of such interventions.

Persuading financial institutions

Financial institutions can be a good source of capital investment in the initial stages. For example, in Kukatpally, Andhra Pradesh, the municipality gave the transportation contract to groups of women who had organized under the Development of Women and Children in Urban Areas (DWCUA) of Swaran Jayanti Shahari Rozgar Yojana (SJSRY). Since the Yojana provides for loans to such groups from banks, they were given loans to buy tractors. Similarly, use of other governmental schemes



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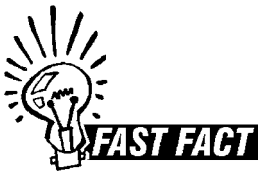

There are many civil society organisations that are actively engaged in MSWM. However, capacity at lower or local levels may not be effective. So it might be useful to form a network with such CSOs.

can be made to raise funds. For example, Housing and Urban Development Corporation (HUDCO) gives loans for Solid Waste Management Systems. However, governmental support may be required for the purpose. Political buy in and inducing municipalities may also help in this regard.

Networking with other civil society organisations

There are several policy level issues that need to be taken up at the central or state level. There are many civil society organizations that are actively engaged in advocating the concerns relating to MSWM. The capacity at the lower levels or local levels may not be effective enough. So it might be useful to form a network with such CSOs. This will have the twin advantage of getting local concerns included in the policy matters and exchange of knowledge resource among members. Some such CSOs or networks are:

- Alliance for Waste Management (AWM)
- Toxics Link
- HuMAN
- GAIA
- Health Care Without Harm (HCWH)

Details about these useful networks are provided here:

Developing a model

Alliance for Waste Management (AWM)

The alliance has been created for advocacy and act as a lobby group to use information as a tool to bring about change in the business-as-usual approach in solid waste management. It intends to make an effort to raise issues concerning the sector at the policy level and strengthen local action through collective efforts. It also aims at working as a watchdog and a monitoring group to track legal and regulatory changes and developments. Its objectives are:

- To form regional groups for collective action.
- To campaign against waste to energy option of MSWM.
- To evolve a common understanding of waste from the perspective of communities and identify priority areas and initiatives to make communities of common stakeholders.
- To forge a working relationship with other stakeholders.
- To identify people who should be part of the mainstream and have credibility in the subject matter.
- To document success stories in the region.
- To carry the process further.

To join this alliance, please contact:

H2 (Ground Floor), Jungpura Extension
New Delhi 110 014
T: +91-(0)11-24328006, 24320711
F: +91-(0)11-24321747

GAIA

GAIA represents both a Global Anti-Incinerator Alliance and a Global Alliance for Incinerator Alternatives. It is an international alliance of individuals, non-governmental organizations, community-based organizations, academics and others working to end the incineration of all forms of waste and to promote sustainable waste prevention and discard management practices. Its ultimate vision is a just, toxic-free world without incineration and its goal is the implementation of clean production, and the creation of a closed-loop, materials-efficient economy where all products are reused, repaired or recycled back into the marketplace or nature.[1]

GAIA members work both through regional networks and through issue workgroups which provide the opportunity to transcend national and regional borders to collaborate with others around the world.

To join any workgroup, or for more information, email:
gaia@no-burn.org,
or contact (for Asia):
George Cheng, Taiwan Watch Institute
E: twwatch@ms31.hinet.net

HuMAN

The Health & Us – Medwaste Action Network seeks to make the delivery of healthcare in India environmentally safe as well as safe for the patient, hospital workers and the community at large by adopting safe practices, products, procedures and technologies without compromising on patient care.

HuMAN, which is affiliated to HCWH, is a group of individuals and organizations. It was established in 1997, as a response to the need for improving health care waste disposal in India, and to shift the thinking from end of the pipe solutions, such as polluting incinerators, to pollution prevention and process related solutions. It seeks to bring a new consciousness among medical personnel, regulators, the industry as well as the community about safer and less polluting healthcare and waste disposal. It works in the public interest, and does not endorse any product or technology.

Its Coordinating Office is at:
H2 (Ground Floor), Jungpura Extension
New Delhi 110 014
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Toxics Link

Toxics Link has been established for disseminating credible information about toxics in India, and for raising the level of the debate on these issues. Its goal is to develop an information exchange and support organisation that would use research and advocacy in strengthening campaigns against toxic pollution, help push industries towards cleaner production, and link groups working on toxics and waste issues. It has developed capacities to interact with the grassroots through outreach amongst various civil society actors, as well as to play a role in influencing policy and have conversations with other stakeholders such as industry and technical experts. It is also central to networks connecting experts, civil society groups and individuals working nationally and internationally on issues related to toxics.

For more information, please contact:
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F: +91-(0)11-24321747
E: info@toxicslink.org

Health Care Without Harm (HCWH)

HCWH is an international coalition of hospitals and health care systems, medical professionals, community groups, health-affected constituencies, labour unions, environmental and environmental health organizations and religious groups. The mission of the coalition is to transform the health care industry worldwide, without compromising on patient safety or care, so that it is ecologically sustainable and no longer a source of harm to public health and the environment. HCWH's goals are[2]:

1. To work with a wide range of constituencies for an ecologically sustainable health care system;
2. To promote policies, practices and laws that eliminate incineration of medical waste, minimize the amount and toxicity of all waste generated, and promote the use of safer materials and treatment practices;
3. To phase out the use of PVC (polyvinyl chloride) plastics and persistent toxic chemicals in health care and to build momentum for a broader PVC phase out campaign;
4. To phase out the use of mercury in all aspects of the health care industry;
5. To develop health-based standards for medical waste management and to recognize and implement the public's right to know about chemical use in the health care industry;
6. To develop just siting and transportation guidelines that conform to the principles of environmental justice: No communities should be poisoned by medical waste treatment and disposal;
7. To develop an effective collaboration and communication structure among campaign allies.

HCWH can be contacted online or at the address given below:

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Toxics Link, on the basis of its countrywide study, which covered about 70 organisations and 40 municipalities, has attempted to work out average costs for start up and the time period required for breaking even. It may be useful to look at these components and their costs, as they may serve as a guide. However, costs may be adjusted to location specific circumstances.

Estimating costs

Feasibility of the start-up can be worked out by calculating expenditures likely to be incurred and revenues likely to be generated. In any decentralized community-based solid waste intervention, the elements of costs will be:

- Collection costs.
- Transportation costs.
- Operation at transfer/disposal station: this includes operation and maintenance of compost shed too.
- Awareness materials/trainings of personnel.
- Organizational expenditures.

Elements of revenue will be:

- User fee.
- Sales of recyclables.
- Sales of compost (if any).

Field level experience suggests that covering more than 10,000 households may involve huge investment. So initially, community based interventions may be confined to a maximum of 10,000 households. Even if we assume that each household has five members, the programme will be serving 50,000 of the population. The following assumptions have been made to do cost-benefit analysis for a 10,000 household solid waste intervention.

- All likely costs and revenues are calculated at the present and fixed value.
- Land and shed for segregation and composting has been

provided free of cost by municipality/some other agency.

- Kinds of services offered: door-to-door collection and sweeping of nearby roads.

- One waste collector collects waste from 150 households, sweeps the nearby roads and then works on the compost shed.

- There is one supervisor for every six waste collectors.

- Two waste collectors share one rickshaw trolley covering 300 households.

- Each waste collector is paid a salary of Rs.2400 per month, including Rs. 600 for recurring expenditures like primary medical health, maintenance of rickshaw trolleys and uniforms and other equipment given for the waste collection.

- Each supervisor is paid a monthly salary of Rs.3,000.

- Only 80 per cent of the households are expected to pay the user fee.

- Each rickshaw trolley costs about Rs.9,000.

- Each waste collector is provided with one time inventory worth Rs.2,500. This includes items like uniform, gloves, shoes and other equipment.

Calculating expenditure

For reasons of simplicity, it's better to first calculate the one-time establishment charge and then the recurring monthly expenditure.

One time establishment cost can be broken down into the following cost elements:

1.Expenditure on rickshaw trolleys

Number of rickshaw trolleys needed is 10,000/300 = 34.

Cost of one trolley = Rs.9,000.

Total expenditure on rickshaw trolleys = 9,000 x 34 = Rs.3,06,000

2. Expenditure on Accessories for Waste Collectors

Cost of accessories such as uniform, gloves, boots, etc, worth Rs.2,500

Total expenditure = 2,500x67 = Rs.1,67,500

3. IEC material/awareness workshops for the community

Assuming that at least 40 awareness workshops, catering to 500 residents per campaign, are organized and expenditure incurred on each workshop is Rs.5,000, the total expenditure on awareness workshops of residents will be Rs.200,000. Finally, we can assume that there will be an expenditure of about Rs.1,00,000 in publication and distribution of the IEC material.

Total expenditure = (Rs. 2,00,000 + Rs. 1,00,000) = Rs. 3,00,000

4. Training of Waste Collectors/Supervisors

Assuming that all the waste collectors and supervisors are trained for a minimum of 30 days and they are paid as per their monthly salary, total incurred expenditure will be **Rs.1,96,800**.

5. Organizational Overheads

One-time establishment cost of the intervening organization can be safely assumed to be about **Rs.40,000**.

Total one time establishment cost (in Rs.) is 1 + 2 + 3 + 4 + 5 = 10,10,300.

***Recurring cost per month*:** Having calculated the one time establishment cost, now we need to calculate the recurring expenditure per month. This would include salaries to the workers to be paid on a monthly basis. The elements of recurring cost per month will be as follows:

1. Salary to waste collectors = 67 x 2400 = Rs.160,800

2. Salary to supervisors = 12 x 3000 = Rs.36,000

3. Organization expenditure = Rs.15,000

4. Incidental expenditure = Rs.10,000

Based on the above assumptions, the cost revenue calculations for different numbers of households is shown in Tables 9 to 11.

Table 9. Cost calculation for 10,000 households

Cost (in Rs.)				**Revenue generated per month (in Rs.)**	
Establishment cost		**Recurring cost**			
Elements	**Cost**	**Elements**	**Cost**	**Elements**	**Revenue**
Rickshaw trolleys (34 @ 9,000)	3,06,000	Salary of waste collectors (67 @ 2,400)	1,60,800	User fee (@ 30 per user)	2,40,000
Cost of accessories (67 @ 2,500)	1,67,500	Salary of supervisors (12 @ 3,000)	36,000	Recyclables	50,000
Capacity-building (workers)	1,96,800	Organizational expenditure	15,000	Compost	-
IEC material/training	3,00,000	Incidental expenditure	10,000		
Organizational overheads	40,000				
Total	**10,10,300**		**2,21,800**		**2,90,000**

Source: Upscaling people's participation in urban solid waste management, *Toxics Link.*

Table 10. Cost calculation for 5,000 households

Cost (in Rs.)				Revenue generated per month (in Rs.)	
Establishment cost		**Recurring cost**			
Elements	**Cost**	**Elements**	**Cost**	**Elements**	**Revenue**
Rickshaw trolleys (17 @ 9,000)	1,53,000	Salary of waste collectors (34 @ 2,400)	81,600	User fee (@ 30 per user)	1,20,000
Cost of accessories (34 @ 2,500)	84,000	Salary of supervisors (6 @ 3,000)	18,000	Recyclables	25,000
Capacity-building (workers)	99,600	Organizational expenditure	15,000	Compost	-
IEC material/training	1,50,000	Incidental expenditure	5,000		
Organizational overheads	40,000				
Total	**5,27,600**		**1,19,600**		**1,45,000**

Source: Upscaling people's participation in urban solid waste management, *Toxics Link.*

Table 11. Cost calculation for 2,000 households

Cost (in Rs.)				Revenue generated per month (in Rs.)	
Establishment cost		**Recurring cost**			
Elements	**Cost**	**Elements**	**Cost**	**Elements**	**Revenue**
Rickshaw trolleys (6 @ 9,000)	54,000	Salary of waste collectors (12 @ 2,400)	28,800	User fee (@ 30 per user)	48,000
Cost of accessories (12 @ 2,500)	30,000	Salary of supervisors (2 @ 3,000)	6,000	Recyclables	10,000
Capacity-building (workers)	34,800	Organizational expenditure	15,000	Compost	-
IEC material/training	60,000	Incidental expenditure	2,000		
Organizational overheads	40,000				
Total	**2,18,800**		**51,800**		**58,000**

Source: Upscaling people's participation in urban solid waste management, *Toxics Link.*

Sources of revenue

Sources of revenue have not been calculated, as they depend on various factors. The user fee varies from Rs. 10 to 15 for lower income localities, to Rs.30 to Rs.50 for middle-income localities and anything between Rs.50 to Rs.100 for higher income localities. Similarly, the types of materials would differ from town to town and the sale of such would depend on the price they fetch. Sale of compost also depends on the quality of compost and the potential market for it. These can be worked out by the planners themselves.

Breaking even

The study by Toxics Link has also established a simple linear equation by putting all these elements of expenditure and revenue, to calculate the time period needed for the attainment of break even point of the intervention and the subsequent profits thereof. It denotes:

- Recurring monthly expenditure as Mc
- Revenue from sales of recyclables as Rr
- Revenue from sales of compost as Rc
- Revenue from user fee as Rf
- Total establishment cost as Ec.
- Rate of interest as r.

If the intervention attains the break-even point in n months, then this equation will be:

$$Rf \times n + Rc \times (n-3) + Rr \times n = E_c (1+r/12)^n - Mc \times n$$

❖ The rate of interest per annum can been assumed at 6 per cent.

❖ The equation also assumes that first three months will see a one-time establishment expenditure.

Based on the above equation, break-even periods (in months) for different number of households are presented in Table 12.

Table 12. Break-even periods for different numbers of households

Number of households	Break even period (in months)	
	Revenue from user fee + sale of recyclables	Revenue from user fee with recyclables given to waste collectors
10,000	17	20
5,000	24	31
2,000	44	63

Spin-offs

Apart from providing a sustainable solution to waste management, this programme of decentralized SWM has many direct as well as indirect economic, social, health and environmental benefits. Some of the important benefits are:

Economic benefits

▲ *Livelihood creation* – The system is labour-intensive rather than capital intensive. Thus, a decentralized solid waste management system covering 10,000 households or 50,000 population has the potential to provide employment to 67 waste collectors, 12 supervisors and 2-3 persons of the intervening organization.

▲ Source segregation keeps the recyclable material cleaner, which, subsequently fetches higher prices.

▲ Consequently, the quality of end products made from these recyclables improves many times over, which in turn, fetches higher prices and helps in preserving and promoting the faith of environmentally conscious consumers in these recyclable goods. Additionally, it can give a new fillip to the recycling industry.

▲ *Economic benefits for municipality* – Municipality can save up to Rs.4,32,000 per annum in secondary transportation for a 10,000 household programme. Municipality can save labour cost, as there will be no need for it to employ people or deploy

trolley, trucks or tractors for primary transportation of waste. It will reduce the work load of municipal staff, as there will be less need of regular road sweeping and drainage cleaning.

▲ *Benefits from composting* – Composting not only provides an extra source of revenue for the intervention, but also helps reclaim the lost fertility of the soil. The dangers of chemical fertilizers are well known.

Other benefits

▲ *High landfill diversion rate* – This system has the potential to attain a landfill diversion rate of more than 80 per cent, which not only saves money in terms of excess land to be acquired for the new landfill site, but also conserves the environment.

▲ *Health benefits* – A clean neighbourhood makes the area less prone to diseases. The provision of formalizing the working conditions of waste collectors provides them with the opportunity to work in healthier conditions. The provision of gloves, uniforms and other safety equipment improves their working conditions.

▲ Emission of harmful gases is reduced due to reduction in the number of mechanized vehicles used for primary transportation of waste, which is healthier for residents of the entire city.

▲ *Social benefits for waste collectors* – Waste pickers can be substituted as waste collectors and their livelihood can be formalized. They would get better recognition and dignity by working as formal waste collectors than as waste pickers. Also, there is reduced or no harassment by municipal staff or the police.

▲ *Empowered citizenry* – Decentralized solid waste management systems, premised upon the management and ownership by local people, contributes in strengthening the civil society. The participative nature of these systems will result in aware and empowered citizens who will utilize their knowledge in other spheres of life.

Sustainability

Sustainability of the intervention depends on the financial viability of the project, which in turn depends on the level of participation of stakeholders and sale proceeds from recovered materials. The three sources of revenue have already been discussed. But it is important to consider a few points that have emerged in the light of experiences with various interventions.

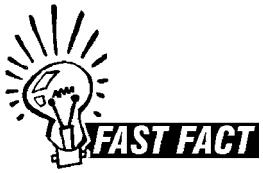
User fee

People's participation is reflected in their willingness to pay user fee. However, equally critical issue is who collects this user fee. There are three ways through which the community might be paying this.

a. *Paying to the municipality directly* – The local body collects a charge for the service and makes arrangement for the work to be performed. The charges may depend on the location or the income category of the locality.

b. *Paying to service provider* – The service provider collects this charge as per agreement in lieu of services rendered. The community is ready to pay them because the ULB services in their area are inadequate.

c. *Paying to contractors* – This arrangement is visible in comparatively bigger towns. These contractors collect fees from the households and pay to the service provider. In some sense, they can be called intermediaries. They are attracted by the margins of such operations.



Sustainability of the intervention depends on the financial viability of the project, which in turn depends on the level of participation of stakeholders and sale proceeds from recovered materials.

It is necessary to work out an arrangement, which is in the interest of sustainable waste management.

Marketing compost

There is an unlimited market for good quality compost. However, the cost of production, transportation and application of compost can exceed the benefits. The price depends on the quality of the compost. Its sale might also need support from government agencies. There are issues like subsidy to the product so that it becomes attractive, making arrangements for its sale through its agencies or direct procurement from producers, which require state support.

Marketability of finished compost

Marketability of the finished compost is affected by the following factors:

- Condition and fertility of local soils
- Government policies toward subsidies on chemical fertilizers
- Availability and cost of other soil conditioners, such as animal wastes and crop residues
- Transportation costs
- Local agricultural and horticultural practices
- Reliability and quantity of compost production
- Availability and cost of other agricultural inputs, including chemical fertilizers
- Seasonal agricultural patterns
- Compost quality, such as the nutrients, particle size and maturity
- Seasonal variations in the waste stream, particularly in terms of the volume of organic waste and its composition

Marketing recyclable products

The recyclable material collected from the households is a source of revenue for the community or the operator. However, they need to be sold to dealers who can pay adequately. It is in the interest of the community or the operator to have a long-term relationship with these waste dealers. Since survey of the situation has already revealed the likely quantities of various items, the best way out is to enter into a contract with the dealers to augment resources.

Upscaling

The issue of upscaling is associated with the success of the intervention. It can be assumed that the conditions, barring the income category of the localities, are homogeneous in a single town. So replication of similar models can be a good idea. The study by Toxics Link found this to be the most frequent type of upscaling and also successful.

Replication of a similar programme in other towns is also possible if the cost-benefit analyses suggest feasibility of the intervention.

Another approach is to have a combination of strategies, depending on the location specific features. This approach allows for a high degree of innovation.

References

[1] Composting and Its Applicability in Developing Countries by Daniel Hoornweg, Laura Thomas and Lambert Otten. 8th Working Paper Series, Published for the Urban Development Division, The World Bank, Washington DC

CHAPTER 8

Implementing the system

Successful implementation of the strategic plan prepared for decentralized SWM starts with the mobilization of all the stakeholders. This is necessary, as in most cases the grassroots initiatives do not have a legal basis. Instead, they can be viewed as a commercial/entrepreneurial activity, where financial viability of the programme determines the run of the programme. Environmental gains are fruits of the activity, which may help in soliciting participation of various stakeholders.

Mobilising community

As mentioned in the previous chapter, community participation is critical for the success of the programme. Therefore, the people need to be reached to seek their cooperation and effective participation in SWM services. This is a very difficult task and unless this is done meticulously, desired results will not be achieved. Information, Education and Communication (IEC), programmes need to be chalked out clearly. Some techniques are mentioned below for your benefit.

Awareness

To maintain a long-term relationship, the community needs to know clearly what behaviors are desired and why. Developing an effective awareness programme requires planning and strategizing. The planners should be realistic about the costs of the promotional efforts and the benefits they yield. At the awareness stage, people need to know the difference between the existing practices and the proposed one, how the latter is going to be beneficial to them and the overall situation. Publicity can be effective at this stage.

Some methods of publicity are mentioned in Table 13, which can be adopted according to location/ need based requirements.

Table 13. Methods of publicity

Low cost	Medium cost	High cost
News releases	Flyers	Commercials,
News advisories	Posters	T.V., radio
Billboards	Fact sheets	Media events
Public service announcements	Media events	Advertisements
Letters to the press	Slide show	Public relation firms
News articles		
Newsletter articles		
Speeches		
Guest spots on radio or T.V.		
Poster contests		

Source: Hansen, Z. Sensible Publicity, A Guide, *Ramsey Co., Minn. Health Department, 1983.*

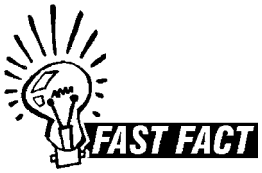
Awareness generation sessions may cover the following topics:

- Municipal Solid Wastes (Management & Handling) Rules, 2000.
- Municipality's stand on implementation of MSW Rules.
- Essence of Public-Private Partnership (PPP).
- Identification of stakeholders.
- Roles and responsibilities.
- Segregation.
- Composting.

Additional information

When the community becomes aware, it seeks additional information, which may require one to one exchanges with planners of the programme, waste management professionals or the educators. Programme managers may need a variety of methods to explain a programme. The methods may include audio-visual presentation, pamphlets or fact sheets. IEC materials may be developed with the help of expert agencies.

This will also provide forum on which the public can express issues or concerns. Participation of the community has been found to increase when programme requirements are easy to follow.



Highlighting the achievements of the programme and the individuals through media, providing awards for exemplary services, and creating special events, such as 'recycling week' or 'composting week' can solicit more participation. Children education programmes in schools like the one run by Srishti in some Delhi schools may also provide intrinsic incentives over the long term, mainly because students are more open to ideas and can influence change and policy, once they come out of school.

Incentivising the programme

Theories of collective action emphasise incentivising the whole programme. It is important that people realize the significance of participation.

Intrinsic incentives

Ideals of frugality, resource conservation, and environmental protection can be strong intrinsic motivators over the long run. Highlighting the achievements of the programme and the individuals through media, providing awards for exemplary services, and creating special events, such as "recycling week" or "composting week" can solicit more participation. Children education programmes in schools like the one run by Srishti in some Delhi schools may also provide intrinsic incentives over the long term, mainly because students are more open to ideas and can influence change and policy, once they come out of school.

Extrinsic incentives

Though the extrinsic incentives provide direct rewards for desired activities, it should be ensured that people do not connect the desired behaviour to the reward. Non-monetary social incentives can also be effective. Community leaders can exhort people by explaining them the need for SWM and that the problem is their own and they have to solve it. The planners should carefully design these incentives in consultation with the community and the municipality.

Confidence-building measures

People tend to prioritize their needs. So, peculiarly enough, as the experiences with various interventions suggest, at the start of intervention people may ask for related services as well. For example, people may ask for drainage clearance before committing to anything regarding solid wastes with the intervening agency. While such problems may appear to be distancing the concern from real issues, the fact is that they provide opportunity to the agency to gain people's confidence and remove any suspicion about them as outsiders. Their efficacy in dealing with such matters would be seen as translating in other areas as well, solid waste in this case.

Since there is every possibility of such situations, it is better to go

prepared. That may require collecting information, not only about solid waste management, but also about other issues concerning residents as well. Information like departments, their activities and the contact persons might be quite handy.

Capacity building

Inducing the desired behaviour from all the stakeholders would depend on the capacity of the actors. These capacities need to be developed. Training programmes as well as orientation workshops may be required and costs for these should be included in the programme itself.

Community mobilisation

1. Tackle information deficit

There is huge gap in information at the community level.

- Take a holistic approach – have an integrated environmental approach

- Use the following medium for making community aware:
  - Audio-visual presentation.
  - Pamphlets.
  - Fact sheets.

- Developing IEC materials is a specialized job. Get experts to design them for effective outreach

2. Incentivise the programme

Design these incentives in consultation with the community and the municipality. Some measures are mentioned here

Intrinsic

- Highlighting the achievements of the programme.

- Highlighting the achievements the individuals through media.

- Providing awards for exemplary services.

- Creating special events, such as 'recycling week' or 'composting week'.

Extrinsic

- Non-monetary social incentives.

3. Take confidence building measures

- If expected, look into problems not related directly to the programme provides opportunity to gain people's confidence and remove any suspicion about the intentions.

- If required, provide information about other related issues or problems and how to get it resolved.

4. Capacity building

Organise:
- Workshops
- Film shows
- Interactive sessions

Cover following issues:
- Municipal Solid Wastes (Management & Handling) Rules, 2000.
- Municipality's stand on implementation of MSW Rules.
- Essence of Public-Private Partnership (PPP).
- Identification of stakeholders.
- Roles and responsibilities of residents.
- Segregation at source.
- Decentralized composting.

Relationship with the municipality

In most of the large towns/cities, the health officers are put in charge of the SWM Department, whereas in mega cities, Public Health Engineers/Civil Engineers are entrusted with this responsibility. For example, Health Commissioner is responsible for MSWM in Bangalore, while in Mumbai Chief Civil Engineer holds the ultimate responsibility for the same. In some cities generalists are also looking after the SWM service. Apparently, there is no clear-cut division of roles and responsibilities.

There should be complete information about the departments, officials and activities with the intervening agency. Especially because there is huge information deficit with the community and they may require such information during the interactive sessions.

The initial rapport may be established through inviting the municipal officials to the capacity building workshops. They should not see the initiative as confrontationist. Such interactions would help in understanding each other's role and constraints effectively. This may also induce the feeling of working in partnership. For example, Toxics Link facilitated the relationship between residents and the municipality in Sarita Vihar, New Delhi.

Decisions on land for on-site composting can be taken mutually, where municipality has to play a big role. Similar other bottlenecks can be removed through regular and frequent exchanges between residents and municipality officials.

Senior-subordinate relationship is highly prized in the bureaucracy. Therefore, keeping senior officials in the loop would be highly beneficial. An official word from above may facilitate many things, which might take very long at the lower levels. This will make things easier for the lower level staff also. For example, Toxics Link took permission from Horticulture Department of Municipal Corporation of Delhi for digging up two natural pits of size 12 x 5 x 2.5 for composting, which saved the programme from a lot of hassles.

Involving the Urban Local Body

- Municipality is legally mandated for carrying out MSWM activities
- Gather information about the organization, its departments and officials with their contact numbers and addresses.
- It is equally important to know about the procedures as to how and when to meet them and how to get work done. For example, a particular office may be open for public between 3 pm to 5 pm only. Similarly, you may need to fill a form for getting the problem listed.
- Apprise municipal officials about the expectations of the public in service delivery.
- Invite the municipal officials to the capacity building workshops as well as at other interactive sessions.
- Organize sessions where officials may answer the questions of community and listen to the problems.
- Keep senior officials in the loop and invite them to some sessions, whenever possible.
- Getting senior officials to instruct subordinates may speed up the process. For example, Dy. Commissioner in Bangalore issued an order making it mandatory for the ward in-charge to attend the monthly review meetings of the community at the ward level.
- It is better if you can arrive at some formal understanding with the municipality. Municipality may help in.
  - Notifying place where the waste is to be taken after collection.
  - Fixing user charges to be paid by the residents.
  - Notifying penalty clauses for non-compliance by residents.
  - Allowing ownership rights over waste.
  - Issuing identity cards to waste collectors, which would save them from harassment from municipal or police officials.
  - Providing land for composting.
  - Synchronizing the activities of the operator with the operations of the municipality.
  - Providing resources through contracting.

Collection and segregation

The residents have the responsibility to help collection. However, they need to be told about timings and ways of segregation of waste. Arrangements like fixed time or ringing of doorbell may be decided in consultation with the residents. In the capacity building workshops or through IEC material they may be informed about the ways of segregating their waste. Many developed countries have elaborate schemes of segregation at the household level and penalties can be imposed in case of violations. However, these have again to be decided through mutual consultations.

Collection and segregation

- Have a fix time for collection of waste
- Alarm bell should be used to inform households
- Residents should store wet food / bio-degradable waste and dry recyclable waste separately at source till it is collected
- Residents should give waste to waste collectors of the intervening agency only
- Give incentives, when a household segregates waste

Raising resources

As mentioned earlier, financial viability is necessary for the sustainability of the programme.

User fee

The charges can be agreed upon through mutual consultations between the residents and the operator. It should be such that maximum people can participate. While indicative rates have been mentioned earlier, they depend on the socio-economic conditions of the people living in the area. So, while Rs. 50 can be fixed as user fee in Delhi in middle-income localities, community in a smaller town may not agree to it in the same income-category.

Similarly, as mentioned in the previous chapter, who collects user fees may also create conflicts, especially if the proposed arrangements threaten the vested interests of people who are associated with the existing system. For example, contractors may attempt to sabotage the entire operation.

Composting

Sale of compost is essential for the sustainability of the operations. If the quality is good, it may prove to be the biggest source of revenue, given the composition of Indian wastes. However, very few urban areas have been able to successfully operate composting plants due to a combination of the following[1]:

- Inappropriate technology
- Poor quality feed stock waste
- Lack of operator education and training
- Mechanical breakdown
- Poor maintenance
- High operating costs
- Offensive odour emissions

Sale of recyclable materials

It is a critical issue, as sale also depends on the volumes of the materials. In smaller towns smaller quantities or lower prices may make the option of disposal of materials at the landfill site cheaper. The municipality can be helpful in this regard. Solutions may need to be worked out together. For example, if the municipality provides transportation facilities, the materials can even be sent out of town.

Indicators to measure effectiveness

Some of the measures of performance that can be adopted to assess the effectiveness of the programme are:

- Participation of residents (numbers), adherence to timings and promptness in payment of service charges.
- Degree of segregation.
- Cleanliness of the surrounding environs (empty sites and drains clear of garbage).
- Regularity of meetings or personal contact with fellow residents, and frequency of interaction with the municipal authorities.
- Administration of accounts and management of labour, etc.
- Response from the municipal staff.

How do you generate the funds to effectively manage the system?

Raising Resources

1. User fees

- Consult the residents before fixing the charges and try to peg it at the lowest possible levels.
- Explain the necessity of user fee to the residents. Use the fact sheet for the purpose.
- Rely least on the user charges. Naya Savara in Delhi does not charge any fee.
- It is better if the agreement can be reached with the community to pay collective fee, instead of household. This will put pressure on residents not willing to pay. For example, community groups or RWAs may collect it from members and pay to the service provider.

2. Sale of compost

- Explore the market.
- Arrange with the municipality or other state agencies to find buyers of the products.
- A formal agreement might be useful.
- Marketing initiative should be taken simultaneously or even before the start of the intervention.

3. Sale of recyclables

- Maximize resource recovery.
- Find the buyers beforehand.
- It is better to enter into a contract with the buyers to maintain a long term relationship.
- Attempt effective segregation at source so that the recyclable products are clean and the recycled products of better quality.

4. Funding from financial institutions

- Intervention might require substantial capital investment, which may be beyond the capacity of the community or the service provider.
- A formal agreement with the municipality may help in getting financial institutions to lend money for the intervention for capital expenditure.
- Many municipalities are getting funds from various sources like HUDCO or Finance Commission for MSWM. They can be a source of funds too, if the arrangement is formal.

5. Dovetailing governmental schemes

- Many anti-poverty programmes give loans to groups of people like Self Help Groups (SHGs) for entrepreneurial activities.
- Entrusting them with part of responsibilities or integrating them into the intervention may help in reducing funds requirement for the intervening agency.

6. Lower cost by increasing management capacity

- Use cost effective collection methods by analyzing alternatives.
- Use cost effective transportation vehicles and routes.
- Attempt to capture economies of scale.

Pitfalls

Ownership of the programme is the critical issue. The community on its own may not be in a capacity to run the whole programme. So, when the NGO or the expert agency carrying the operations withdraws, there is the danger of collapse of the entire programme. The irony is that even if the community is willing to participate and thus help in fulfilling greater objectives of environmental safety and natural resource conservation, apathy of municipal officials may kill the initiative. Moreover, such initiatives remain outside the ambit of formal institutional arrangements. In fact there are instances where municipal staff has resented such efforts.

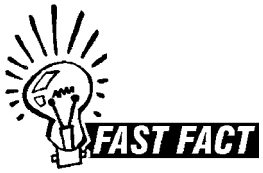
Another issue, which is of concern, is non-participation of a few members of the community. It has been noticed that the community or Resident Welfare Associations itself might be divided. Though such scenarios are included in the risk analysis, it may further discourage others, which may not augur well for the process. Logic of collective action says that if the cost of violation of a provision is higher, that may desist the violators from doing so. Besides that, such initiatives are also investing in the social capital and therefore it can be expected that social sanctions may induce desired behaviour.

Organizing waste collectors

- Try to work out with the municipality and the community to help organize the waste collector.
- Give adequate training to them regarding collection and segregation, besides orienting them about other aspects of MSWM.
- Give proper clothing and protective gear to safeguard them from hazards.
- Attempts must be made to reduce high turn-over of waste collectors so that expenditure on training and orientation of new recruits is avoided.
- Low turn-over of collectors will also mean continuity of services.
- Give enough incentives to motivate them. They are attracted by
  - A distinct identity.
  - Assured livelihood.
  - Less harassment.
  - Greater social acceptance.

Pitfalls

- Ownership issues may not be settled. The communities may not be having the necessary capacities or willingness. Then there is danger of collapse of the intervention at the withdrawal of the facilitator.
- The centrality of municipality can hardly be over-emphasised. But they have in several instances shown reluctance:
  - MSWM is still a low priority with many municipalities.
  - There have not been any departmental restructuring to streamline MSWM.
  - There has been no internal training or capacity building of the employees.
  - Budgetary allocations are not adequate.



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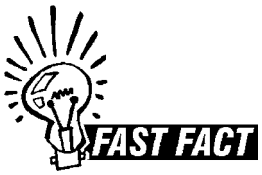

Institutionalisation requires support from all quarters. Requisite impetus can come through advocacy efforts at the policy level both at the central and state levels.

- Political leadership may thwart attempts of intervening agency.
- The collection of user fees itself may be problematic, as social and political divisions have often been noticed in the community groups or RWAs.
- Who collects the user fees may also be a contentious issue.
- Waste contractor mafia would attempt to sabotage the intervention.
- Information flow from important stakeholders especially municipality may be lower.
- Transaction costs may mount if stakeholders do not cooperate. For example, if transportation of waste from storage points by municipality is not effective, it may worsen the situation.

Institutionalisation – The way out

Institutionalization of the entire process is imperative for achieving the long-term goals. Institutionalization refers to efficacy of implementation of formal rules and informal constraints. In other words, it implies establishing a procedure. However, it may require support from all the quarters. Requisite impetus can come through advocacy efforts at the policy level both at the center as well as at the state level. That may force the municipality to give legal sanction to the process. Political buy in at the local level may also be helpful in this regard.

Meanwhile, people's participation needs to be apparent for creating sustained pressure on the authorities to incorporate such initiatives in the overall Integrated Solid Waste Management programme. Similarly, involvement of NGO as a facilitator needs to be recognised.

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Annexure 1. Different recyclable waste materials collected by waste pickers, their colloquial names and prices

Name of waste	Colloquial name	Selling price at waste dealer (Rs.)
Plastic		
Pet bottles (coke, mineral water bottles*)	Raincoat	2
Plastic thread, fibers, rope, chair cane	Cane	6 – 7
Milk sachet/packets**	Dudh Mom	6
Hard plastic like shampoo bottles, caps, plastic box, etc	Guddi	7
Plastic cups and glasses, LD, PP	Fresh PP	7 – 8
Paper		
White paper used in offices/press cutting	White	3
Mix shredded paper	Raddi	2
Cartons and brown packing papers	Gatta	2.50
All mixed paper	2 No Raddi	0.50 – 0.75
Fresh newspaper	Gaddi	3 – 3.50
Carton sheets	Raddi	3 – 3.50
Tetrapack	Gutta Sheet	2
Aluminium		
Beer and cold drink cans		50
Deodorant, scent cans***		50
Electrical wires		40
Aluminium foil	Foil	20
Other metals		
Steel utensils	Steel bartan	20
Copper wire	Tamba	80
Glass		
Broken glass	Shisha	.50
Bottles (beer)	Bottle	2

* Some people come to buy uncrushed water bottles at Rs 1 apiece, to refill it illegally.
** Red printed milk sachets are costlier due to better quality
*** These Aluminium cans are thick and of good quality.

Annexure 2. Useful resources

Publications

- *Action Points for Managing Municipal Solid Waste*. Central Pollution Control Board
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- www.eplasticsindia.com
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- www.ZeroWasteAmerica.org
- www.culturechange.org/

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