Semester 2

Part III

Project Management
Entrepreneurship in Waste Management
Environmental Costs and Risk Management

PG Diploma in
Waste Management & Environmental Hygiene

सत्यमेव जयते

Department of Higher Education
Ministry of Human Resource Development, Government of India

Where there is Rural Wellbeing
there is Universal Prosperity

Course 6 Waste Management as Project Management and GIS

PG Diploma in
Waste Management & Environmental Hygiene

Mahatma Gandhi National Council of Rural Education
Hyderabad - 500004

Foreword

Manifold increase in quality of life and high percentage of consumption of resources has resulted in unexpected and negative impact on the urban environment. Cities face the gigantic task of managing huge amount of wastes generated on a day-to-day basis, the rising costs, safe disposal technology and methodology and the terrible impact of waste both locally and globally. There is a need for a paradigm shift in the approach of waste disposal to waste processing and waste recycling by involving public-private partnerships with the ultimate aim of waste minimization. Global demand for waste management is increasing due to new legal requirements and urbanization.

A typical waste project management would include the following - establishing functional waste management units; developing strategic master plans and feasibility studies; designing documents; supply and work contract management; supervising construction/implementation; providing support to authorities/companies on system operations; and monitoring and evaluating the project for due successful completion.

Geographic Information Systems (GIS) are sophisticated modern technologies to capture, store, manipulate, analyze and display spatial data into thematic layers of digital maps. GIS along with Global Positioning System – GPS and Remote Sensing – RS assist in the recording of spatial data and the direct use of these data for analysis and cartographic representation. The most widespread application of GIS in waste management is in landfill siting, optimizing waste collection and transport, estimating solid waste generation, and waste generation forecasting at the local level.

This course on Waste Management as Project Management and GIS is suitable for students of all streams - Commerce, Humanities, Science, Management, Journalism, Mass Media, Healthcare services (B Pharm, Social Work), Education, and Engineering. The extent of environmental damage and the innovations in combating the issues require scientific understanding of the subject.

The subject has vast possibilities and several interlinking themes. There is extensive scope to explore and experience different aspects of sanitation, pollution, environmental hygiene and waste management during classroom learning, practical experiments in field and laboratory, internship and dissertation. There is a sea of opportunity in this field of waste management and environmental hygiene, and an urgent need of skilled as well as dedicated workers to make our country clean and green.

Nature has interlinked realms. Similarly, subjects dealt in this course cannot be compartmentalized. They necessarily have to merge with one another. It is therefore important that students try to make these linkages in their minds rather than treating subjects in isolation. Students can make the most of this learning opportunity as they prepare to launch their careers in a field that holds great premise.

Dr. W G Prasanna Kumar

Chairman, MGNCRE

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This Post Graduate Diploma course on Waste Management and Environmental Hygiene is a cumulative effort of several sincere and committed visionaries and academicians. Envisioned by Shri VLVSS Subba Rao, Senior Economic Advisor, MHRD, the curriculum took shape under his keen guidance.

The sincerity with which the course curriculum was completed and published can be assessed from the fact that a prior National Consultation Workshop was held with several subject matter experts and academicians across the country, to review the contents of the course material.

The workshop was held to familiarize Central, State and Private Universities, local and social bodies with the contents of the curriculum and to discuss and share feedback on ways to improve the course curriculum. The workshop also focused on building industry–academia partnerships in Waste Management and Environmental Hygiene through an intellectual interaction. The findings and inputs of the consultation were subsequently incorporated in the course material.

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Contents

List of Tables

List of Figures


RECYCLE
REPURPOSE
REUSE
REFUSE
REDUCE
HOW WELL
DO YOU KNOW
THE 5Rs

Objectives

- To orient in project management techniques to create a successful business/manager of waste
- To understand waste and assess the waste management practices in India

Rationale

Waste management and environmental hygiene is the need of the hour and needs to be addressed across all sectors and communities. The course on Waste Management and Environmental Hygiene gives the student an overview of waste management including collection, transfer, transport, and disposal along with methods of processing, basic disposal facilities, disposal options, recycling, project management and GIS applications, reclamation and remediation, entrepreneurship and job opportunities in waste sector. In addition, this course provides the student with relevant information about waste markets, recycling trends, cost and affordability of waste management practices, and incentive based concepts. This course is therefore essential for the students who wish to pursue a career in waste sector as moving ahead, waste management will become an infrastructural necessity.

Competency

The course will be taught and implemented with the objective to develop required skills sets in the students so that they are able to acquire following competencies: Plan segregation, collection, transportation, recycling and disposal of wastes, know recycling trends and available waste markets, acquire skill development and know the scope and entrepreneurship opportunities in the waste management sector.

Methodology

The theory will be taught and practicality of the course will be addressed through questionnaires, self-assessment and dissertation. The course will be through class room lectures, guest lectures, field visits, audio – video learning mode, brainstorming sessions, seminars and Q&A, and case studies on Mapping of Waste and Wastewater management. A lecture series will strengthen students' understanding of waste management which will help in acquiring different learning outcomes in rational and theory to practice approach. Competency that will be gained as part of course outcome includes - understanding, learning, applying and implementing skills, knowing career prospects in waste management sector, and internship and placement opportunities.

Topics Covered

- Conception of Project
- Changing Waste Market Survey Market linkages
- Technology Management, Common Waste Management
- Redundancy, Backup Service Technological Innovation
- Contracting, Sub Contracting
- Out-Sourcing, In-sourcing
- Demand Management PERT, CPM, MBO Gantt Chart (Trend analysis: Statistics) Mapping of Resource, GPS and GIS

Waste Management as Project Management and GIS – An Introduction

Waste management is considered as one of the most immediate and serious environmental problems confronting municipal authorities in developing countries. A successful waste management programme needs to provide hygienic, efficient and economic collection, transportation and disposal of waste without polluting the atmosphere. To ensure this standard management system GIS can be used as an effective tool in selecting suitable disposal sites and identifying the optimum routes for transportation. Environmental safety criteria and attributes will enable the wastes to be isolated without posing any risk to the environment.

GIS provides an opportunity to integrate spatial, aspatial data and other relevant data to select suitable disposal sites and identifies optimum routes for transportation of waste. GIS acts as an important decision support system.The aim of having a project management and GIS curriculum is to make the students understand how the concepts of waste management can be brought into practice.

During the course work the students will have the opportunity to interact with varied stakeholders to discuss the issues on waste management through a questionnaire survey included in the chapters. This interaction will help the students to understand the ground scenario and provide value based information for decision makers and also students too will be able to provide innovative solutions. The course shall also provide information on the employment opportunities in waste market sector. The course is a combination of lectures, online tutorials/audio-video sessions, seminars, problem based learning, assignments, field works and project work.This course will have field visits to understand the real issues in the real world and how the waste management practices are being implemented in rural areas. The field visits include visit to collection centers, transport facilities, dumping sites,and oversee sorting process, and recycling.The course also includes industry visit to see how the entire supply chain of waste handling and management happens. It will give insights on sustainability, product life cycle assessment and good practices of an industry in producing more from less.

Using the findings of the waste audit as a baseline plan, a full waste project plan can be implemented with all the tasks and objectives listed with achievable timescales and realistic costs. A dedicated waste project manager can use available internal and external resources to ensure that the waste project management is completed on time within budget, coordinate all waste project management meetings and subsequently prepare the project report.

Chapter 1
Introduction to Waste and Resource

Objectives

- To understand waste, resource
- To understand waste management in India and the global scenario

Structure

1.1 Knowing Waste
1.2 Waste management: Scenario in India and abroad
1.3 Managing waste
1.4 Waste management in India
1.5 Scientific waste management

To Do Activities

1. Revise about the natural resources
2. Facilitate discussion with students, the steps in proper waste management. What kind of resources to be extracted before the waste moves to landfill?
3. Explore the topic as a business opportunity.
4. Conduct practical exercise
5. Hold a seminar
6. Discussion what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

1.1 Knowing Waste

In simplified terms, wastes are unwanted or unusable materials. Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. From the standpoint of environment, the most common examples of waste include Municipal Solid Waste (household trash/refuse); hazardous waste; wastewater (such as sewage, which contains bodily wastes (feces and urine) and surface runoff); radioactive waste and the like.

In terms of modern waste management systems, waste can be divided into:

- Municipal waste, including household waste, commercial waste, and demolition waste
- Hazardous waste, including industrial waste
- Biomedical waste, including clinical waste
- Special hazardous waste, including radioactive waste, explosive waste, and electronic waste (e-waste)

Just as some people sweep dirt under the carpet, reporting waste has been an intractable issue at the global level. Most commonly it is measured by *size* or *weight*. Still, there is a yawning gap between the two. For example, organic waste is much heavier when it is wet, and plastic or glass bottles can have different weights but be the same size.

Litter is incidental to waste. That is, it consists of waste products that have been disposed of improperly, without consent, at an inappropriate location.

Resource

Anything which is of any physical, chemical, biological, social and/or virtual entity oflimited availability and that needs to be consumed to support and benefit life or its activity is a resource. Thus, any part of our environment such as land, water, air, minerals, forest, rangeland, wildlife, fish or even human population that man can utilize to promote is welfare may be regarded as a resource. Five basic ecological variables viz. energy, matter, space, diversity and even time are called as resources.

Ubiquitous and Localized

Some natural resources can be found everywhere such as sunlight and air; when it is so, the resource is known as *ubiquitous* (that is, existing or being everywhere) resource. However, most resources occur only in small, sporadic areas and they are referred to as localized resources.

Exhaustible and Inexhaustible

There are very few resources that are considered *inexhaustible* (will not run out in foreseeable future) and these include solar radiation, geothermal energy, and air (though access to clean air may not be). The vast majority of resources are, however, *exhaustible* (have finite quantity and could be depleted if managed improperly.

Biotic or Abiotic

The living resources are known as *biological* or *biotic* resources, whereas nonliving things are called as abiotic resources. Resources which last longer are inexhaustible and which are limited are exhaustible. Politically and commercially even humans, time and space are considered resources.

Renewable and Non-renewable

Natural resources are further classified as *renewable* and *non-renewable* resource. Naturalresources are classified based on quantity, mutability, maintainability and reusability.

Although waste by definitionmeans something "discarded as no longer useful", there is ample scope to convert it wholly or partly into resource *inter alia* by rethinking, reimagining, renewing, and recycling waste. All we need to do is to thing that something or the other in 'waste' has value. As we chase this value hidden in waste we contribute to environment.

Fig 1.1 Waste can be a Resource[1]

1.2 Waste Management: Scenario in India and abroad

Solid waste management (SWM), as a predominant component of waste management, is a major problem for most of the urban local bodies (ULBs) in India. This has been the case for decades, though urbanization, industrialization and economic growth have resulted in increased municipal solid waste (MSW) generation per person.

[1] https://www.communitywoodrecycling.org.uk/learn-more/recycling-vs-reuse/ , community wood recycling, 2018

Effective SWM is a major challenge in cities with high population density. Achieving sustainable development within a country experiencing rapid population growth and improvements in living standards is much more difficult in India because it is a diverse country with many different religious groups, cultures and traditions. This explains why despite significant development in social, economic and environmental areas, SWM systems in India have remained relatively unchanged.

Estimating the quantity and characteristics of MSW in India and forecasting future waste generation is fundamental to successful waste management planning. The quantity of MSW generated depends on living standards, the extent and type of commercial activity, eating habits and season. India generates approximately 133 760 tonnes of MSW per day, of which approximately 91 152 tonnes is collected and approximately 25 884 tonnes is treated. MSW generation per capita in India ranges from approximately 0.17 kg per person per day in small towns to approximately 0.62 kg per person per day in cities.

Around the world, waste generation rates are rising. In 2016, the worlds' cities generated 2.01 billion tonnes of solid waste, amounting to a footprint of 0.74 kilograms per person per day. With rapid population growth and urbanization, annual waste generation is expected to increase by 70% from 2016 levels to 3.40 billion tonnes in 2050.The average American creates 4.4 pounds of trash, also called municipal solid waste (MSW), per day. That translates into 1 ton of MSW per person annually. Across the United States, much of that waste is sent to landfills (54% according to the US Environmental Protection Agency).

Compared to those in developed nations, residents in developing countries, especially the urban poor, are more severely impacted by unsustainably managed waste. In low-income countries, over 90% of waste is often disposed in unregulated dumps or openly burned. These practices create serious health, safety, and environmental consequences. Poorly managed waste serves as a breeding ground for disease vectors, contributes to global climate change through methane generation, and often provokes urban violence.

Solid Waste Management in India

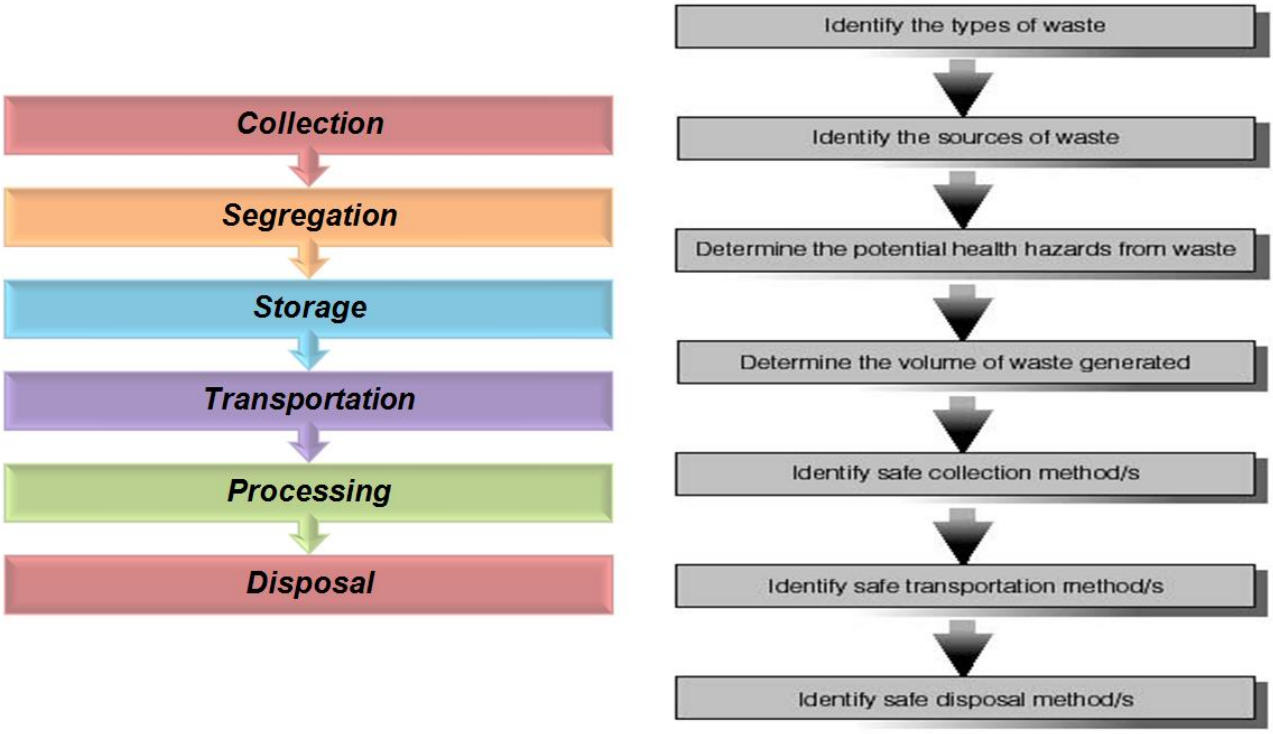


Fig1.2Solid Waste Management in India[2]

1.3 Managing Waste

Managing waste properly is essential for building sustainable and livable cities, but it remains a challenge for many developing countries and cities. Effective waste management is expensive, often comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported.

A major fraction of urban Municipal Solid Waste Management (MSW) in India is organic matter (51%). Recyclables are 17.5 % of the MSW and the rest 31% is inert waste. The average calorific value of urban MSW is 7.3 MJ/kg (1,751 Kcal/kg) and the average moisture content is 47% (Table 6). It has to be understood that this composition is at the dump and not the composition of the waste generated. The actual percentage of recyclables discarded as waste in India is unknown due to informal picking of waste, which is generally not accounted. Accounting wastes collected informally will change the composition of MSW considerably and help estimating the total waste generated by communities.

The problems associated with waste become more acute as the size of communities' increase and this provides opportunities for decentralized waste management by self-help groups and NGOs. The waste produced in urban areas of India is approximately 170 000 tonnes per day, equivalent to about 62 million tonnes per year, and this is expected to increase by 5% per year owing to increases in population and changing lifestyles.

[2]Dr Asha Pandey, 2013, http://mytutorial.srtcube.com/solid-waste-management-in-india/environment-science/826-454#7490

Amidst all this, the informal sector has a key role in extracting value from waste, considering the fact that approximately 90% of residual wastes are currently dumped rather than properly landfilled. The shift to sustainable SWM requires new management systems and waste management facilities.

MSW is a monumental task, be it for the urban local bodies or the nation as a whole. Current SWM systems are inefficient, with waste having a negative impact on public health, the environment and the economy. Although MSW is supposed to be collected and disposed in a scientific manner, few civic bodies manage to do that effectively.

No wonder, in most cities, streets and opens places are littered with garbage. Apart from being an eyesore from the standpoint of the look of the place; the whole thing results in unhealthy environment. Most of the ULBs in India collect and transport MSW to the outskirts of the cities and towns and dump it creating huge landfills. These landfills lead to ground water pollution and also have an adverse impact on the environment. Stench and health hazards are add-ons. Furthermore, if scientific waste management practices are not implemented, valuable recyclable materials like paper, plastic, glass and other recyclable materials go into the landfills.

Scientific MSW management

Scientific SWM involves various stages such as source segregation, collection and transportation to Dry Resource Collection Centres (DRCCs). In source segregation, the recyclable solid waste and wet waste are segregated at the source. The segregated solid and wet waste is then collected separately by the municipal workers and transported to DRCCs. There the recyclable materials like paper, plastic, glass and metals from the solid waste are further segregated and sent for recycling.

1.4 Waste Management in India

Despite 72 years of Independence, waste management in India as not evolved properly to the levels desired from the standpoint of wastes in terms of size and complexity. In particular, MSW is a monumental task, be it for the urban local bodies or the nation as a whole. Although MSW is supposed to be collected and disposed in a scientific manner, few civic bodies manage to do that effectively.

No wonder, in most cities, streets and opens places are littered with garbage. Apart from being an eyesore in terms of ambience and overall look of the place, it results in unhealthy environment. Most of the ULBs in India collect and transport MSW to the outskirts of the cities and towns and dump it there, willy-nilly creating huge landfills. These landfills lead to ground water pollution and also have an adverse impact on the environment. Stench and health hazards are add-ons. In the absence of scientific waste management practices, valuable recyclable materials like paper, plastic, glass and other recylcable materials go into the landfills.

On the one hand, natural resources continue to become scarcer by the day; and, on the other hand, many valuable materials are going waste as they are not retrieved from garbage. In many places, garbage is burnt, causing great damage to environment

Evolution of Waste Management

The waste management system in vogue in the informal sector was unscientific and unsustainable. Old-timers would remember that during the period starting from the early seventies and up to the late nineties the man going round the colonies in a cycle was central to the process of collection and disposal. This man usually used to buy paper, glass, scraps of iron and other metals and plastic. All of such material was in turn sold by the man on the cycle to the corner scrap shop. The scrap shop in turn sold the waste to an aggregator with a small godown. The aggregator sold it to the wholesaler with relatively bigger godowns. It was from such wholesalers with expansive godowns that the bulk of wastes went to recycling industries. Noticeably, in this informal set-up the bonds between individuals were more or less personal, considering that the man on the cycle was usually a person known to the scrap shop owner. In most cases, scarp shop owners brought them from their native villages.

Things changed from 2000 with the gradual phaseout of the men on cycles and expanding role of the scrap shop owners so much so that households had to go to the scrap shop or call him home to take the refuse. These scrap shop owners simultaneously became aggregators with relatively larger premises. Those who had previously functioned as aggregators gained weight as wholesalers. These wholesalers began to sell waste to the recycling industry.

In the case of Urban Local Bodies, things changed to some extent with the notification of MSW 2000 Rules and drastically following MSW 2016 rules.

Prior to 2000, household wastes found their way to dumper bins, often with rickshaw pullers taking them away from homes at nominal charge. ULB trucks moved wastes from dumper bins to transfer stations. From the transfer station, waste was moved to landfill or dump yard.

Post MSW 2000 Rules, mostly rickshaw pullers moved it to dumper bins. From dumper bins, waste was moved to transfer station, from where it was dumped in landfill. Source segregation of waste – into dry and wet – was central to MSW 2000 Rules that ensured door-to-door collection. These rules also ensured transportation and processing of waste, with wet waste being routed for composting and dry waste for recycling. The concept of zero waste more or less became crystalized.

Decentralized waste management took shape post MSW 2016 Rules and has become somewhat concretized with the promotion of Swachh Bharat guidelines. Waste segregation is now required to be done at the level of households itself. Segregated wastes from households are taken by collection vehicles to the transfer station, which now has two wings: DRCC and Wet Resource Centre, with the former buying the material and the latter using it for composting. Finally, only what remains goes to the landfill or dump yard.

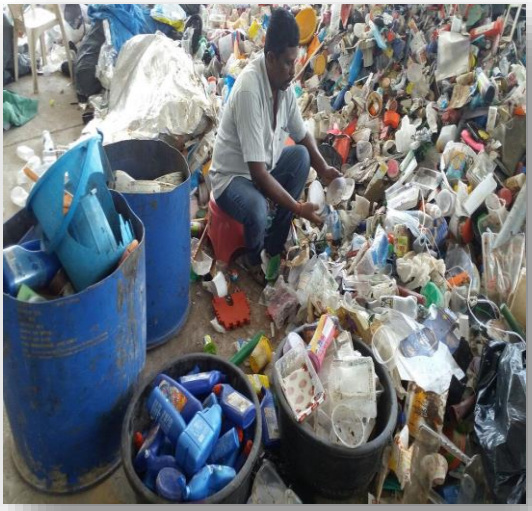


Fig 1.3Dry Waste Segregation at DRCC

1.4 Scientific Waste Management:

Case Study - The Transformation of Siddipet Town into a Model of India

Siddipet was one of the successful town in solid waste management in Telengana District of India. The town is working towards transformation into liveable, environmental friendly and citien friendly town and has become the model town in waste management in India. The Siddipet town is located about 100 km from Hyderabad and the Siddipet municipality, formed in the year 1952. The areal extent of the town is about 36.03 Km2 with 34 municipal wards and a population of about 1,14,000.

Within a period of just four years starting 2014, Siddipet became India's model town in respect of Solid Waste Management, thanks to the WOW initiative, which ITC implemented in association with the municipality. Central to WOW is the emergence of the Dry Resource Collection Centre as a catalyst of paradigm change in the way the town handled MSW. Today the 'breath-taking' difference is that the disgusting dump yard that had made life miserable prior to the implementation of the initiative is now a resource park, with every street looking spic and span.

Then
Prior to the implementation of the WOW initiative, the streets were littered with garbage. Overflowing garbage bins were found at every street corner. Stench from most of these bins was nauseating for passers-by. Apart from creating an unclean and unhygienic environment, the ill-disposed garbage used to often choke drainage lines. Burning of garbage was another common factor that contributed negatively to environmental pollution and global warming. People were not aware of segregating the dry and wet waste at the source. In the absence of proper segregation at source, valuable materials like paper, plastic, metal, glass and others went into landfills. These landfills used to have an adverse impact on people living in the vicinity.

Now
Thanks to WOW

➢ The habit of source segregation has been inculcated among the citizens.
➢ dry recyclables, paper, plastic, metal, glass and other materials which were hitherto dumped in landfills are now recovered and recycled
➢ retrieval and recycling of paper has contributed significantly to the conservation of environment by saving trees
➢ sustainable livelihood options have been created for disadvantaged sections of society, particularly waste collectors and rag pickers

Summary

Waste management, is the management of unwanted, unusable, worthless or defective substances. The chapter explains what a resource is and compares traditional solid waste management waste with resource recovery models. Much of waste management in India has been dealt with in the first semester. Recapitulating that, the chapter delves on scientific waste management. Thecase of Siddipet town is showcased here.

Self- Assessment Questions

The following questionnaire and the related exercises are intended to help elicit responses that may help policymakers in improving the solid waste management system in your city, apart from streamlining sanitation and the existing water supply situation. Please answer the questions carefully after assessing the situation fairly.

A. Details of household

1. Name of the respondent: ……
2. Are you the head of the household? Yes/No
3. Name of the head of the house hold: …….
4. Total members of the Household ……; Male……; Female…….. Children (6-14)……

   Kids (1• 5 years).....; Infants (<1 year).....
5. Education of the HH head…… : Highest education among the members of the HH……..

   0. Illiterate; 1. Primary; 2. Middle; 3. SSC; 4. Plus Two: 5. BA/BSc/BCS; 6. MA/MSc; 7. Above
6. Total number of HH who are employed……..
7. Employment status of Head of Household

1 Unemployed 2. Street Vendor/Small Informal Business

3 Government Employee 4. Own Business

5 Private Employee 6. Other

8. Average Monthly Household Income

1. Less than Rs. 10,000 2. Rs. 10,001-20,000 3. Rs. 20,001-50,000

4. Rs. 50,001-100,000 5. Greater than Rs. 100,000

9. Do you think that media has raised your awareness about water, sanitation and solid waste management?

Yes 1 No 0 *(if yes cont. to Q.11)*

10. What type of mass media component was more effective in generating your awareness?

1. Radio 2. Television 3. Newspaper 4. Social media

B. Household waste generation and disposal

12. Which of these do you think is a priority concern about waste in the area (tick)?

1. Littering and looks bad 2. Effect on human health

3. Effect on environment 4. Others…….

13. What do you do with your household rubbish? For each method, write down the number of each used in a week.

No. /Days

1. Collect in plastic bags .....

2. Put away in cardboard boxes .....

3. Dump it in rubbish bin/ drum .....

4. Others …….

5. No storage—direct disposal to dump

14. Where do you dispose the waste generated?

1. Nearby container 2. Open spaces

3. Near home 4. Others—Specify ……..

15. Identify the quantum of different types of waste generated?

1. Kitchen waste…….. % 2. Plastic ……% 3. Paper ……..%

4. Solids ……% 5. Others …….. %

16. Do you separate different type of waste (dry/wet) at your home?

Yes 1 No 0 *(if yes cont. to Q17)*

17. Would you do so if you are told by your collection service provider?

Yes 1 No 0

18. Are there any large bins in your area?

Yes 1 No 0

C. Garbage collection services

19. Do you have regular garbage collection in your area?

Yes 1 No 0 *(if no cont. to Q26)*

20. If yes, do you use it?

Yes 1 No 0 *yes/no (if no cont. toQ26)*

21. How often do you use the collection service?

1. Once a week

2. Other—specify.....

22. Which collection service do you use?

1. Public 2. Private

3. Other—specify.....

23. How much do they charge per month?

Rs: ..... per month

24. Are you satisfied with your current waste collection service?

YES 1 NO 0

25. What is the main reason for your level of satisfaction/dissatisfaction?

1. Costs 2. Unreliability

3. Improper collection 4. Reliable

5. Cooperative 6. Others ……

26. Please identify some of the main problems with the current solid waste management system?

1. Waste lying around 2. Stench
2. Rats 4 Flies
5. No problem 6. Others – Specify:

27. What is the distance between your house and dumping site?

1. ……. Meters

D. Waste-related waterborne and vector infectious diseases

28. Has anyone in your household suffered from any of these listed diseases during the last six weeks?

Yes 1 Yes/No

No 0

1. Diarrhea 2. Dysentery 3. Dengue 4. Typhoid

5. Ringworm 6. Scabies 7. Cholera 8. Malaria

9. Cough 10. Asthma 11. Skin disease 12. Others……

29. What are the main causes of environmental degradation in your city?

30. What are you more concerned about?

1. Air pollution, 2. Water pollution, 3. Waste pollution

4. Damage to scenic beauty, 5. Noise pollution, 6.Others (Please specify))

E. Water Source and Supply

31. What is the source of your drinking water?

(Spring =1, Streams=2, Ponds = 3, Wells=4, Lakes=5, Rivers=6, Government water tank=7, Private water supply=8, self-Pump/Motor (tank) =9)

32. Do you buy bottled water? Yes/No *(if No cont. to Q38)*

Yes 1 No 0

33. What is the total cost of bottled water for your household, per month?

Rs: ...../ month

34. If you use piped water, what is your average water bill each month?

Rs: ...../ Month

35. In a day, what is the total number of hours of water supply?

No: of hours _____

36. Specify your level of satisfaction with piped water supply:

1. Not satisfied 2. Dissatisfied

3. Satisfied 4. Highly satisfied

37. If you are not satisfied with the current water supply, specify reason(s):

1. Because it makes you sick 2. Costs too high

3. Taste and smell 4. Limited access hours

5. Others—Specify……

38. Is drainage system sound in your area? (Yes=1, No=2)

39. What kind of drainage system is it?

(Kachainali=1, Pakkinali=2, Open=3, underground=4, Covered with steel grill=5, other=6)

40. Are the water supply lines passing through the drainage? (Yes=1, No=0)

41. Who maintains drainage system?

(Municipal Corporation =1, Self-maintained=2, Community=3, Any other=4)

42. Is toilet available at your home? (Yes=1, No=0)

43. Whether flush system is available in the toilet? (Yes=1, No=0)

F. Health:

44. What is the current health awareness status in the locality?

(Very good=1, Good=2, Average=3, Minimum=4, Nil=5)

45. Do you use any purification method (such as boiling) before you drink piped water?

1. Yes 2. No

46. Which purification method do you use?

47. Have any children in your household below the age of 12 had any of these conditions in the last six months?

1. Diarrhea 2. Malaria 3. Typhoid

4. Cholera 5.Faeces with Blood/Mucus

6. Hepatitis A 7. Other

48. What is the average medical expenses of your household? _____

G. Environmental awareness

49. This year, did you or any member of the family participate in any community cleanup activities or other voluntary cleanups?

1. Yes 0. No

50. Is waste management an environmental problem?

1 Yes 0 No

51. Do you know how your service provider disposes your collected waste?

1 Yes 0 No

52. Are you concerned about the disposal methods of the service provider?

1 Yes 0 No

53. **Do you think that leaving a better environment to future generations is something?**

1. Very important 2. Not important at all

Chapter 2
Conception of Project

Objectives

- To understand waste management and the varied context based approaches to managing wastes
- To know project management conception and approach in a step wise way for effective learning

Structure

2.1 Sustainable development goals and WM connect
2.2 Concept based approaches of managing wastes
2.3 Project Management – Conception and Approach
2.4 Project Management – Planning, Build-up, Implementation and closeout design and development

To Do Activities

- Start with how a project should be conceptualized. Revisit waste management hierarchy and the latest concepts of circular economy and alternative technologies.
- Discuss case studies on waste management in India
- Study strategy- lifecycle- and market based approaches to waste management.
- Make students read and understand project management selection charts.
- Study the caselets and facilitate them to make presentation on the same.
- Work individually or in groups to come up with unique ideas of waste management as a project management.
- Facilitate the discussion on the strategic, lifecycle and market based approach of two or three of the best ideas.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities**.**

2.1 Sustainable Development Goals and Waste Management Connect

Waste is an unavoidable product of society, and one of the greatest challenges moving ahead. Reconsidering the way waste is generated and approached is the first step in transforming the waste management process and facilitating a more sustainable and inclusive environment. The possible approaches applied over the years have been to minimize the amount of waste produced (reduce), to reuse and recycle waste materials. However with advancing technologies, newer way of designing, remanufacturing with cradle to cradle approach, waste management processes and plan is getting strengthened under the umbrella “Integrated waste management. Waste in a generalized way is considered as” anything that is meant to be discarded and has no further use”, however it’s a resource meant to be brought to value chain. Waste management encompasses management of all processes and resources for proper handling of waste materials, collection and handling of waste, wastewater and other wastes, transportation and disposal in compliance with various health codes and specifications and environmental regulations.

India contains more than a sixth of the world's population— over 1.21 billion people— and is expected to become the world's most populous country by 2025(UNDESA, Population Division, 2013). Currently with a population of about 1.34 billion people we have a greater challenge and opportunity to convert waste into value creation. It is particularly important that we establish and manage the waste management sector of our country, as it has now become an infrastructural necessity for all other sectors to survive.

In order to develop appropriate methods of management of materials, waste and waste water, classification is the first prerequisite requirement as different waste types require different treatment and also in framing an efficient waste management plan and program. At the municipal scale waste handling, segregation, collection, transportation and disposal is being practiced and implemented with regard to dry and wet waste in accordance with solid waste management and handling rules and policies. However policy implementation gap still exists, as authorities at the ward wise, local, regional level and city level experience inadequacy to manage and implement the policies proposed. Identification, collection, monitoring and assessing relevant data and converting it into framework brought into practice forms an integral part of waste management (solid as well as waste water).

In lieu of this, national strategies with regard to budgetary and capacity support need to be aligned with the waste management issues of local and regional authorities which in turn shall result in greater participation and outcomes. Also aim should be reducing the waste generation and increasing the resource efficiency.Fig 2.1shows schematic representation of project waste management plan and which are the priority phases in its implementation.

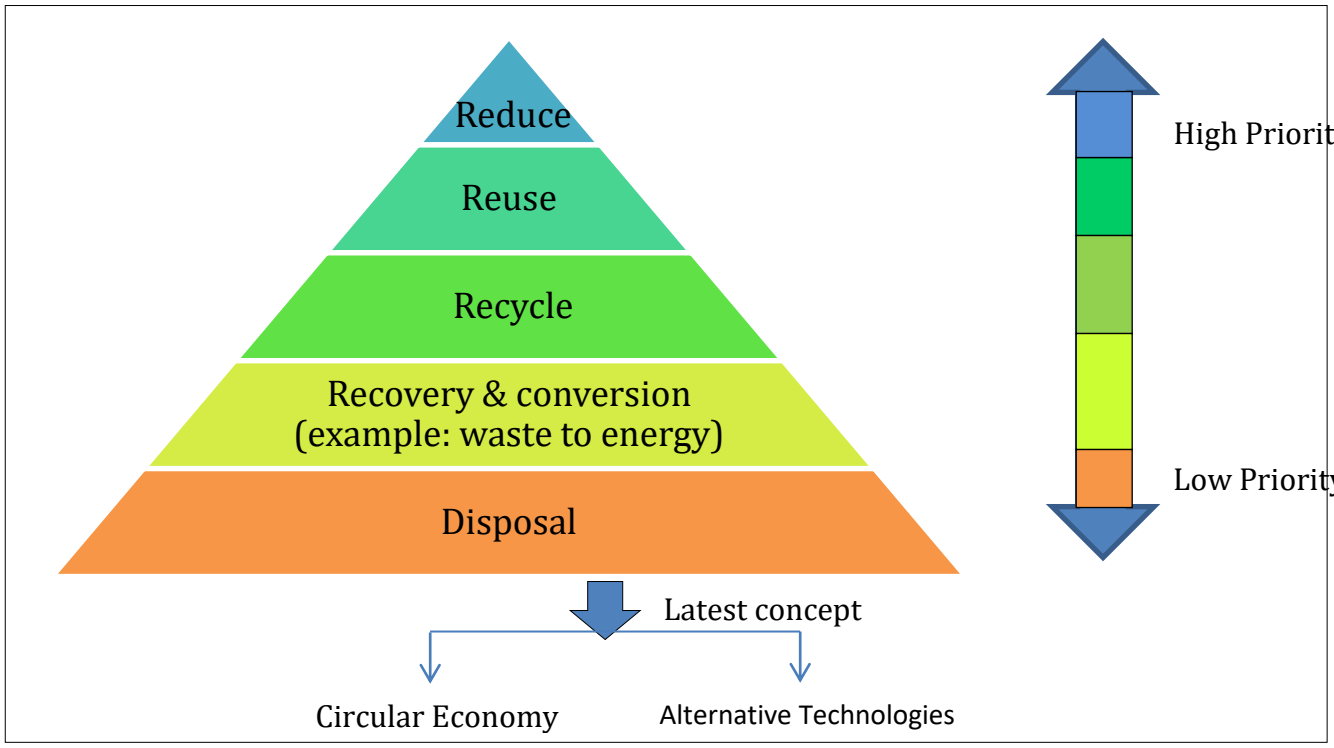


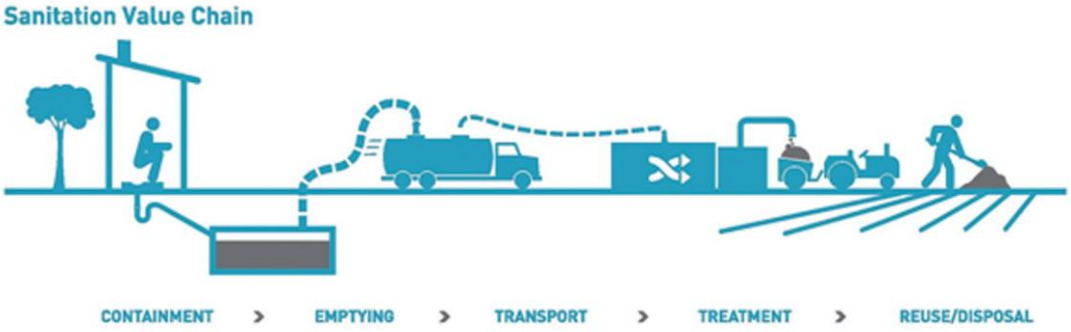
Fig 2.1Schematic Representation of Waste Management Project Concept Hierarchy[3]

[3]http://www.climatetechwiki.org/technology/jiqweb-apr

Sustainable Development Goals and Waste Management

In September 2015, the United Nations General Assembly formally adopted the 2030 Agenda aiming for global action consisting of 17 Sustainable Development Goals (SDGs) and 169 associated targets. The implementation of SDGs initiated since 2016 needs every country to meticulously plan, prioritize, and adapt the goals and targets in accordance with the local challenges, capacities and resources availability.

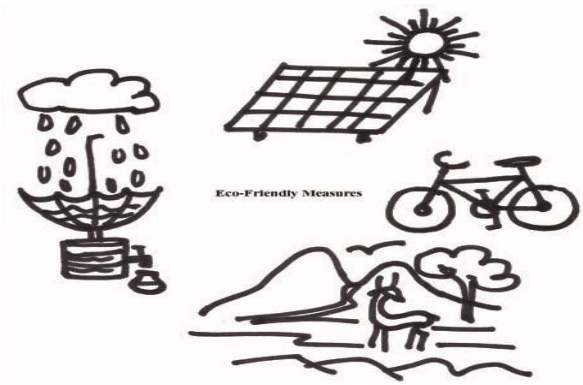
The 17 goals include - no poverty, no hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, infrastructure, reduced in equalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice and strong institutions and partnerships for goals. Though these are not mandatory goals for countries, but each goal in a way if applied shall provide tangible benefits. India being a signatory to these goals should work on these goals and its targets set with action based and ground based results.



As regard to waste management, the following goals are applicable SDG # 4 quality education – in the form of awareness and capacity building in waste management can be applied,clean water and sanitation (SDG#6) which can focus on waste water and environmental hygiene and sanitation, affordable and clean energy (SDG#7), here it can applicable with regard to waste to energy, SDG #9 industry and infrastructure – applicable in terms of developing recycling centers, better infrastructure for waste management, sustainable cities and communities (SDG #11) - it is applicable as waste management is an infrastructure necessity along with environmental and social connect, as cities have the major issues handling and disposing wastes . The efforts of communities through their attitude towards wastes connect its SDG #11. SDG #12 goal of responsible consumption and production – is applicable as it works on sustainable consumption, valuing resources, produces more from less. SDG # 13 climate action – as waste disposal and treatment practices results in GHGs emissions, the goal 13 too is relevant to waste management. SDG #14 – Life below water – since plastics menace is a problem both to marine and other aquatic life forms, this goal is relevant in waste management. SDG #16 – Life on land is relevant as landfill, illegal dumping are a major targets for working.

2.2 Context based Approaches of Managing Waste

Context based approaches of managing wastes involves measurement, management and reporting of waste management practices which in turn impacts resource



management and efficiency, providing quality service to stakeholders and enhancing the overall wellbeing.

For any given project waste management the long term goal is creating efficiency and convenience with better system usage, changing the culture of waste handling and having extensive awareness programme from lower to higher hierarchy or stakeholders, developing innovative solutions, research and development and use of advanced technology in day to day operations. According to a World Bank estimate, an individual in a developing country produces an average of 0.45 - 0.50 kg of municipal solid waste.India generates approximately 133 760 tonnes of solid waste per day, of which approximately 91 152 tonnes is collected and approximately 25 884 tonnes is treated [CPCB].The waste generation per capitain India rangesfrom approximately 0.17 kg per person per day in small towns to approximately 0.62 kg per person perday in cities(Kumar *etal*, 2008).

The context based approach of managing waste involves long term goals of 1. Creating efficiency 2.Changingthe culture of waste handling and awareness to varied stakeholders. 3. Innovatingnew solutions 4.Application of advanced technology for day to day operations. The following are the context based approaches in managing wastes:

1. Strategy based approach of waste management
2. Life cycle based approach of waste management
3. Market based or economic based approach of waste management

1. Strategy Based Approach of Waste Management

Strategy based approach is necessary, as the key challenge towards resolving waste issues is data. This approach involves mapping the flow of wastes and recyclable materials and getting where maximized data availability exists. It helps in policy, regulation and development. A good data helps waste management planners and personnel's have a better waste market status which in turn will enable better network base with stakeholders and addressing waste issues.

2. Life Cycle Based Approach of Waste Management

Life cycle of managing waste initiates from the time it is generated, includes : waste preventive measures in operations, production of product depends upon demand and supply, recovery of material (recycling) or converting waste into energy and deriving benefits and avoiding emissions and adverse impacts. Life cycle assessments (LCA) steps include assessing the emissions, resources consumed and pressures on health, environment and safety that can be attributed to a product or services.

In addition, LCAs also include social (e.g., employment), economic (e.g., costs) and sustainability-related considerations. Most of the countries have "eco-labels" as a broad approach for addressing the consumption and towards managing wastes. Green label scheme has been implemented that established product criteria and certified products that have a lower impact on the environment compared to other products serving the same function. For example: Opting for FSC certified packaged products (Forest Stewardship Council), products with label CE (ConfirmiteEuropeenne certification), BIS (Bureau of Indian Standards) Certification etc.Product criteria are based on the impacts a product may have on the environment during its life cycle (referred to as "life cycle consideration"), as well as on how easily industries can meet this criteria with reasonable process changes or improvements. Another notable attribute is extended producer responsibility which is driven by life cycle approach.

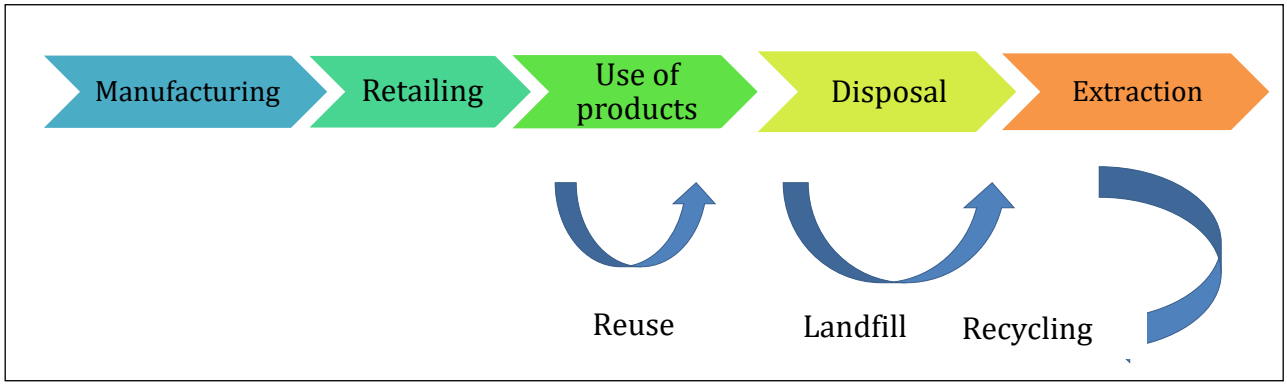


Fig 2.2Schematic Representation of Life Cycle Based Approach

3. Market or Economic Based Approach of Waste Management

Market based approach or so to say market based instruments refers to three context approaches of economic policy: 1. packaging taxes 2. Deposit-refunds and 3.Marketable permits. Economic based approach objective is a sound public policy thatmaximizesenvironmental and societal benefits. The economic approach is concerned with influencing behaviour of organization or consumer, so as to reduce pollution and improve environment. For example, if plastic bags are not charged, people and organizations will not limit its use, these in turn choke drains; affect environment and results in incurring cost on cleaning up.

These costs are referred as external costs or externalities. This ultimately is a reflection of market failure. On the other hand, when the plastic bag gets charged as it is happing in current scenarios, the level of awareness increases, its usage becomes reduced and results in reduced expenditure on management and reach to landfill.

As the saying goes “Today waste is yesterday’s product and tomorrow’s waste is today’s product, with new waste management approaches set and delayed reach to landfills of waste and alternating it with reuse and recycling policies – business opportunity has speeded up in waste economy. For value creation, waste has to be seen as a resource. The key to value creation is how waste is extracted, recycled and brought into revenue model for employment opportunities.

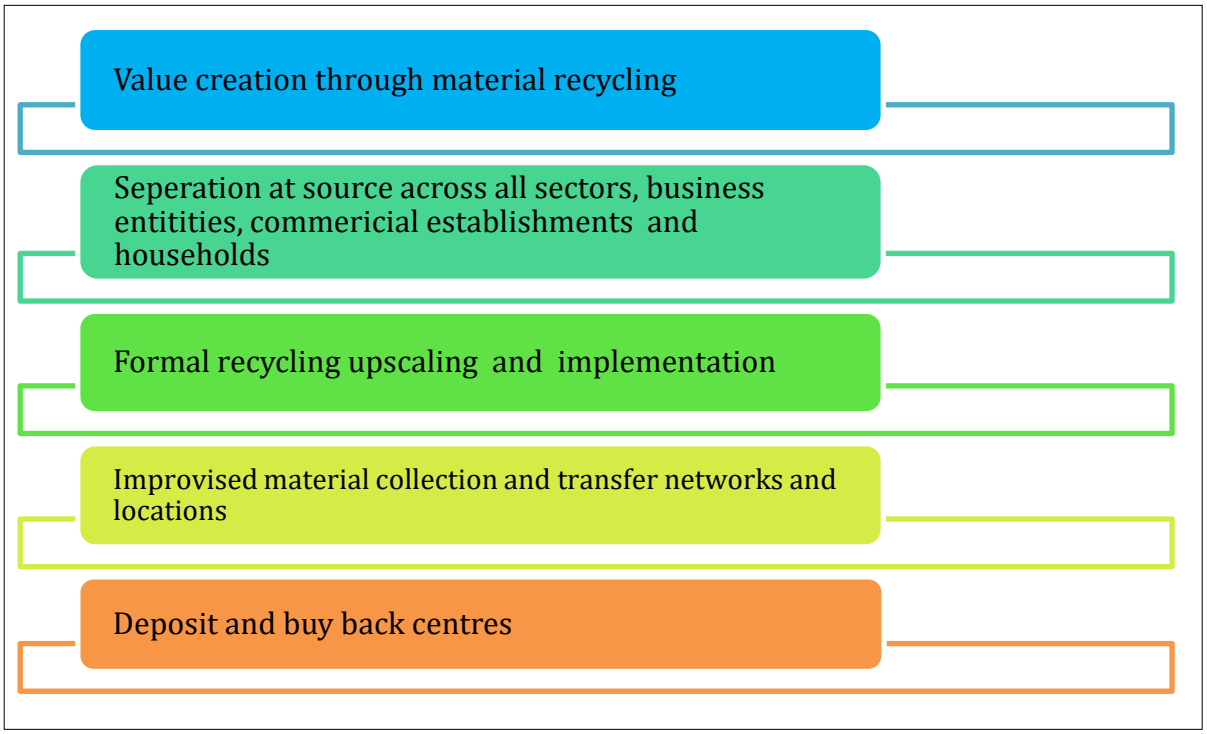


Fig 2.3 Schematic Representation of Waste to Value Creation Concept

2.3 Project Management – Conception and Approach

The project management concept approach necessity arises in order determine in a systematic manner performance that is then correlated with success and efficacy of measures taken. The approach assumes consistency in terms the devising objectives, activities and responsibilities, resource allocation and timeline for implementation across varied waste management stages.

The fundamental components of waste management are represented by generation, reduction, collection, recycling and disposal, and in turn lead to the identification of approaches by desired objectives of zero waste and or minimized wastes are achieved. The figure: 5. below represents schematically the over concept workflow before detailing the waste management project design, monitoring, measuring, verification and reporting happens. For example, if we consider project management and management of strategies in recycling waste, the outcome would be significant reduction of environmental pollution, improving resource efficiency, creating market for valuables from wastes and employment opportunities. This in turn shall expand the horizon by reintroduction of economic cycle waste which shall suggest possible future developments and scope for waste markets. Here strategies for project management includes: 1. Waste recycling to be efficient and economical, 2. Minimizing and eliminating the volume and quantity of wastes from landfills 3. Creating suitable networks for collection and transport of wastes to locations where waste can be reused and recycled. 4. When there is effective cooperation between stakeholders implementation of successful waste management plan becomes pertinent. 5. Also while promoting waste recycling and cooperation between the different stakeholders, project management can be subjected to high risks and fail in the intended purpose for which the project was planned. The subsequent tables below gives in details the risks, applications considerations and measures for project management of wastes with the a high degree of risk because it is a challenge to achieve the intended purpose.

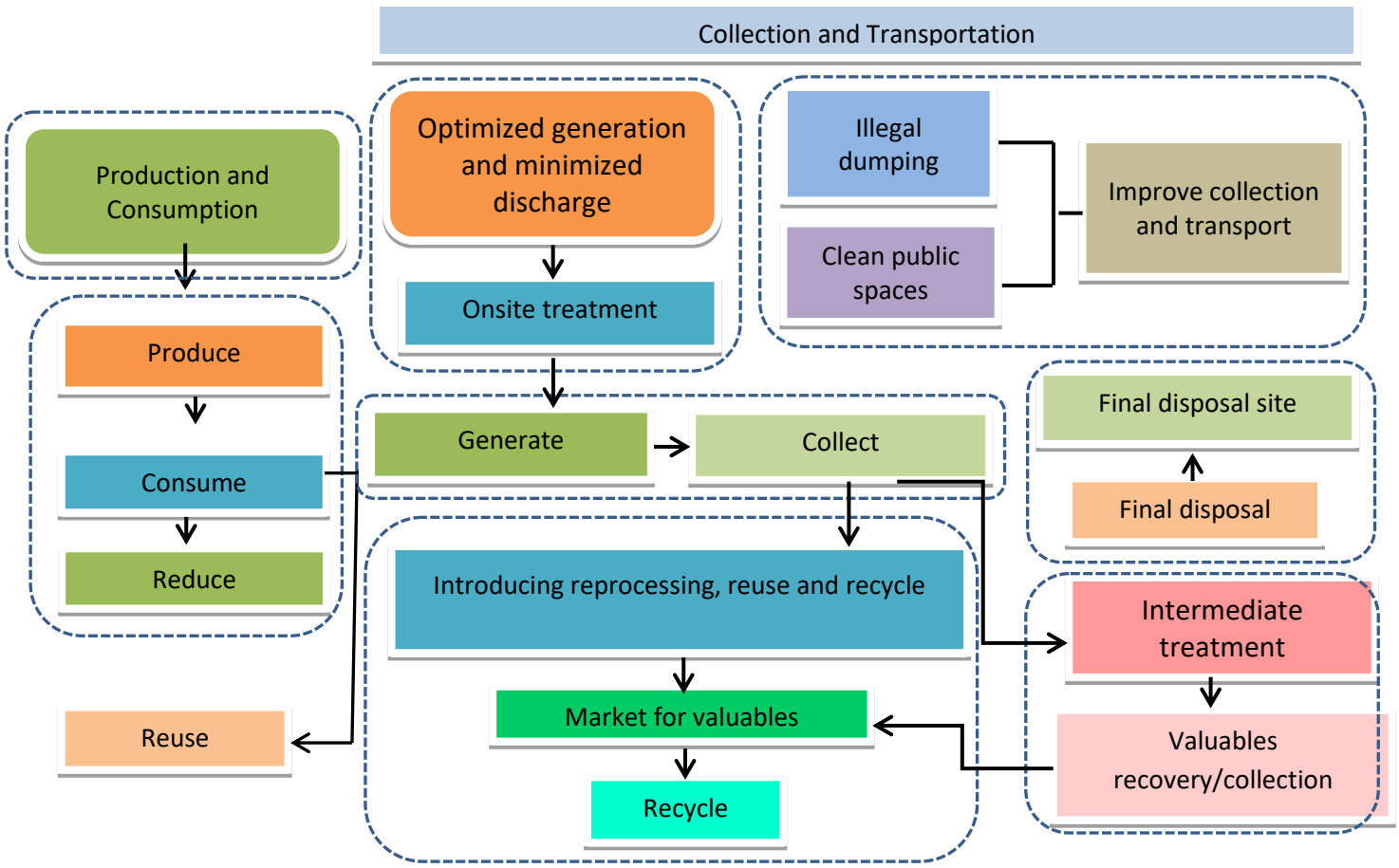


Fig 2.4 Project Management Conception– Waste Management Hierarchy

Project Management Checkpoints and Phases

Fig 2.5 Project Management Checkpoints

The four phases of project management:

Fig 2.6 Four Phases of Project Management

2.4. Project Management – Planning, Build-up, Implementation and closeout design and development

Table 2.1 Project Management – Planning, Build-up Implementation and Close out Design and Development[4]

Waste Management	Policy Type	Project Design
Type : I	**Basic Project design in Project Management**	
Applications	**Approach Measures**	
1. Considering the project design of waste management	Project Planning stage From the project management perspective, "waste management" is defined as the "initiatives taken to manage the set of processes that involve the collection and transportation of the discarded (waste) that is generated and discharged, as well as the intermediate treatments, reuse and recycling and final disposal of the waste.	
2. **Risks associated**	Policy to mitigate the risks	
If the implementation system of the waste management project does not reflect the overall view or is not in accordance with the development stage, there is a risk of not being able to produce reasonable results	1. Integrated solid waste management to achieve the 3R : • Implementing proper solid waste management practices in developing countries requires increasing solid waste management capacity throughout the entire society as well as building sustainable implementation frameworks. • Suitable assessment are carried out on all levels, such as individual, organizational, institutional, and social level to understand the existing capacity of targeted governments or municipal councils so that appropriate assistance could be provided to partner governments to establish integrated waste management frameworks. • From the perspective of project design to mitigate risks the following are the considerations : (1) legal and institutional	

[4]**IDB-AIDIS-PAHO. 2011. Regional Evaluation on Urban Solid Waste Management in Latin America and the Caribbean -2010 Report**

	improvements, (2) organizational improvements, (3) financial improvements, (4) private sector involvement, (5) waste producer initiatives, (6) citizen participation, and (7) cultural and social considerations
	2. Assistance for process-wide improvements : Waste management involves a waste management flow that starts with production/consumption and moves through the generation/discharge of waste, collection and transport, intermediate treatment or reuse/recycling, and final disposal. Once the underlying causes problems within each process are identified, measures are designed and implemented in consideration of five different processes: (1) Optimizing production and consumption; (2) Minimizing generation and optimizing discharge; (3) Improving collection and transport; (4) Encouraging intermediate treatment, reuse, and recycling; and (5) improving final disposal. 3. Assistance based on development stages The amount of waste generated and its composition depend on the level of consumption pattern and the status of economy. The following three stages of development. Level I: Improving public health and sanitation Level II: Reducing environmental impacts and pollution control Level III: Using 3R initiatives to establish a sound material-cycle society 4. Having local government and municipal authorities partnership model 5. Having private sector partnership model 6. Having PPP (Public Private Partnership) model 7. Institutional capacity building model
Expected outcomes	Provide specific and appropriate roles for each stakeholder that is involved, activities of players that are suitable for the rational frame are conducted.

Waste Management	Policy Type	Project Area
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
1. Selecting an area for waste management project	For positive outcomes and implementation, the number of the project's target region and areas are to be set.	
2. Risks associated		
If target regions are not properly selected, there is a riskof negatively impacting the implementation ofactivities	When selecting project waste management it should be clear whether the project purpose is to improve the situation in a particular target area or to expand the development scheme to other regions.	
	Selection Criteria	
	1. Performance and capacity of waste management in target regions and areas	
	2. Reason or intent for collaboration and partnerships with varied stakeholders	
	3. Considering environmental, social and economic conditions	
Expected outcomes	Selection of region as per the requirement/need shall strengthen the implementation	

Waste Management	Policy Type	Project outcomes consideration
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Externalities / when important conditions becomes difficult to manage	Externalities greatly impact the projects, it becomes necessary to conduct checks, consultations and coordination with responsible institutions from the project planning stage, as well as to minimize effects	
Risks associated		
When the issues are not solved, there is a risk of not being able to carry out planned activities.	Instead of mentioning externalities as outside of scope of the project, the important conditions should be "internalized" as much as possible by collaboration and partnership models Areas that need attention include • Verification and monitoring of projects • Jurisdiction Scope • Fiscal measures • Development status, regulatory mechanism and administrative status	
Expected outcomes	By continuous monitoring the possibilities of not being able to clear the externalities and by not carrying out necessary countermeasures in advance project outcomes can be implemented successfully	

Waste Management	Policy Type – Institutional and capacity building	Effective policy implementation
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
When implementing the policy recommendations and while implementing cooperation related policies to waste management	At what level : Project formation level Project planning level Project implementation level Post-project completion	
Risks associated		
If the policy recommendations for implementation fail to consider the situation/ volume/type/ and region base of wastes	• The policies aim to ensure effective waste management • There shall be policy advisory-type projects which does not assist systems but assist at the policy level which includes government, municipal authorities, law development and regulatory heads along with other stakeholders.	
Expected outcomes	• Active participation • Enhancing collaboration • Ensure availability of necessary workforce • Training and capacity building for understanding and developing future policy making trajectories	

Waste Management	Policy Type – Institutional and capacity building	Private sector participation
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Participation of private sector in waste management	At what level : Project formation level Project planning level Project implementation level	
Risks associated		
When there is no private sector participation or where its sufficient participation does not happen, only the government/municipal authority plays a direct role in waste management, effectiveness does not happen and results in reduced reach to advanced technological management.	For realization of effective waste management, the requirements and conditions for private sector participation must be understood and appropriately introduced. • Private sector participation adds to increased efficiency of waste management. Many projects—such as waste collection, street sweeping, vehicle maintenance, facility management, smart waste management approach through sensors and GIS and GPS based approach can be entrusted in a collaborative way to private sector • Contracting and subcontracting, outsourcing and insourcing for increased efficiency. • Capacity for costs analysis and estimates • Surveillance monitoring • Framework for cost recovery mechanism • Enactment of regulatory mechanism guidelines and standards for waste sorting, storage, processing and disposal.	
Expected outcomes	Increased efficiency and better reach. Also with private sector participation, optimization of special waste handling and expansion is possible along with application of spatial/GPS and GIS technology	

Waste Management	Policy Type – Institutional and capacity building	Regional waste management system
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
When waste disposal system, final disposal sites, intermediate treatment facilities, transfer stations, collection and recycling system of valuables covers multiple municipalities waste management system	At what level : • Project formation level • Project planning level • Project implementation level • Post-project completion level	
Risks associated		
Increased expenditure on waste management	Implications of implementing regional waste management will be in accordance with the need of the project What necessitates the regional management? • Necessity of implementing efficient collection and transportation activities • Optimizing the scale of facilities and treatment responsibilities	
	• Since multiple regional and local governments are involved in waste management, it becomes necessary to perform the maintenance and management of treatment and disposal facilities in collaboration • System design based on the situation	
Expected outcomes	Induces efficient facility operations in waste management and creates opportunities for establishing the recycling industry, in turn scaling up the economics of waste markets.	

Waste Management	Policy Type – Institutional and capacity building	Industrial waste management system
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Project for improving industrial waste management	For what : Industrial waste, Waste Treatment Law, treatment responsibility, industrial waste treatment At what level: • Project formation level • Project planning level • Project implementation level	
Risks associated		
If a generalized approach of implementing industrial waste management happens based on classification of wastes, however if the approach is not as per the requirement and situation, risk of failure does exists	• Creation of mechanisms by (institutional systems) so that governments and municipal authorities can properly manage treatment waste service operations • The waste treatment differs for each type of waste, due to this the generated amount and treatment status has to be identified clearly.	
Expected outcomes	The challenges of industrial waste will be effectively understood, and institutional systems will be resolved.	

Waste Management	Policy Type – Institutional and capacity building	Capacity development and efficient administrative machinery for waste management
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Includes Organizational capacity, central and local governments, human capital, physical capital, intellectual capital, private sector and public-private partnerships	For what : implementing capacity development procedures for administrative organization related to waste management At what level: • Project formation level • Project planning level • Project implementation level	
Risks associated		
In case where suitable organizational selection and measures that reflect the characteristics of the organization are not taken, there is a risk that appropriate capacity development would not be achieved	• Capacity development happens at three levels : o Organizational arrangement: Related operations are distributed across multiple level between varied stakeholders. o Revenue Structure : Organization role in building effective administrative capacity for effective revenue creation through waste recycling also cost effective measures for waste treatment o Instruction Structure: Responsibility, knowledge transfer and protocol and regulatory enforcement and guidelines for effective implementation of waste management. • Capacity Development and Technology Transfer of Waste Management • Training and skill development for personnel with technical and management skills and planning capability • Providing opportunities for implementing project activities through pilot project management and conducting workshops for capacity building towards technology transfer and dissemination	
Expected outcomes	By utilizing strategic the physical, human intellectual and technological capital waste management is made effective	

Waste Management	Policy Type – Institutional and capacity building	Participation of citizens/communities/societies/residents/stakeholders
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Residents understanding and participation, waste management by communities, education and mass media, CBO (Community-based Organization, municipalities, 3R and segregated waste collection	Where: waste management projects that necessitate participation and understanding of the communities and/or residents for effective implementation. At what level : • Project planning stage • Project implementation stage For what : • Effectively promote participation and enabling activity practices outreach, in order to get information and accordingly work on challenges and future outcomes. • For enhancing the sustainability of waste management and community involvement	
Risks associated		
When active participation cannot happen in projects where the communities refuse to participate in the policy implemented, there is a risk in such cases like for example: plastic ban: if not implemented with effective alternatives for the citizens, the ban ceases to show results and the implementation policy fails.	• Find out the key targets (community leaders, CBO, women, local authorities, organizations such as NGOs) to encourage their active involvement in waste management activities. • Implementation of community education and awareness programs • Holding stakeholder meetings to promote residents' understanding and participation • Surveys	
Expected outcomes	Effective waste management through participatory approach	

Waste Management	Policy Type – Institutional and capacity building	Participation of citizens/communities/societies/residents and other varied stakeholders
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Residents understanding and participation, waste management by communities, education and mass media, CBO (Community-based Organization, municipalities, 3R and segregated waste collection	Where: waste management projects that necessitate participation and understanding of the communities and/or residents for effective implementation. At what level : • Project planning stage • Project implementation stage For what : • Effectively promote participation and enabling activity practices outreach, in order to get information and accordingly work on challenges and future outcomes. • For enhancing the sustainability of waste management and community involvement	
Risks associated		
When active participation cannot happen in projects where the communities refuse to participate in the policy implemented, there is a risk in such cases like for example: plastic ban: if not implemented with effective alternatives for the citizens, the ban ceases to show results and the implementation policy fails.	• Find out the key targets (community leaders, CBO, women, local authorities, organizations such as NGOs) to encourage their active involvement in waste management activities. • Implementation of community education and awareness programs • Holding stakeholder meetings to promote residents' understanding and participation • Surveys	
Expected outcomes	Effective waste management through participatory approach - Citizen's participation from the stage of project formation and planning.	

Waste Management	Policy Type – Institutional and capacity building	Conceptualization of Reduce, Reuse and Recycle
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
Effective material-cycle, 3R (reduce, reuse, recycle), 3R introduction, 3R promotion, economic and financial analysis, incentive provision, business benefit sharing, composting, rare metals recovery, E-waste (electrical and electronic equipment waste), soil pollution	At what level : • Project formation level • Project planning level • Project implementation level	
Risks associated		
Risks arises due to active cooperation and involvement of stakeholders for the promotion of waste management	• Understanding financial costing of waste management • GHGsemissions – polluter pays principle • Interventions via waste segregation and collection for effective resource recovery and recycling • Capacity improvements to cope up future challenges	
Expected outcomes	Effective waste management through waste reduction, valuing resource, creation of material cycle /circular economy, strategic allocation of resources for manufacturing of products with minimize wastes concept	

Waste Management	Policy Type – Institutional and capacity building	Conceptualization of Disposal site
Type : II	**Basic Project Area Selection**	
Applications	**Approach Measures**	
• Securing disposal sites, site selection conditions • When selecting the location of new final disposal sites and expanding existing disposal sites	At what level : • Project planning level • Project formation level	
Risks associated		
Final disposal sites without appropriate site selection procedures inhibit efficient disposal and may pose risk of public health concerns and environment damage	• Location to be selected and land for disposal should be secured appropriately with utmost priority consideration on environmental and social issues that may arise in case of improper disposal practices and making the land vulnerable for no further reclamation and remediation. • Location far from residential areas. • Location far from water resources. • Have secured capacity to allowing necessary waste volumes without leachate problem. • It is legally and financially available	
Expected outcomes	Effective waste management through waste reduction, valuing resource, creation of material cycle /circular economy, strategic allocation of resources for manufacturing of products with minimize wastes concept	

Case Studies

Waste Management Case Study: Godrej Society "Good and Green Policy

For the campus of Godrej spread across on both the eastern and western parts of Vikhroli- waste management has been a goal for the last 5 years. Since 2010, the company has been focusing on sustainable initiatives under the aegis of their 'Good and Green Policy'. The policy mandated to look into two goals- Environmental and Social Sustainability making their entire campus (industrial and residential) water and carbon neutral. Of the entire 12 MT produced, 6 MT is that of the industrial waste. As a specific strategy, the company focuses on going zero waste by the year 2020. The hazardous waste has been consistently managed along with any effluents through their STPs and ETPs as mandated by the law. However, packaging waste and other scrap was not handled and is now being streamlined. Every division is provided with a shed with separate compartments for scrap, corrugated boxes, packaging material and biodegradable waste. The Environment Engineering office looks into managing all of this from these divisions ensuring appropriate vendors are contacted for pick-ups of these specific wastes. For example, thermocol is collected separately and handed over to a vendor who resells it. The entire industrial arm manages to recycle about 98% of their waste. All the organic waste from he different departments go to a mobile OWC (Organic Waste Converter) operator who picks it up and sells the compost at a cost.

HamsaIyer , Observer Research Foundation,; Case Study of Mumbai ; Decentralized Solid Waste Management Procedia Environmental Sciences 35 (2016) 101 – 109

Company	Country of operation	Years of operation	Scale and Reach
Banyan Nation	India	3	• Integrated 1000+ informal recyclers • Diverted 1000 tonnes plastics from landfills • Recycled 500 tonnes of plastics • Reduced 750 tonnes of CO_2 emissions
Let's Recycle	India	4	• Reached 500^+ clients • Impacted 5000^+ people from low income communities
Waste Ventures India	India	7	• Diverted 1300^+ tonnes of wastes from dumpsites • Reduced 790^+tonnes of CO_2 emissions • Produced 110^+ of organic compost • Served 200,000 clients

Source: Inclusive Innovations, Editors are Elaine Tinsley and Natalia, Researched and developed by Intellecap; https://www.innovationpolicyplatform.org/system/files/4%20Integrated%20Waste%20Manangement_Apr6.pdf

Case Study: An ITC Initiative - Wellbeing out of Waste (WOW)
Initiative objectives, achievements and awards

Objectives:

- To inculcate the habit of source segregation among the citizens.
- To contribute to the conservation of natural resources by recovering dry recyclables & recycling.
- To generate employment to the weaker section of society and to create sustainable livelihood.
- To contribute to the economy by retrieving valuable recyclables and making them available to respective industries.

Achievements:

- Educated 19 lakh households on source segregation of wet & dry waste in India.
- WOW message reached to 7.6 million Indians.
- Educated 30 lakh school children and 2,000 corporates on source segregation.
- Generated direct and indirect employment to about 1,000 skilled and unskilled workers in the waste collection and management chain.
- 30 SHGs and 80 entrepreneurs are operating DRCCs in Telangana ULBs and earning Rs. 10,000/- to 15,000/- pm on an average.

- Livelihoods generated for 14,500 waste collectors & rag pickers supporting 59 social entrepreneurs impacting 77 lakh citizens.
- 50,196 MT dry recyclable wastes collected and sent for recycling.

Awards

- Swachhata Puraskar for ITC-WOW DRCC concept (2017) bySwachhata Bharath Mission
- ASSOCHAM award for best practices in PPP Model in solid
- waste management(2016&2017)
- Safaigiri award by India Today (2016)
- Most useful Environment Project (2016) by the Confederation of Indian Industry (CII)
- Innovative Environmental Project (2016) by the CII
- Environment Best Practices (2012) by the CII
- CNN-IBN Ecovative Award (2011)
- Papyrus Award (2009) from Bureau of International Recycling (BIR)

Case Study

In Pune, Maharashtra, India, the municipal corporation piloted a waste collection approach in partnership with not-for-profit organizations whereby they trained 1,500 waste pickers in door-to-door collection to provide services to 125,000 households in exchange for user fees. The pilot was successful as a sustainable mechanism for institutionalizing door-to-door collection and improved working conditions of the waste pickers. The pilot was scaled to cover 60 per cent of the city, involving a cooperative of waste pickers to collect the waste from households, for a user fee, deposit the waste in Pune Municipal Corporation (PMC) bins and then retrieve and sell recyclables and retain the earnings. As of today, the cooperative covers 122 out of 144 wards in Pune. The organic waste stream is processed in decentralized biogas (for commercial wet waste) or composting plants (for residential wet waste) across the city. The electricity generated from the biogas plants is used to power street lights whereas the compost is used in city gardens.

Source: India, National Institute of Urban Affairs (2015)

Wrap Recycling Action Program (WRAP) - USA

A coalition of businesses, government agencies, and recycling advocates in the USA are working together in public-private partnership to double the recycling of plastic film products, such as plastic wraps and bags. The Wrap Recycling Action Program (WRAP) partners help raise awareness and increase participation in plastic film recycling across the country.

Plastic wraps and bags typically are not collected in curbside recycling bins in the USA – instead, they can be returned for recycling to more than 18,000 grocery and retail stores. Consumers collect clean and dry wraps and bags and then drop them in storefront recycling bins. Collecting plastic bags and wraps for recycling removes them from the waste stream and helps prevent litter caused by human carelessness and loss from garbage trucks and waste sites.

Summary

Waste management is closely linked with sustainable development goals. Advanced technologies, remanufacturing, cradle-to –grave approach are concepts to maximize resource efficiency and minimize wastage. For initiating a waste management business, a context-based approach is needed that can create efficient resource use, linked with a culture of proper segregation, waste handling and awareness of stakeholders and innovative solutions. Approaches based on strategies, life-cycle analysis and market/ economy based models are to be adopted. The concept of waste to value is explained in this chapter with schematic diagrams. The phases of project management- planning, building, implementation and closeout- should be studied against checkpoints scope, risk, quality and cost.

Self Assessment Questions

Basis: Theory to Practice

I. General Information

1. Identification Number :
2. Name of the Municipal Corporation :
3. Region/District/City/State:
4. Geographic Feature (1. Coastal 2. Arid 3. Humid 4. Semi Humid
5. Category - 1. Household 2. Shop 3. Office 4. Industrial area 5. Company 6. Others (Please specify)
6. Income Group: 1. Salaried 2. Business 3. Retired (Pensioner) 4. Not applicable
7. Size of family :
8. A. Housing type (Tick accordingly) 1. Multi Storied Apartment 2. Independent House 3. Owned 4. Rented
   B. In case of organization, institutes and other building types: 1. Multi storied premises 2. Single/independent building
   C. Shopping/grocery shops/malls: Single / Multistoried

II. Waste Profiling

Waste profiling means to determine the characteristics of waste, and define whether it is hazardous waste or non-hazardous waste. It also aims to determine for what is the level of concern with regard to different type of waste generated (Which type of waste do you think needs priority).

Table 1 Waste profiling household

a) Household :

Waste Type	Level (1 – 3 = low, 4 – 6 = Medium, 7-9 High, and 10 = Highest priority)					
Kitchen Waste(food, vegetable and fruits waste)						
Garden, small plants sweeps						
Plastic waste (bottles, straws, and bags)						
Paper, cardboards and other paper waste						
Glass, bulb and other electrical fittings						
Rubber, Leather						
Metals, cans						
Clothes						
Medical waste (medicines bottles and strips, cotton						
Hazardous Waste (Sanitary pads and diapers)						
Electronic or e-Wastes						
Others						

Table 2 Waste profiling shops and other day to day requirements

b) Shops and other day to day requirement establishments :

Waste Type	Level (1 – 3 = low, 4 – 6 = Medium, 7-9 High, and 10 = Highest priority)					
Food, vegetable and fruits waste						
Garden waste , small plants sweeps						
Plastic waste (bottles, straws, and bags)						
Paper, cardboards and other paper waste						
Glass, bulb and other electrical fittings						
Rubber, Leather						
Metals, cans						
Clothes						
Medical waste (medicines bottles and strips, cotton						
Hazardous Waste (Sanitary pads and diapers)						
Electronic or e-Wastes						
Others						

Table 3 Waste profiling hotels/restaurants

C) Hotels / Restaurants

Waste Type	Level (1 – 3 = low, 4 – 6 = Medium, 7-9 High, and 10 = Highest priority)					
Food, vegetable and fruits waste						
Garden waste , small plants sweeps						
Plastic waste (bottles, straws, and bags)						
Paper, cardboards and other paper waste						
Metals, cans						
Others						

Table 4 Waste profiling schools, colleges, institutes, organizations and business establishments

d) Schools, colleges and other institutes, organizations and business establishments

Waste Type	Level (1 – 3 = low, 4 – 6 = Medium, 7-9 High, and 10 = Highest priority)					
Canteen waste (food, vegetables and fruits and other left overs)						
Garden, small plants sweeps						
Plastic waste (bottles, straws, and bags)						
Paper, cardboards and other paper waste						
Glass, bulb and other electrical fittings						
Metals, cans						
Electronic or e-Wastes						
Others						

Waste Management – Level of Awareness (Please tick your preference, either yes or no accordingly)

Table 5 Waste Management – Level of Awareness

Are you aware of waste management practices of segregation at source, collection, handling, transportation and disposal, recovery and reuse, recycle	Yes	No
Are you concerned about waste generation at the point of purchase and consumption	Yes	No

How important is the role of different stakeholders in waste management (on a scale of 1 to 5 (with 1 being important and 5 being very important)

Table: 6. Role of Stakeholders in Waste Management

Stakeholder type	1	2	3	4	5
Consumers					
Manufacturers					
Retailers					
Municipalities					
Residential associations					
NGOs and self-help groups					
Government					
Private sector					
Public sector					
Door to door waste collectors					
Transporters					
Disposal personnel					
Policy makers					
Civil Societies					

Chapter 3
Changing Waste Market Survey

Objectives

- To know the changing market scenarios with regard to waste markets – recycling trends and status in India
- To understand the concept of circular economy with special focus on market linkages and waste management credits perspective

Structure

3.1 Changing Scenarios
3.2 Waste Markets – Recycling trends and Status in India
3.3 Circular Economy – Market linkages and waste management credits perspective
3.4 Technological management and interventions

To Do Activities

- Discuss interesting initiatives taken by companies across the globe. Use case studies mentioned in the chapter.
- Discuss circular economy.
- Explain recycling trends to students that while volume of waste generated in India is rising exponentially, recycling figures are abysmally low.
- Visit a recycling centre and also the workshop of an informal waste collector. Let students analyse their findings to understand how the recycling industry in India can be revolutionized.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

3.1 Changing Scenarios

As wastes characteristics and composition keeps on evolving, the way it is managed, treated, disposed, recovered and recycled too differs. In lieu of this, changing scenarios are often considered the window to possible future waste policy making. The scenarios and analysis are meant to provide inputs for review of waste policies available as well as provide guidance for framing long term policy and regulations making and implementation. Though the scenarios are not complete predictors of future wastes, they just act as think tank steps or initiatives providing future developments and consistent illustrations of possible paths and way outs. An efficient methodological approach for changing scenarios involves participative qualitative approach by bringing together key experts and stakeholders combined with quantitative approach. Waste markets and recycling trends provides details, so that future priority areas, markets and recycling ways predictive scenarios can be developed. Circular economy and market linkages too, are efficient tools for scenario building along with technological management and interventions involved details.

3.2 Waste markets – Recycling Trends and Status in India

The waste market examines the waste sector top to bottom or so to say complete chain starting from generation, collection, processing, disposal and recovery in terms of revenue and volume of waste. It helps in future pricing as per capacity and demand for disposal, recovery and recycling, improves environmental

protection and public health, create jobs and increase growth in waste management and recycling sectors.Figure: 3. provides schematic representation of waste market attributes. Waste markets have opened up avenues for not just municipalities and government bodies, but the private sector and other stakeholders' role which in cohesion can reduce the reach of waste to landfills and a future towards market based approach towards waste management. Understanding waste markets provide an idea about:

- Which waste type for recycling and recovery must be allowed to move to a facility where it is best treated?
- Routing of waste to better sorting techniques, improved processes and treatment, recovery and recycling.

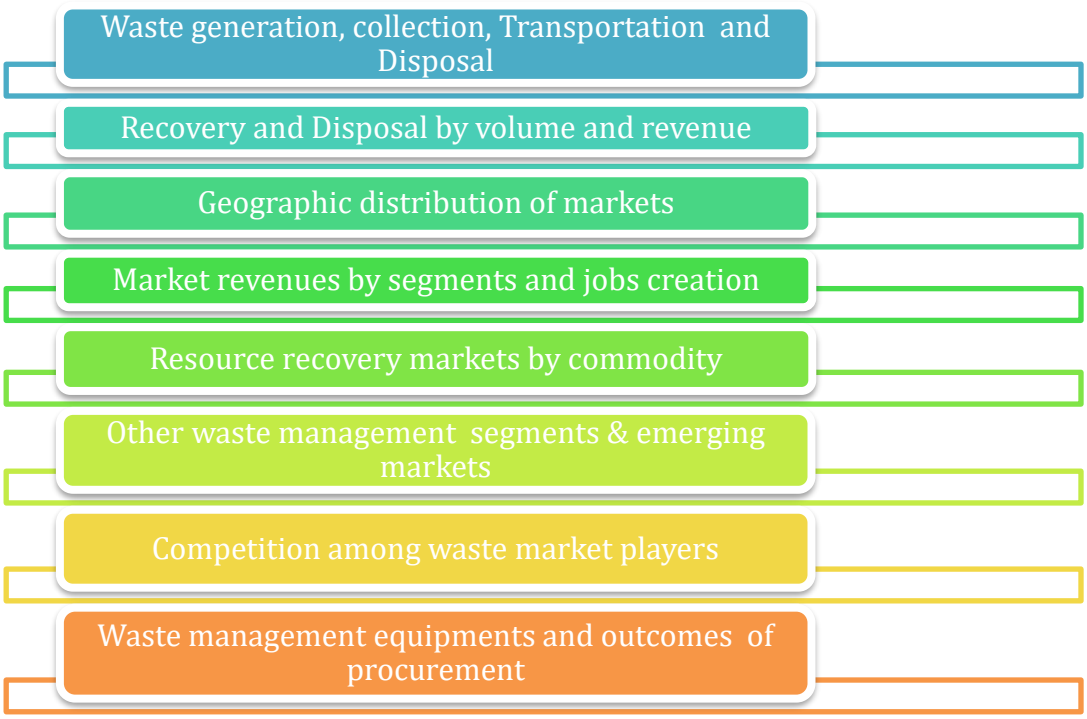


Fig. 3.1 Schematic Representation of Waste Markets Attribute

Recycling Trends and Status in India

For waste management service market to be effective, waste recycling is the basic and strategic requirement across the globe. As regard to developing countries, especially India with increasing population, growing consumerism, e-wastes have resulted in increased waste volumes across different types of waste sectors. With the revision of waste regulations as regard to solid waste management rules, 2016 and plastic waste management rules, 2016 and e-waste management rules by Ministry of Environment, Forest and Climate Change, source segregation, material recovery, waste treatment and recycling markets will see marked progress and high growth opportunities provided all the stakeholders across the entire supply chain engage, participate and implement it. With the Government of India initiative of "Swachh Bharat Mission" waste management, cleanliness and hygiene has made rapid strides and the progress is seen through the various waste management status. However at ground level, lack of proper source segregation and collection across many places and cities is still hindering the potential of waste recycling market. In lieu of this, decentralized solutions to increase formal recycling across all sectors have

come as new avenue for waste market and employment opportunities. As regard to % recycling to the waste generated, India recycles12.3% MSW, 4.8% e-wastes and 1.3% C & D.

Under pure market conditions, the economic viability of recycling and treatment is driven by the market value of the materials extracted from the waste stream; either for re-use, recycling, composting or conversion to energy. The market can be relied upon to deliver a certain level of recycling and treatment, mainly for higher value materials such as ferrous and non-ferrous metals, glass, certain plastics and pure organics/biodegradables. Also higher intensity of treatment is driven by a combination of the policy (regulatory, financial, economic) framework, coupled with the specific local market influencing factors.

Fig 3.2. Waste Management – Basis of Defining Waste Markets

Example case: More than 97 % of municipalities in Japan have their own waste sorting facilities. Almost all of these facilities (99 %) have waste treatment facilities such as incinerators and provide waste collection services and other types of intermediate treatment for recycling.
Can India aim to have such facilities for sorting to speed up ease in recovery and recycling?

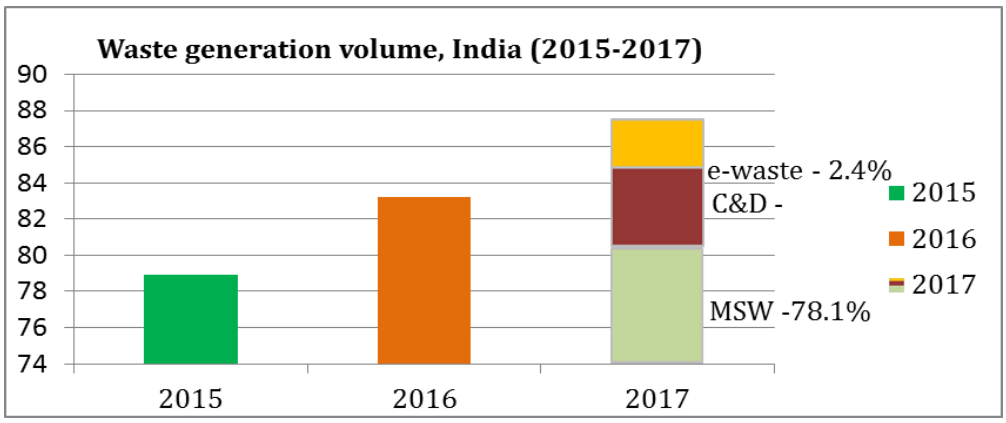


Fig 3.3 Waste Generation Volume, India 2015-2016[5]

[5] **Frost & Sullivan: Outlook of Indian Waste Management and Recycling Market, 2017**

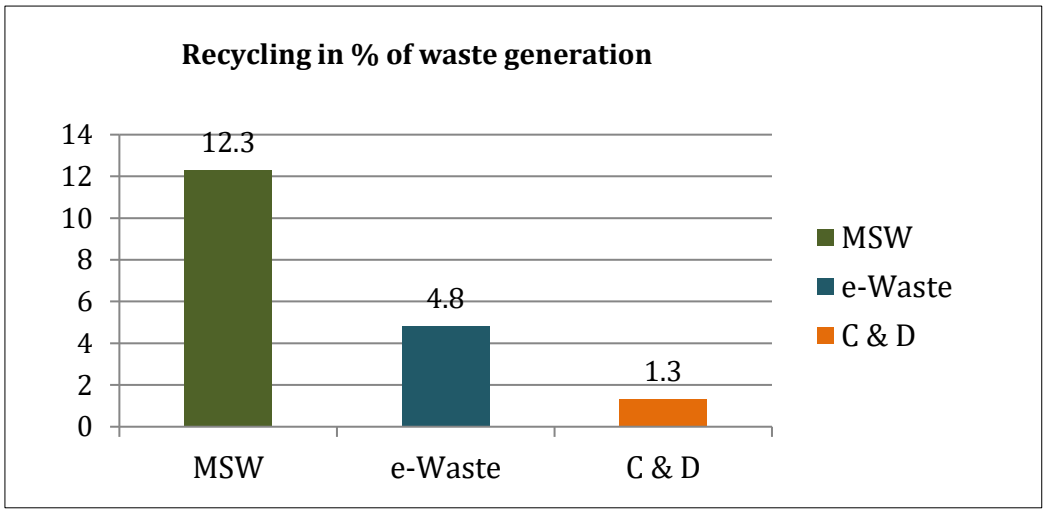
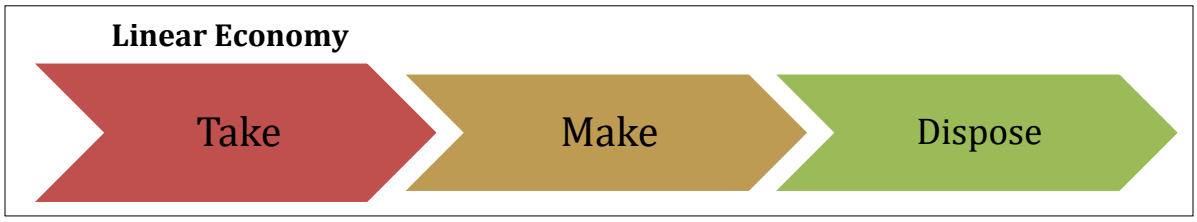


Fig 3.4 Recycing in % Waste Generation[6]

3.3 Circular Economy - Market Linkages – Waste Management Credits Perspective

Circular economy is being looked up as the future alternative. In wake of resource scarcity, insecurity and ecological crisis and with approach of use and dispose in our everyday life, circular economy is a one stop solution. Since resource management is a matter of cost optimization along with being a strong driver of shared valued creation. As regard to the business as usual (BAU) approach of linear economy of "make, use and dispose". Circular economy is regenerative in design and aims towards environmentally sustainable economy and futuristic goal of being resilient in the face of resource insecurity and ecological crisis.



[6]**Frost & Sullivan: Outlook of Indian Waste Management and Recycling Market, 2017**

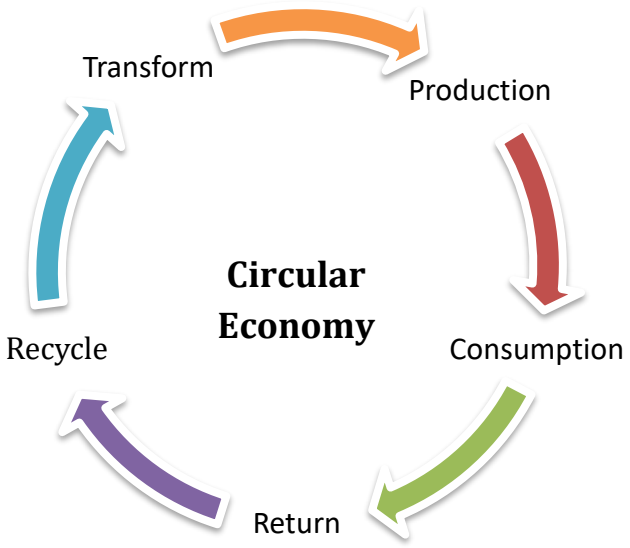


Fig 3.5 Linear and Circular Economy

Plastics – Circular Economy: Overview

In January 2016, the World Economic Forum, the Ellen MacArthur Foundation and McKinsey & Company published a report - *The New Plastics Economy – Rethinking the future of plastics.* It aimed ata multi-industry, global initiative which aims to accelerate business-driven innovations and help scale the circular economy.This year, India was the host for World Environment Day June 5th and called upon varied stakeholders across the world to help BeatPlasticPollution.

The question often arises is, can we completely eliminate plastics from our life? If, yes then how (alternatives) and if no then how to maintain their circularity, retain them by reuse, recycle and delay their reach to landfill.

- Redesign through innovation- reuse and recycle with transition strategies towards efficient and optimized plastic packaging can be win –win proposition.
- Replace single-use plastic bags by reusable alternatives.
- Scale-up reusable packaging in a business-to-business and consumers to business approach. Provide recycling centers hub for consumers.
- Drop box facility for consumers to drop their plastics, e-waste and other wastes of value that can be brought back into value chain.
- Plastic packaging, which often subjected to leakage into the environment, generates negative externalities, degradation of natural systems and greenhouse gas emissions that have been valued conservatively by UNEP at USD 40 billion.
- Increase the demand for recycled plastics through voluntary commitments and or explore policy measures to support recycling.
- “Forum or open window platform” which includes consumers, retailers, plastic manufacturers, public officials, government bodies, academicians, scientific bodies, civil societies, other stakeholders and

interested parties. Together these groups can develop an integrated approach to bringing back end of life plastics to value chain.

- Provision of advice and initiatives to prevent foodgoing to waste, linking efforts to saving resource and money on the weekly /monthlyshop.
- Through marketing campaigns and food fads, ads that draw consumer's to buy them,the consumers need to be made more aware of and empowered about theenvironmental and socially committed products. This shall develop synergiesbetween consumers, business entities, manufacturers, retailers and otherstakeholders and create circularity for the entire supply chain.
- Waste should be seen as an opportunity for enhancing livelihoods
- Certification of circular economy products could be used to communicate the sustainability ofservices, and the reparability and recyclability of products.
- Valuing the Material footprint (raw material stage), Consumption footprint (ethical,accountable and responsible consumption) are the way forward towards achievingthe Goal 12 of UN SDGs. Manufacturing pattern, resource use, product consumption,management and end use (reuse and recycle) and its correlation to environmental,economic and social impact it creates ultimately affects the sustainability.
- Integration of circular economy into education and awareness at different levels.
- A university curriculum on applied sciences which focus on circular economy, redesigning and innovation.

Embedding principles of circular economy shall allow the plastics to remain in circularity rather than in landfill and convert challenges into opportunity which shall deliver value to the business and society as way forward for future. Without innovation and redesign, almost 45 % plastic packaging will never be reused or recycled.

Example case: Innovation and redesign
Product Redesign in Japan

- Manufacturers of PET bottles reduced the amount of resin and, as a result, produced thinner bottles. This reduced the weight of PET bottle waste to be collected and handled by manufacturers.
- Liable under the end-of-life vehicle recycling law, Japanese automobile manufacturers usedthe 3Rs and a life cycle approach to improve vehicle design for better recyclability and overall environmental performance.
- The Japanese electronics manufacturer, Sony, reduced the weight of electronics such as cameras and home audio equipment.
- Toshiba reduced the number of components in its air conditioner design.
- The sports brand Adidas, together with an environmental initiative called "Parley for the Oceans," launched shoes produced with plastic debris collected from the oceans.

Source: OECD and Japan, Ministry of Environment, Japan (2014).

Market linkages of Circular Economy

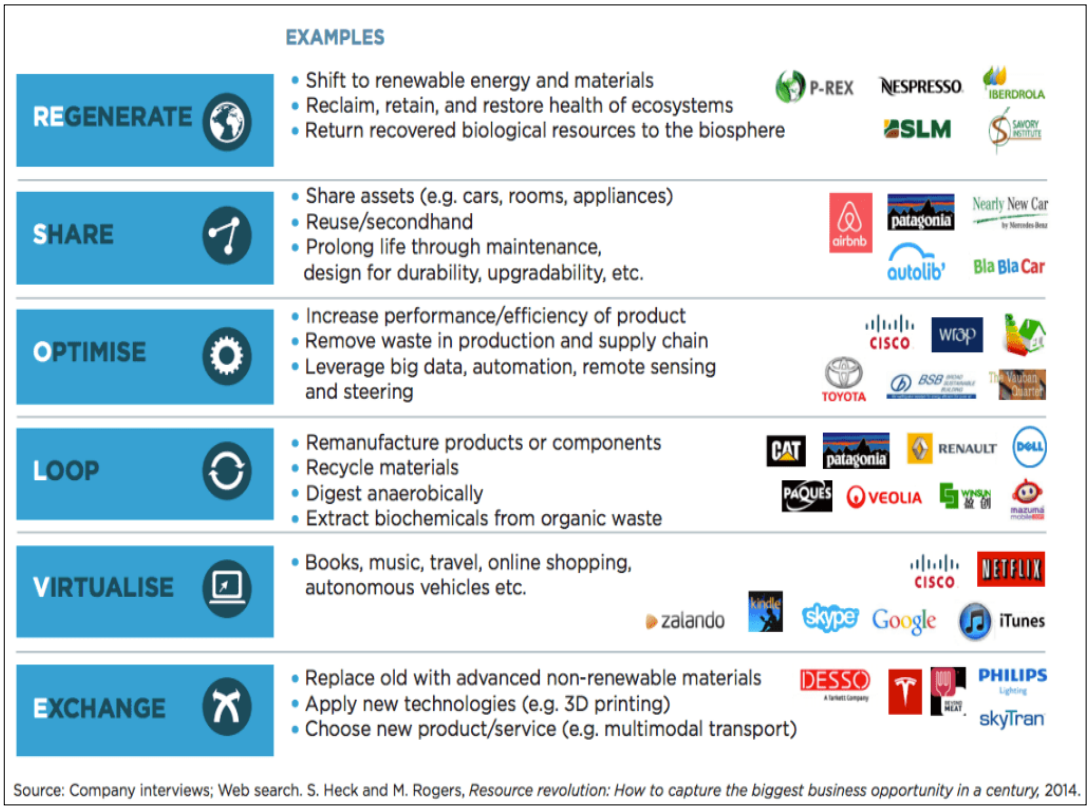


Fig 3.6. Market Linkages in Circular Economy – Source: Company Interviews, Resource Revolution

As regard to the traditional throw away concept of waste, circular economy aims to maximize no waste concept through : discarded products and materials are prevented from ending up as waste, used more efficiently or shared, reused or remanufactured, and, as a final option, recycled or used biologically. Since internal optimization and internally wastes are brought into use and loop and cycles are closed and circular pollution is prevented and allows “job opportunities or green jobs” to work in the most promising recycling and ever so growing waste market base.

The polluter pays principle (PPP), is one of the basis of circular economy where in adverse environmental impacts are included in product costs and for availing the product benefits and towards environmental and social responsibility willing to pay more (WTP) concept is heightened. Incentives be given for creating and for repair, reuse, refurbishment and recycling businesses, this shall increase product responsibility.

Policies and Legislations

Waste management authority responsibilities incudes national government (concerned departments and ministries) and local government which includes state, province, region and municipality and other related stakeholders.The central government has the responsibility to provide nationwide consistent policy and regulatory framework and address trans-boundary movements of waste. Local government manages local

waste management-related issues. Also National waste management initiatives are often influenced by international agreements and global ratifications and rules.

The nodal departments Ministry of New & Renewable Energy (MNRE) and Ministry of Environment and Forests (MoEFCC) together initiates and influences the waste to energy programme legislations, incentives and other relevant initiatives under the power generation programme. The initiatives include:

- Bio-methanation for power and thermal applications
- Biomass gasifier based captive power and thermal applications in industries
- Biomass power based on agro / forestry residues through combustion technology
- Bagasse based co-generation in sugar mills
- Non-bagasse based co-generation in other industries

*__Key legislations__

- Solid waste management (Amendment) rules, 2016
- Plastic waste management rules (Amendment) rules, 2016
- The Hazardous Waste Management (Amendment) rules, 2016
- Biomedical waste management (Amendment) rules, 2018

** **Details of the rules are provided in tool kit link provided in the annexure section.***

Basel Convention

India is a party to the Basel Convention on trans-boundary movement of hazardous wastes. The Basel Convention aims at controlling and reduction of trans-boundary movements of hazardous and other wastes subject to the convention, prevention and minimization of their generation, environmentally sound management of such wastes and for active promotion of the transfer and use of cleaner technologies. As a party to the Convention, India is obliged to regulate and minimize the import of hazardous waste or other wastes for disposal or re-cycling and also to prohibitexport of waste to parties, which have prohibited the import of such wastes.

3.4 Technological Management and Interventions

With the influx of technology savvy startups, government regulations public private partnerships and other stakeholders in waste and recycling markets, there is a remarkable growth, demand and opportunity in waste management sector. The concept of smart waste management has resulted in radical transformation.

As per the analysis from Frost & Sullivan's Environment & Water Growth Partnership Service program (part of Energy & Environment Practice), finds that the total waste recycling market is set for growth with revenues forecast to reach INR 5.25 billion this year at a year-on-year growth rate of 22.6% from 2016 to 2017. The study analyses the Indian waste management and recycling market, focusing on key market developments, drivers, restraints, growth opportunities, technologies, and competitive landscape across the municipal solid waste (MSW), plastic waste, construction and demolition (C&D) waste, and electronic waste (E-waste) segments. Meanwhile across the globe, the use of cutting-edge technologies is giving rise to innovative business models such as commercial waste collection zones**.** These models allow haulers to invest in infrastructure improvement and introduce inventive methods for MSW collection. By optimizing waste collection routes, combining real-time data, and employing data-related technologies such as predictive analytics**,** it will be possible to eliminate the unplanned dispatch of vehicles to collect waste. BHS, ISB-Global,

and Trinov are a few notable companies that perform waste analytics and reporting to improve waste management efficiency (Frost and Sullivan, 2017).

As per the next billion initiatives on Trash to Resource research, India generates up to 62 million metric tons of waste every year. Ninety-one percent of this waste – including recyclable plastics, paper, glass, wood and metal – makes its way through a largely inefficient waste management infrastructure to landfills in the fast-gentrifying suburbs. Kabadiwalla Connect (KC), a technology-based social enterprise based in Chennai, has recently determined that leveraging the informal ecosystem of urban waste recyclers has the potential to decrease by 70 percent the amount of waste sent to landfills.

They aim to do just that with their end-to-end technology platform that leverages the extant, albeit informal ecosystem of waste collectors, aggregators and recyclers by making them more accessible to small and medium waste generators, and to government and private enterprises which have the capabilities to process and recycle the waste.

How can packaging contribute to waste management and effective waste markets for circular economy? Packaging should:

- be designed holistically with the product in order to optimize overall environmental performance
- be made from responsibly sourced material
- be designed to be effective and safe throughout its life cycle, to protect the product
- meet market criteria for performance and cost
- meet consumer choice and expectations
- be recycled or recovered efficiently after use

Case Studies

Hindustan Unilever – Waste management milestones and commitment:

- 54% generated during manufacturing in 2017, compared to 2008 reduction in waste.
- Maintained the status of 'zero non-hazardous waste to landfill' in all HUL factories and offices. 100% of the nonhazardous waste generated at our factories was recycled in environment friendly ways.
- More than 380 tonnes plastic waste has been collected, segregated & co-processed till 2017. Globally HUL, has reduced their plastic packaging by 1/3rd since 2010.
- Unilever's sustainable living plan report of 2017, mentions it's commits to ensure 100% of their plastic packaging to be reusable, recyclable or compostable by 2025. All Unilever factories and offices in over 190 countries are 'zero non-hazardous waste to landfill' sites.
- It has added a saving of 1,300 tonnes of paper across categories and 95 tonnes of glass in Foods category through material usage optimization in 2017.
- Unileveris using r-PET (80% recycled PET) in their blister packs for personal care brands like Pepsodent toothbrush. In 2017, we they have launched Surf Excel Matic Liquid in refill packaging pouch format for our consumers, making it convenient to reuse the primary pack.

Intel: Finding value in waste material

Computer chip manufacturer Intel has set a goal to recycle 90% of its non-hazardous waste and divert 100% of its hazardous waste from landfills by 2020. Since 2008, Intel has recycled 75% of the total waste generated from its operations, such as through up scaling, recycling, recovery, and reuse. For example, Intel developed an onsite electro-winning system to recover solid copper for reuse from an aqueous waste stream generated by semiconductor manufacturing. The recovered copper can enter the metals market supply chain for reuse in other industrial or commercial applications. The copper recovery process has been replicated at Intel's microprocessor manufacturing sites and more than two-thirds of the waste was recovered in 2016. Additionally, over the past 10 years Intel has donated more than 1,000 pounds of copper to Arizona State University for use in the creation of works of art.

Dell Waste Recycling Commitment

Dell has spent more than a decade working with sustainable materials in products and packaging. Since 2012, Dell has recycled more than 50 million pounds of post-consumer recycled materials into new products. As part of its 'Legacy of Good' programme, the company has pledged to recycle 100 million lbs of material into its product portfolio by 2020.

Source: Global Recycling Day; https://www.globalrecyclingday.com/

Special Environment Endeavour 2018 for India, as it hosted the World Environment Day 2018 – Theme "Beat Plastic Pollution"

World Environment Day takes place every year on 5th June. It is the United Nations' flagship day for promoting worldwide awareness and action for environment. It is one of the largest global platforms for public outreach, celebrated by millions of people across the globe towards environmental commitment. This year India was the host country for World Environment Day and the theme for this year was Beat Plastic Pollution - If you can't reuse it, refuse it.

The declaration of the Global Plastics Associations for Solutions on Marine litter

The declaration of the Global Plastics Associations for Solutions on Marine litter represents a public commitment by a global industry to tackle a global problem: plastic litter in the coastal or marine environment. As per the declaration plastic waste for the environment sustainability is unacceptable and that we all have a role in combating marine litter. The initiative identified six work areas and aimed at contributing to sustainable solutions: education (public-private partnership), research, public policy, sharing best practices, plastics recycling/recovery, and plastic pellet containment. The signatories also agreed to publicly report on progress toward meeting their commitments. Till December 2017, 355 projects were planned, underway, or completed. 74 plastics associations representing 40 countries had signed the Declaration. India issignatory to this declaration, Operation Clean Sweep.

(Source: Declaration of global plastics association)

Summary

The changing markets for waste are dealt with in this chapter. The trends in recycling, the circular economy and technological interventions are highlighted. The changing scenarios cannot predict the future, but can

provide inputs for policy framework. Disposal and recovery by volume and revenue, geographic distribution of markets, resource recovery markets for each commodity, growing competition, waste management equipments, etc are covered under recycling trends. An overview of how a circular economy is to be created for plastics is illustrated. Examples of market linkages and design innovations from across the world and India are showcased. Some international policies and regulations like the Basel Convention arehighlighted.

Video Links

- Circular economy basis from the founder of the Ellen MacArthur Foundation https://www.youtube.com/watch?v=eOGy683afyo
- European Union Commissioner, Mr. Karmenu Vella, talk about Circular Economy Mission to India and why the concept is so important. Circular Economy Action Plan adopted by EU foresees actions to close the loop on products and material life cycles through better eco-design and greater recycling to benefit both, environment and economy https://www.youtube.com/watch?v=O90OCB6CjLE

Further Readings

- www.weforum.orghttps://www.weforum.org/agenda/2017/06/four-companies- embracing-the-circular-economy/

Self – Assessment Questions

Questionnaire Survey Sustainable Consumerism: Way forward towards effective waste management and Reduce, Reuse and Recycling concepts

Questionnaire : Willingness to practice reduce, reuse and recycling	Yes	No
Do you pledge not to use plastic bags?		
Are you aware of refurbished/recycled products?		
Willingness to buy refurbished/recycled/Resale products		
Do you practice giving old yet usable products/ materials at home to the needy and played toys for the under privileged children?		
Are you aware of recycling companies?		
Are you Willing to practice 3Rs for wastes (e-wastes, paper wastes and plastic bottle wastes if you receive incentive or credit for doing so?		
Are you willing to reduce and reuse, repair your plastic waste and e-wastes or electronic wastes, wires, mobiles etc.?		

Willingness to drop your e-waste and plastic and pet bottle waste at drop off recycling facility, if facility is made available?		
Are you aware of the environmental impact as a consumer before purchasing general day to day products?		
Are you aware of the social impact as a consumer before purchasing general day to day products?		
Do you see energy star rating labels while buying electrical/electronic appliances?		
Would you be interested to buy Eco-friendly garments/clothing made from recycled materials?		

Chapter 4
Practices and Innovation

Objectives

- To have insights into practices and innovation in waste management via the key practices and strategies – CAMS and CMS
- To know step wise approach to management, mitigation, monitoring and verification of waste management project with focus on NAMAs
- To understand the concept of backup services and technological innovation

Structure

4.1 Practices and innovation in waste management
4.2 Common Waste Management Practices & Strategies – CAMS, CMS
4.3 Management, mitigation, monitoring and verification – NAMAs
4.4 Backup services and technological innovation

To Do Activities

- Learn CAMS and CMS. Teach how each step in the waste management activity differs with income.
- Read out the table on waste management issues, responsibility and verification, for each waste management activity.
- Explain how to measure progressive goals and the application of NAMA at international level and MRV at national level.
- Conduct a seminar on back up services and technological innovations, with each student researching on one topic and presenting as a talk or slide show before the class.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities**.**

4.1 Practices and innovation in waste management

In waste management practices there is no throwing 'away' and there is a continuous evolution in developing innovation efficient management measures. Since most of the waste fractions, collection, disposal methods contribute to GHGs emissions, there is new challenge of managing wastes by developing secondary material markets out of waste through recovery and recuse practices which maximizes waste reuse and lengthens its reach to landfill.

According to OECD, municipal waste is collected and treated by, or for municipalities. It covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institution and small businesses, yard and garden, street sweepings, contents of litter containers, and market cleansing.

Waste from municipal sewage networks and treatment, as well as municipal construction and demolition is excluded. The IPCC (Intergovernmental Panel for Climate Change) includes the following in municipal solid wastes: food waste; garden (yard) and park waste; paper and cardboard; wood; textiles; nappies (disposable diapers); rubber and leather; plastics; metal; glass (and pottery and china); and other (e.g., ash, dirt, dust, soil, electronic waste). Based on the waste, managing practices differ and so does innovation and technological interventions to resolve. Also the economy or income level of a country, region or city too influences the approach of waste management. Before knowing in detail the practices like Common Waste Management Practices & Strategies – CAMS (collective alternative management systems), Competence Management System (CMS). The table below provides details of solid waste management practices by income Level.

Table 4.1 Waste Management Practices by Income Level (adapted from *What a Waste 1999*)

Activity	Low Income	Middle Income	High Income
Source Reduction	No organized programs, but reuse and per capita waste generation rates are common	Some discussion of source reduction, but rarely incorporated into an organized program	Organized education programs emphasize the three 'R's' — reduce, reuse, and recycle. More producer responsibility & focus on product design
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay. High fraction of inerts and compostables impact collection—overall collection below 50%	Improved service and increased collection from residential areas. Larger vehicle fleet and more mechanization. Collection rate varies between 50 to 80%. Transfer stations are slowly incorporated into the SWM system.	Collection rate greater than 90%. Compactor trucks and highly mechanized vehicles and transfer stations are common. Waste volume a key consideration. .
Recycling	Although most recycling is through the informal sector and waste picking, recycling rates tend to be high both for local markets and for international markets and imports of materials for recycling, including hazardous goods such as e-waste and ship-breaking. Recycling markets are unregulated and include a number of 'middlemen'. Large price fluctuations	Informal sector still involved; some high technology sorting and processing facilities. Recycling rates are still relatively high. Materials are often imported for recycling. Recycling markets are somewhat more regulated. Material prices fluctuate considerably.	Recyclable material collection services and high technology sorting and processing facilities are common and regulated. Increasing attention towards long-term markets. Overall recycling rates higher than low and middle income. Informal recycling still exists (e.g. aluminum can collection.) Extended product responsibility common.
Composting	Rarely undertaken formally even thoughthe waste stream has a high percentage of organic	Large composting plants are often unsuccessful due to contamination and operating costs (little waste separation); some small-scale	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller portion of compostables than low- and

	material. Markets for, and awareness of, compost lacking.	composting projects at the community/ neighborhood level are more sustainable. Composting eligible for CDM projects but is not widespread. Increasing use of anaerobic digestion.	middle-income countries. More source segregation makes composting easier. Anaerobic digestion increasing in popularity. Odor control critical.
Incineration	Not common, and generally not successful because of high capital, technical, and operation costs, high moisture content in the waste, and high percentage of inerts.	Some incinerators are used, but experiencing financial and operational difficulties. Air pollution control equipment is not advanced and often by-passed. Little or no stack emissions monitoring. Governments include incineration as a possible waste disposal option but cost prohibitive. Facilities often driven by subsidies from OECD countries on behalf of equipment suppliers.	Prevalent in areas with high land costs and low availability of land (e.g., islands). Most incinerators have some form of environmental controls and some type of energy recovery system. Governments regulate and monitor emissions. About three (or more) times the cost of landfilling per tonne.
Landfilling/ Dumping	Low-technology sites usually open dumping of wastes. High polluting to nearby aquifers, water bodies, settlements. Often receive medical waste. Waste regularly burned. Significant health impacts on local residents and workers	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common. CDM projects for landfill gas are more common.	Sanitary landfills with a combination of liners, leak detection, leachate collection systems, and gas collection and treatment systems. Often problematic to open new landfills due to concerns of neighboring residents. Post closure use of sites increasingly important, e.g. golf courses and parks
Costs	Collection costs represent 80 to 90% of the municipal solid waste management budget. Waste fees are regulated by some local governments, but the fee collection system is inefficient. Only a small proportion of budget is allocated toward disposal	Collection costs represent 50% to 80% of the municipal solid waste management budget. Waste fees are regulated by some local and national governments, more innovation in fee collection, e.g. included in electricity or water bills. Expenditures on more mechanized collection fleets and disposal are higher than in low-income countries.	Collection costs can represent less than 10% of the budget. Large budget allocations to intermediate waste treatment facilities. Up front community participation reduces costs and increases options available to waste planners (e.g., recycling and composting).

4.2. Common Waste Management Practices & Strategies – CAMS (collective alternative management systems), Competence Management System (CMS)

In this framework waste management practice obliges producers, importers and retailers of several consumer commodities either to organize (individual), or to participate in (collective) alternative waste management systems in order for the set recycling targets to be achieved. Each system provides the infrastructure and technical knowledge needed for operation with each local authority, as well as funding to cover all additional costs of alternative management. The role of local authorities is imperative, have unique opportunity to formulate and implement new, often breakthrough policies towards sustainable environmental management, both by reducing their own waste production and by promoting policies that provide citizens with convenient tools to participate actively. It includes non-household waste producers within the local authorities or municipality administrative area and constitutes a crucial target group.

Figure 3.1 represents the possible alternative waste management hierarchy ie; the respective available collective alternative management systems (CAMS). The introduction of EPR (Environment Product Responsibility) through these CAMS has been growing to be an important strategy and results in improving and achieving recycling targets. Such type of initiative to boost recycling markets is already being practiced in many EU member countries (Salhofer and Isaac, 1999).

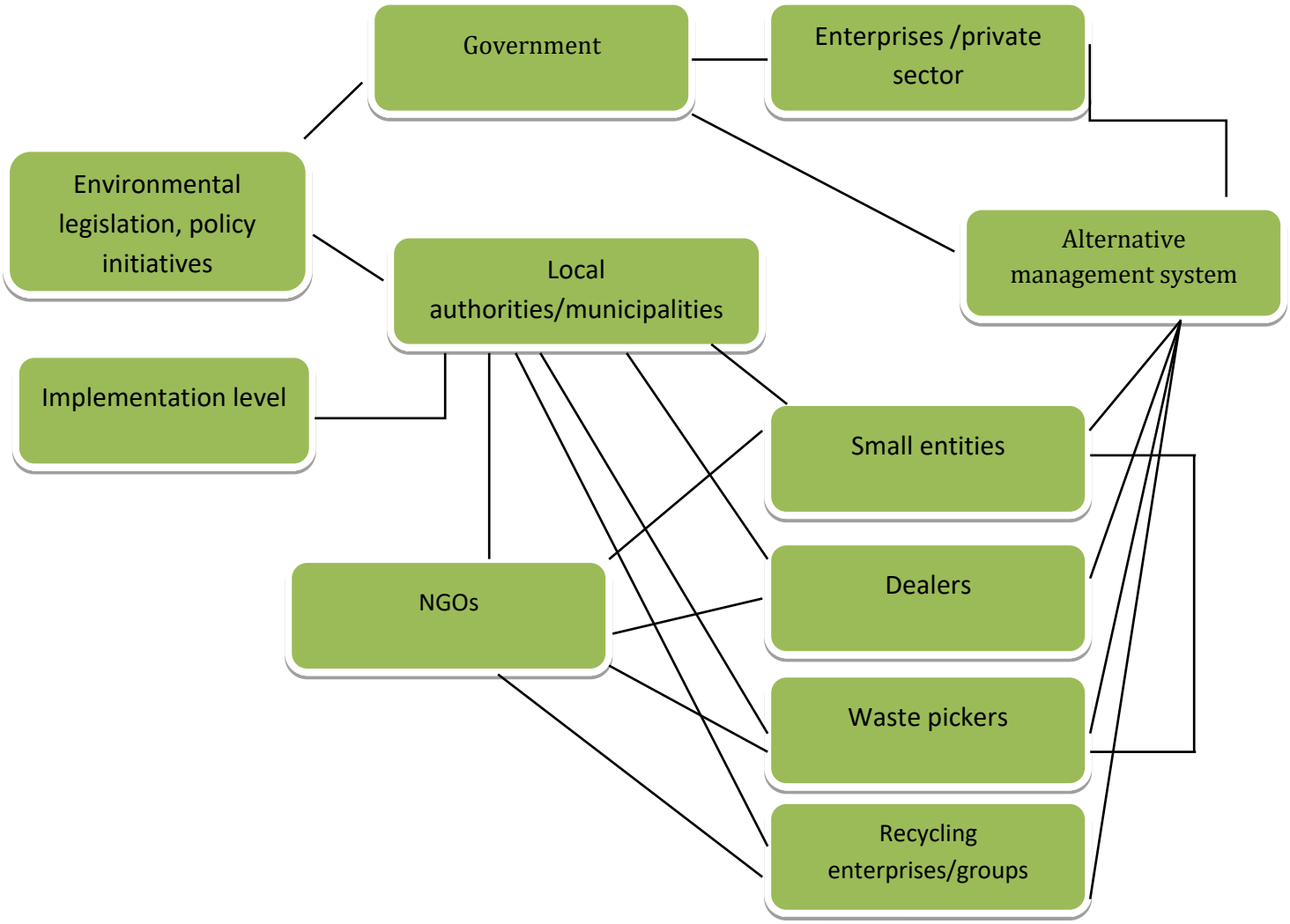


Fig 4.1 Framework practices possible hierarchy based on Baud *et al*. (2001).

Competence Management System

- The Competence Management System Scheme enables operators in waste sector to demonstrate technically competent management of permitted activities by establishing and maintaining a competence management system that is independently certificated as meeting the requirements of the CMS Standard.
- CMS consistent with other recognized management system standards such as ISO 9001 and 14001 but provides requirements for the development and demonstration of Competence.

4.3 Management, Mitigation, Monitoring and Verification

A series of management actions and mitigation measures are essential to implemented effective waste management. Along with monitoring and mitigation, reporting and verification waste management practices implemented forms the main strategic tool for building future trajectories. The following are the ways and means for undertaking management, mitigation, monitoring and verification.

1. Monitoring

Table 4.2 Waste Management Monitoring Objective

Objective	Ways and Means
Risk based	• Addresses material issues on the basis of waste generation source and the series of paths it takes till it undergoes disposal. • Environmental and social impact assessment of waste management – includes externalities and internal optimization and measures so that externalities can be avoided. Waste market failures and risks-for example: any new waste management practice and innovation be it plastic bags ban a regulatory or enforcement approach comes with a series of positive outcomes i.e.; greater awareness and lesser or reduced reach of bags to landfills and increased use of eco-friendly /alternative bags.However on the other end it creates redundancy in plastic manufacturing industry and that's the risk and a challenge.
Compliance based	• Incorporating policy and implementation based monitoring with regulatory /legislative framework with ease of delivering positive outcomes.

Key Performance Indicators (KPIs)

Waste management and monitoring require robust key performance indicators (KPIs) to be developed. KPIs are qualitative and quantitative measurements used to estimate the performance and effectiveness of management measures initiated and implemented.

Table 4.3 Key Performance Indicator

S.No.	Key Performance Indicators (KPIs)
1.	Any non-compliance with waste management measures
2.	Volume of waste generated
3.	% of waste recycled
4.	% of wastes generated, that are being managed by waste contractors

5.	Number of complaints received from the community regarding waste management practices.
6.	Training provided for waste management and whether adequate staff available for waste management and recycling practices

Table 4.4 Waste Management Issues, Responsibility and Verification

S.No.	Issue	Requirement	Responsibility	Verification
1.	Waste Management	All requirements as per environmental compliance in relation to waste management must be met	Service provider / personnel	Audit
2.	Waste Management	All relevant requirements for pollution prevention associated with waste management to be in place.	Service provider / personnel	Audit
3.	Waste Management Plan	**Good Practices guidelines :** • Develop an inventory of likely wastes • Identification of local licensed waste management facilities; • waste generation will be minimized as far as possible; • Waste reuse/recycling opportunities will be maximized • Waste segregation (liquid and solid/ reusable and recyclable) will be undertaken using appropriate storage and labeling • Waste collection, storage and transfer in line with good industry practice • Specific disposal procedures • Auditing and reporting	Review and approval from Service provider / Contractor for waste management plan	-
4.	Transport	The transport of the waste for its permanent disposal or for recovery and recycling facility	Service provider / personnel	Audit

5.	Waste Management	Hazardous waste to be managed separately and collected by authorized third party operators. Containers of hazardous waste will only be moved or transferred to the site using proper equipment and vehicles.	Service provider / personnel	Audit
6.	Training	Personnel involved in waste management has to be given regular training, specific to the range of wastes being generated and managed, and wherever relevant including requirements hazardous waste management	Service provider / personnel	Audit
7.	Waste Management	For each type of waste, the waste management solution has to be assessed; Operators will keep track of the waste.	Service provider / Contractor	Review
8.	Waste Storage	Waste to be stored in bins within trash bags and collected and transported to dedicated points on the basis of each type of waste.	Service provider / personnel	Audit / visual inspections
9.	Reporting	Record and report on the different types and quantities of waste generated and how they are disposed on a monthly basis by completing the waste management data sheets as per the requirements	Service provider / personnel	Visual visits and inspections
10.	Waste Reduction	In order to reduce the volume of waste that needs to be stored and transported pressers and shredders to be provided	Service provider / personnel	-
11.	Waste Disposal	No waste should be disposed or abandoned in forested or protected or sensitive areas	Service provider / personnel	-
12.	Waste Management	Packaging waste to be managed and mitigation measures to extent its use and reach to landfill or alternative recovery and reuse.	Service provider / personnel	-
13.	Re-cycling	Formalize recycling and provide platform for employment opportunities for waste pickers and informal waste handlers to be brought into mainstream waste management	Service provider / personnel	-

14.	Regulatory and legislative framework	All waste management and handling be performed in strict compliance with the legislation.	Stakeholders	-

NAMAs and Waste Management: How to design a MRV methodology for application of NAMAs in waste management sector?

Measuring, Reporting and Verifying (MRVs) requirements for applying NAMAs (Nationally Appropriate Mitigation Actions) depend upon the country specific needs. As such MRVs are divided in two categories: 1. MRV of the voluntary national mitigation actions under UNFCCC at international level and 2. MRV at national level.

As regard to business as usual (BAU) or baseline monitoring and establishing data base for waste, NAMAs too requires the same parameters as we do while estimating GHG emissions. It includes:

- Waste generation
- Waste composition
- Waste collection
- Waste treatment
- Recovery and conversion
- Energy consumption and energy generation

Table 4.5 Waste Management – Measuring Progress Goals

I. Measuring : Progress Goals			
Sustainable waste management – Reducing GHG emissions			
To reduce the waste volume that reaches the landfills and other dumping sites		To increase the separation and sorting of waste at source so that waste recycling can be formalized	
Actions			
Capacity building and training workshops to develop skill workforce in waste management	Create public private partnership, government and municipalities platform and other stakeholders for building operations for effective waste management and its financing/funding	Awareness camps, campaigns for citizens with the motto of educating sorting and separation of waste and practicing reduce, reuse and recycle concept and refusing plastics bags and opting alternatives.	Developing incentive based or economic enforcement schemes/ making citizens an integral part of waste management by providing credits for their waste management efforts
Outcomes of Actions Taken			
Success rate of the programme is known by the number of local	Number of public private partnerships and government and	Increased awareness level among citizens and waste workers and co-	Success rate or progress of the incentive or economic enforcement schemes is

authorities, waste management personnel and other stakeholders trained and skilled workforce employed /enrolled	municipalities network platform and other stakeholders created for effective waste management operations and funding be utilized strategically for reducing the reach of wastes to landfill, increased recovery options	workers. A network of community based organizations is being created with inclusive and formal waste pickers' enrolment to work in mainstream waste management sector	measured by the extent it has got implemented and the participation by the citizens and other stakeholders.	
Positive Impacts				
Environment : Reducing air, water and soil pollution	**Climate change** Lower greenhouse gases emissions or reduced tco_2e	**Social impact :** Job creation	**Economic impact :** Revenue generated due to commercialization of waste management and recycling Waste to value creation	**Infrastructure** Improved waste management infrastructure results in better implementation with positive impact on overall wellbeing of society, communities and cities as a whole.

Table 4.6 Waste Management - Reporting

II. Reporting		
Reporting involves regular communication from the entity implementing a NAMAs to different entities, such as the designated authority that manages the MRV system or theentity providing international support		
Purpose		
Providing information for the relevant entity for inclusion in NAMA registry, reports for policy mainstreaming towards sustainability and deriving co-benefits		
Fulfilling Requirements in accordance with the greenhouse gases emission reduction protocol		
Tracking the efficiency of implemented policies		
Validating policy implementation		
Requirement		
What	**To whom**	**Frequency or interval frame of reporting**
Includes		
• Indicators for assessing progress		
• Indicators for assessing impacts		
• Estimating methodologies		
• Measurement approach		
• Quality assurance/Quality control (QA/QC)		

Table4.7 Waste Management - Verification

III. Verifying
Verification step shall confirm about what has been measured and reported is complete, accurate and information provided is transparent

4.3. Back up services and technological innovation

There is an immediate need across all sectors to rethink about the waste management strategies through sustainability lens. Though materiality issues has been an integral part of sustainability and have already been brought into mainstream in sustainability agenda, however the requirement is which material issues are of priority and are addressed. Since zero waste concept has been embraced as a policy matter by policy makers, the incorporation of advanced and alternative technologies for waste management has emerged as a win-win proposition and a base for circular economy. A back up service option using technology where in the absence of required man power if waste is segregated at source properly then transport of waste and its further processing becomes easier and it's time saving as well as energy efficient. Some of the technological advances are as follows:

Microturbine Technology

Modern landfills with microturbines for generation of electricity from landfill gas are tried and tested and successful technology for waste management (He, R *etal*, 2007). This technology is used to supply electricity to the small scale nearby projects. This technology is helpful in resolving the issue of air pollution and greenhouse gasesemissions from landfills.

Landfill gas recovery technologies

The landfill gas emissions are greatly varied due to geological, hydrological and geotechnical properties which have environmental impacts. The biotic and abiotic factors lead to generation of gas at landfill which is the combination of CH_4 and CO_2known as biogas. Chemical oxidation produces abiotic gas in the presence of water and metals like Aluminum. Al produces leachate which further undergoes redox reaction to produce of hydrogen gas. Metallic aluminum hydration and bottom ash results in gas production. If mismanaged this gas can cause explosion of landfill or gradual leaking can cause global warming as both the gases (CH_4 and CO_2) are greenhouse gases (He, R *etal*, 2007). For example: The voluntary program landfill methane outreach program is developed to reduce greenhouse gases which are causing climate change. This organization aware the public, stakeholders and local communities about the benefits and technologies of landfill gas recovery, (Cheremisinoff N. 2003).

Bioreactor Technology

The latest technology to process disposed of waste rapidly is bioreactor technology. The basic aims of this technology are to enhance the rate of decomposition, circulation of leachate and increase in the growth of microbes, which decompose municipal waste. The waste is then dried by Conventional landfill technology (Guivarch C, Hallegatte S. 2013).

Refuse Derived Fuel (RDF)

The commercialization of waste using RDF has been utilized to make wastes useful. RDF generally refers to the processed MSW, which is basically the fraction of segregated high calorific waste. For the segregation of

the waste, it is classified in a mechanical and Mechanical Biological Treatment and then they are labeled as RDF. Solid recovered fuel is a new term which is becoming famous in Europe (Hernandez-Atonal, 2007). Municipal Solid Waste that reaches to the plant goes through several steps of treatments and processes. Firstly the waste is collected in the shredder that breaks waste bags, in order to reduce their sizes. Then this shredded material is moved to a digestion tower where this waste is preserved for (almost 6 to 8) days. The first four days, the waste is kept in temperature between 60 and 65°C, which is than increased to 70°C for another two days. Resultantly the organic part of the waste is stabilized, thus even the smallest traces of biological compounds are gone.

Removal of steel cans and magnetic things from the main stream is done through a magnetic separator. The waste is further separated into three different sizes that is smaller than 8mm, then between 8 to16 mm and lastly greater than 16 mm for further processing (Sarc and Lorber, 2013).

Web based GIS (Geographic Information System) Technology

Over the last few years the GIS technology has gained popularity in almost every field of life. Coupling the GIS technology along with waste collecting became popular over the past few years in developed countries. Through this municipalities can manage the entire waste cycle from production point to disposal areas, by optimizing and automating every step of cycle. This solution of coupling the waste collection and the Web- GIS oriented systems has become increasingly used over the last years in Italy. According to the Italian and European case studies the implementation of web based GIS technology optimized waste collection and source separation for recycling had become efficient up to 80% (Rada, *etal*, 2013).Another new advancement is The Internet of Things (IoT), which is a technology and market development based on connectivity between everyday objects and applications. IoT can be applied to improve the waste management efficiency.

Table 4.8ICT and Non ICT –Enabled Waste ManagementSnapshot[7]

	ICT enabled integrated waste management	Non-ICT enabled integrated waste management
Why	• Huge amount of unattended wastes resulting in environmental and health issues	• Improper waste management and open dumping at landfills leading to environmental issues and health hazards
	• Predominance of informal waste management sector approach	• Inadequate engagement and interaction between various service providers
	• Inadequate end to end technology that enables collection, segregation and disposal of wastes	• Unaffordable waste collection and segregation services leading to improper waste disposal
	• Lack of data to support policy decision making	

[7]**https://www.innovationpolicyplatform.org/system/files/4%20Integrated%20Waste%20Manangement_Apr6.pdf*ICT – Information and Communication Technology; Non-ICT – Non –Information and Communication Technology**

How	• Enterprises providing end to end services including collection, sorting, segregation, transportation and disposal	• Enterprises have designed and developed modern machinery to that collects, treats and collects the compressed treated wastes for efficient disposal
	• Application GPS enabled technology – in tracking waste collection and transportation, better waste management through GIS	• Providing end to end services
	• Leveraging ICT as a key technology approach for efficient service provider across value chain	
	• Smart analytics for better landfill management	

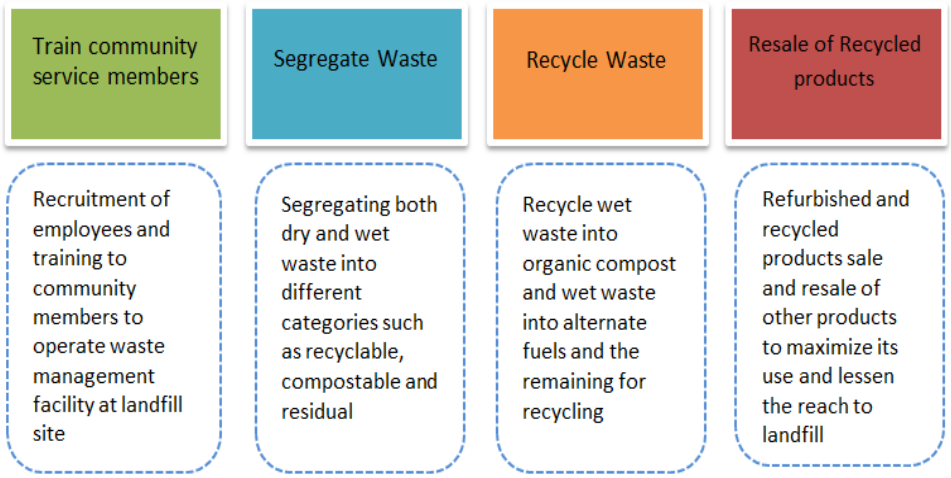


Fig 4.2 Waste management solutions to low income groups snapshot[8]

Multi-Compartment Bins

Recently, developed countries including Sweden are using multi compartment bins for source segregation of waste. These types of waste bins have separate compartments for different types of waste. Through this organic, paper waste and recyclables can be segregated on the spot of generation, while recyclable can be recycled or reused, as through this method contamination can be avoided (Metcalfe, *etal*, 2012).

Automatic Bottle Sorting System

[8]**BaliFokus website http://www.balifokus.asia/partners**

This technology is widely used in Japan in recent years. It is comprised on sizing, aligning and clearing machine, along with color identification sensors. The role of sizing machine is to divide the bottles according to the size, after this thebottles will sent to colour sensing machine and then conveyer belt. The bottles of each color are shredded and cullet is prepared. Through this volume of waste is reduced and cullet can be further used in different fields, (Christensen, 2011).

Biodegradable and Degradable Plastics

A new technology plastic which is able to degrade 90% of itself in 90 days has resolved many issues regarding plastic disposal and is being implemented in many countries. Biodegradable plastic can be introduced to composting or anaerobic digestion along with organic waste in order to give productive output. Many starch based plastics have been reported as biodegradable.

A degradable plastic does not contain stabilizing chemical to prevent degradation due to UV light and oxygen, as compare to traditional fossil based plastic. Degradable plastic have additives which help in slow and self-degradation due to the sunlight and oxygen. In this process the product slowly loses its shape and then disintegrates completely. This is known as physical disintegration.(Christensen, 2011).

Extended Producer Responsibility (EPR)

Extended Producer Responsibility (EPR) is a part of sustainable practice and a policy approach through which producers are given significant responsibility – financial / or physical for the treatment or disposal of post-consumer or used up products. It assigns responsibility in a way to incentivize waste prevention at source, promote product design for environment and support waste recycling and material management goals. It formalizes the waste sector by setting up financial cost standards and environmental standards. As regard to India, CPCB (The Central Pollution Control Board) has the authorization for EPR under the new e-wastes rules. EPR, which has been proven to effectively manage waste, is one of the most favouredprogrammes among manufacturers. It enables products stewardship so that manufacturers can be more responsible of their products' life cycle while empowering manufacturers to contribute more significantly towards environmental protection.

Case Studies

Chennai has a population of 7.1 million spread over a large land area. In 2011, the city expanded its boundary from 175 to 426 km^2, further stressing the already suboptimum levels solid waste management services. The city generates an estimated 4,840 tonnes of waste per day. MSW is deposited in bins across the city, which is then collected by workers daily. However, owing to various factors such as lack of manpower and planning, the city collects and disposes of only 60 %of the total waste generated. The waste collected from the bins is taken to 12 transfer stations spread across the city and from there to two main dumping grounds.

A GIS-based study was conducted to minimize routes from collection sites to transfer station and further to the dumpsites, considering that would in turn reduce costs, time, and wear and tear on vehicles. The study involved an area of about 35 km2, covering 13 waste collection routes and 1 transfer station. The waste generated in this area is 187.4 tonnes per day, and the related costs were INR 128/tonne, corresponding to 136,321 USD per year (8.76 million Indian Rupees/year).

The results showed that with the help of proper GIS planning, routes in the study area could decrease by over 18 km, leading to an operating cost savings of almost 10 per cent. In terms of time, these routes would lead to total savings of about 17 minutes or a 12 per cent decrease in time travelled. Overall, using the recommended routes would lead to a savings of 353,564 USD per year (22.72 million Indian Rupees/year). If such a system could be planned and adopted for the whole city, the cost savings would be considerable.

Source: Sanjeevi and Shahabudeen (2016)

Summary
Waste management practices differ with the type of waste, the. CAMS (collective alternative management systems), Competence Management System (CMS) as well as framework practices for a waste management hierarchy are explained. A series of management actions are required, which include mitigation, monitoring, and verification. The monitoring objectives can be risk based or compliance based. Key performance indicators (KPIs) help in this monitoring. Good practice guidelines and proper training are also very important for proper management and storage of waste and all the interconnected steps in waste management. Nationally Appropriate Mitigation Actions (NAMA) requires country specific MRVs (Measuring, Reporting and Verifying). The Business as usual (BAU) baseline is used to improve the waste management processes. Backup services, microturbine technology and Refuse driven fuels (RDF) are explained. Web-based GIS technology helps with better waste management. Modern equipment such as multi compartment bins automatic bottle sorting system, biodegradable plastics and EPR are some of the ways of addressing waste management as project management.

Self-Assessment– Questionnaire: Stakeholder engagement

Questionnaire - stakeholder engagement communication sheet	Yes	No
Municipality Level		
1. Does the municipal corporation of city have required database of solid waste for developing waste management plan?		
2. Does it have a long term plan of waste management in sync with the growing population?		
3. Does the municipal corporation quantify waste generation based on seasonal basis for effective infrastructure planning?		
4. Does the municipal corporation have a yearly waste budget for better implementation of waste management practices?		
5. Does the municipal corporation make the solid waste management report public?		
Industry Site visit		
Students are advised visit an industry sector – say for example energy and utility, textiles, pulp and paper etc and have to prepare good practice report of that particular industry waste management plan		
Students are advised to visit a business group or entity – small, medium and big		

Resident/citizen level		
6. Are the residents/citizens willing to segregate their waste and dispose it in bins with colour stickers each representing the particular waste type?		
7. Are the residents willing to attend a monthly awareness drive on waste management, if conducted with in the apartment/house/society/estate premises?		
8. Are the residents interested to avail the drop box facility or deposit your plastics bottles box facility, if provided? It will increase PET recycling and		

provide job opportunity to informal waste pickers.		
9. Is mandatory residential waste management cell or forum in residential societies required?		
10. Do residents practice any waste management practice in their society example: composting, waste water treated for horticulture/gardening? if yes mention		

Video Links

- Additional understanding link on practices and technological advancement in waste management- https://www.youtube.com/watch?v=XGqrNi3kTLc
- https://www.youtube.com/watch?v=P_a3GsrvgLU
- https://www.youtube.com/watch?v=bGD_TSwLPyM
- https://www.youtube.com/watch?v=SLs4cjJkrbY
- https://www.youtube.com/watch?v=MR9tlMEGV_s
- https://www.youtube.com/watch?v=SqSLlkPdMy8
- https://www.youtube.com/watch?v=qsfr_HNdHZo
- https://www.youtube.com/watch?v=iQqlGsLddB8

Chapter 5
Skill Development and Job Opportunities

Objectives

- To know the possible job opportunities available in waste management sector
- To understand how organizations need to address redundancy and its reasons
- To understand the role of startups in waste management, contracting and sub-contracting, out-sourcing and in-sourcing and demand management

Structure

5.1 Skill development and job opportunities
5.2. Opportunities in waste management sector and addressing redundancy
5.3. Contracting and sub-contracting, Out-sourcing and in-sourcing
5.4. Demand Management

To Do Activities

- Conduct practical exercise: Visit a few localities as consultants to communicate with residents, housing associations, other private bodies and find out their waste management issues. Counsel them as well as provide solutions to their problems based on their learning from this course.
- Visit a locality in teams of two or three. Discuss local waste management issues with the residents, communities, businesses etc. Find out the issues they are facing, or any issues that come to your notice. Counsel them as 'Trainee Consultants in Waste Management', giving them better alternatives.
- Hold a seminar on role of startups and SMEs. If possible invite a few entrepreneurs in this field to address the students. They will guide your students about the step-by-step process , the challenges and achievements in this field.
- After the exercise, counsel about their individual preferences. Explain career prospects for their field of interest. Use the chart depicting 'Job Opportunities in Waste Management' as a guide.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities**.**

5.1 Skill Development and Job Opportunities

Waste management and handling responsibility is not just an environmental and sustainability requirement but an infrastructure necessity and skill development becomes an integral part of the hierarchy. Ability to resolve waste issues needs skills and efficient workforce and technological interventions. With the quantum of waste generated, there is scope for developing secondary waste to value markets via recovery and recycling, thus creating job opportunities and enhancing career prospects in this sector.

There is a constant requirement for waste management practices to be devised with the aim to provide best value service, say for example: safe waste disposal in line with government regulations, packaging regulations and recycling targets. The best possible responsibilities that are required as a part of skill development include:

- Oversee waste management arrangements
- Supervise the transportation of waste to ensure that it takes place efficiently without contaminating air, land or water sources
- Ensuring compliance with legislation in waste handling and disposal of waste.
- Formulate and control budgets for waste disposal
- Monitor the quality and performance of waste services, including contract management of external providers
- Meeting waste reduction and recycling targets
- Investigate and follow up claims of the illegal dumping of waste and work with other waste regulation enforcement staff
- Consult with residents, community groups, housing associations and other associations about waste management issues, identify their requirements and provide appropriate solutions

Job opportunities and continuous professional development (CPD) if improved and encouraged, and training be provided in waste sector shall provide an integrated solution to managing wastes and developing future targets and goals. The development and training shall develop skill sets such as general management, technical skills, legislation, IT skills, finance and budget management.

Career prospects

- Careers in the field have become increasingly structured, often attracting graduates with environmental degrees and an interest in waste management. Progression through specialist postgraduate study in this area is an option.
- You can progress to become area manager or head of waste management, recycling centres supervisors and waste management supply chain specialists.
- You may find opportunities in waste management regulatory bodies and in relevant governmental departments.
- At operational level – can be involvedin the responsibility for budgets as well as the strategic management of resources and people.

5.2 Opportunities in Waste Management Sector and Addressing Redundancy

Skilled workforce and scope for green jobs have brought a transition in the way green economy is being perceived. This transition in green economy includes managing ever increasing wastes and our contribution to reduce GHG emissions, recover, reuse and recycle useful resources, diverting wastes away from landfills, opportunities for waste to value creation and opportunities to promote social inclusion and upgrade the quality of existing jobs in waste sector for both men and women. There is a need for developing solutions to bridge the gaps by recognizing and integrating the contributions made by workers in informal economy; this can lead to sustainable development and for it to work, jobs that depend on waste prevention, reuse, recycling and recovery need to be decent jobs and streamlined into formal job markets in waste sector.There are opportunities to create jobs across the waste hierarchy, varying in skill level starting from waste collection, sorting to recycling.

Criteria

- **Improving current jobs and livelihoods** – Developing solutions in bridging gaps in the waste market and formal induction of skilled workforce and bringing informal workers into mainstream through capacity building, training and skill development.
- **Unlocking new opportunities** – Identifying areas in circular economy for up scaling new job opportunity through focus on areas – product design and manufacture, waste reuse, refurbishment and remanufacturing and alternative waste management technologies.

Though with technological advancement, human effort has been reduced but for effective waste management, we need workers, operators, manufacturers, retailers, consumers and other stakeholders to be an integral part of supply chain for holistic solving of waste issues. With clear regulations and incentives to support responsible waste management and recycling businesses in different waste sector, there is tremendous scope for livelihood opportunities and up scaling of new waste market for small enterprises and business development.

Fig5.1 Global Trends in Waste Sector[9]

*** Image Source:**

The two "Ws" - "Where" and "Why" in waste management job sector:

[9] International Labour Organization: https://www.ilo.org/global/topics/green-jobs/events-training/WCMS_538802/lang--en/index.htm

Where

- Immediate opportunities for low-skilled job creation in the waste sector
- Open-spaces cleaning (e.g. clearing of illegal dumping sites, street cleaning and sweeping, litter picking)
- Waste collection - Collection and sorting of recyclables
- Low barriers to entry for job

Why

- Cleaner production
- Industrial efficiency
- Design for Environment
- Collection, dismantling, refurbishment, remanufacturing, reuse
- Waste to energy processing
- Landfill operation
- Professionalizing informal waste sectors;
- Recycling plastics into polyester yarns that can be resold for both consumer and industrial packaging;
- Collecting and treating municipal waste;
- Collecting and treating industrial waste; and
- Processing biomedical and other hazardous wastes.

Key Challenges and Opportunities

- Sorting through trash is the critical attributable challenge in waste management :
  - Segregating waste means optimizing its market potential.
  - Initiating shifts in waste producers' mentality towards separating waste and empowering those collecting it.
  - Translating sorting and separation into management practice leads to higher productivity and efficiency.
- The biggest challenge all stakeholders in waste management sector face is miserable segregation practices. The Solid Waste Management Rules, 2016 mandates that all waste must be segregated into three categories at source: wet, dry, and hazardous. However, these rules are poorly enforced. This is due to both informal and formal waste collectors often lacking the proper resources to segregate waste and training.

Job Opportunities in Waste Management

Fig 5.2. Job Opportunities in Waste Management

Role of startups and small and medium enterprises (SMEs)

Startups and small and medium enterprises along with companies and investors are getting involved in effective waste management solutions. They are aligning the waste management initiatives with the government initiatives as is the case with the ongoing Swatcha Bharat Abhiyan. They are helping in decentralizing waste handling and treatment while also steering a major shift in making understand the importance of segregating the waste at the source itself to speed up recovery, reuse and waste to energy conversion, limit the reach of wastes to landfills as much as possible.

Some of the accomplishments by startups in waste management:

- Initiating digitization of household garbage and recycling collection.
- Providing reliable garbage collection alternatives
- Bringing informal waste collectors to formal sector, utilizing and up scaling their existing network
- Refurbished e-wastes, reusing clothes and composts being sold down the value chain and to the bottom of economic ladder and underprivileged.
- Waste management advisory, waste audit services, recycling, circular economy application in waste to value creation.

Addressing Redundancy

With rapid advances in technology and increasing pressure on application of highly efficient and cost effective waste management practices, there is likely chance of reduced workforce or decrease in hiring personnel in waste sector or for that matter any sector. There will be inevitably roles or work that are no

longer required or need human workforce as automatic, digitized machinery does the work with quite few workforce, resulting in redundancy. The lesser the timeline to implement the change there will be fewer options left for the employees. Organization take cost saving and cost cutting options by not retaining talents and request to leave, resulting in redundancy being an expensive option too, if handled poorly. On the other side, there will loss of intellectual workforce and which in turn impact an employer brand if redundancy is not managed in a dignified way.Strategic hiring and providing requisite skills and training as per the requirement of waste management and recycling job shall keep a check on redundancy.

In Japan there is a term called “Mottainai”, which means regret when something good is wasted and preaches to respect resources. It expresses a feeling of regret at wasting the intrinsic value of a resource. It encompasses to apply the concept of 4 Rs’ reduce, reuse, recycle and respect and a newer R added as repair indicating circularity of resources.

Addressing labour redundancy includes:

- Freezing the hiring of new staff for additional work to be done.
- Not to fill the new vacancies
- Offer better opportunities or similar work opportunities
- Introduce private sector strategically in selected areas

5.3. Contracting and Sub Contracting, Out-Sourcing and In-sourcing

To increase the efficiency of waste management contracting and tendering along with sub-contracting is being undertaken. Municipal solid waste management (MSWM) service is often perceived as the responsibility of Municipality, but it is difficult to manage all waste management operations by themselves due to increased volume of waste, increasing population, low community participation to the municipality service provided, lack of technological know-how and competent staff, engagement of huge labour force however with less productivity as the waste management hierarchy starting from segregation consumes most of time making the collection, transportation, disposal, recovery, reuse and recycle practices less productive. Private sector with the objective of decentralizing waste management working in tandem with municipalities shall strengthen better implementation by providing better machinery, enhancing productivity by increasing skilled manpower.Private sector seems to be a viable option in enhancing the performance of public service life solid waste management.

Contracting benefits includes:

- More flexibility in management to hire qualified staff
- Pay according to their performance
- Terminate the employment of unsatisfactory workers
- Working hours according to service demand
- Access to technology and expertise
- Higher level of efficiency and accountability
- Focus on customer satisfaction
- Access to finances for new investments

Contracting provides the option for municipalities to focus more effectively on planning, management and monitoring, on the other hand private sector takes control of operations. The ultimate goal of contracting is

a cooperative effort for perceived benefits to citizens and other stakeholders at large. However some of the risks associated in private sector include very low pay to the workers in recycling, segregation and collection practices causing distress and labour problems. Lack of transparency is also another risk, as contracting is a collaborative effort between public, private sector and the municipality and needs constant management and monitoring and up scaling.

Contracting mechanism options available include:

1. **Service Contract:** Used for waste collection, transport, transfer and disposal facilities. Payment is done based on the quantity of waste, number of trips being undertaken for collecting, transporting and disposal of wastes. The facilities are owned by the municipal corporation but machinery and workforce is by private sector. Depending on the need demand, the service contract period is fixed.
2. **Management Contract:** The private organization takes over the management and operation of waste management along with its staff, facilities and machinery.
3. **DBO Contract(Design, Building and Operation)**: Here the contractor bears the responsibility from the inception stage i.e.; design, building and operation. This mechanism is more cost effective as payment is done as and when the work progresses. This results in higher implementation rate.
4. **Build Own and Transfer (BOT):**As per this contracting setup, BOT agreements are more effectively applied for waste treatment practices like composting and for disposal (landfill facilities). Here the private sector is responsible for construction, financing and operation of the facility during the contracting period and once the work is complete the facility and assets are transferred to public entity.
5. **Build, Own, Operate and Transfer (BOOT):** Here the contractor is expected to build the facility at his own cost and then operate the facility for long term as per the agreement with the municipality and then, on mutual basis either recover the costs for facility or transfer the assets to municipality.
6. **Build Operate and Own (BOO):** This type of contract mechanism is very much similar to the BOT setup except in this the private is not obliged to transfer the facilities are asset to the public entity. In this mechanism private sector is responsible for design, construction, operation, and services and financing of the investment.
7. **Concession Agreements:** In this type of contract the private operator manages the infrastructure facility, operates it at commercial risk and has to invest in creating new facility. It has fixed term and involves transferring the assets back to the municipality at the end of the term.
8. **Lease:** In this type,private company operates a service with assets owned by the public sector. It is suitable for the operation of waste treatment facilities such as composting plants or biogas plants.

Basically contracting is being aimed for –

- Door to door collection of waste as this service is not being provided by municipal authorities.
- Street sweeping
- Providing of large containers for secondary waste storage in various parts of the city.
- Construction, operation and maintenance of transfer stations

Sub-Contracting

Subcontracting creates employment improve service delivery. Sub-contracting is being given for refuse collection and waste disposal to entrepreneurs and enterprises. This type of mechanism allows ease to monitor and evaluate performance and devise waste management plan accordingly.

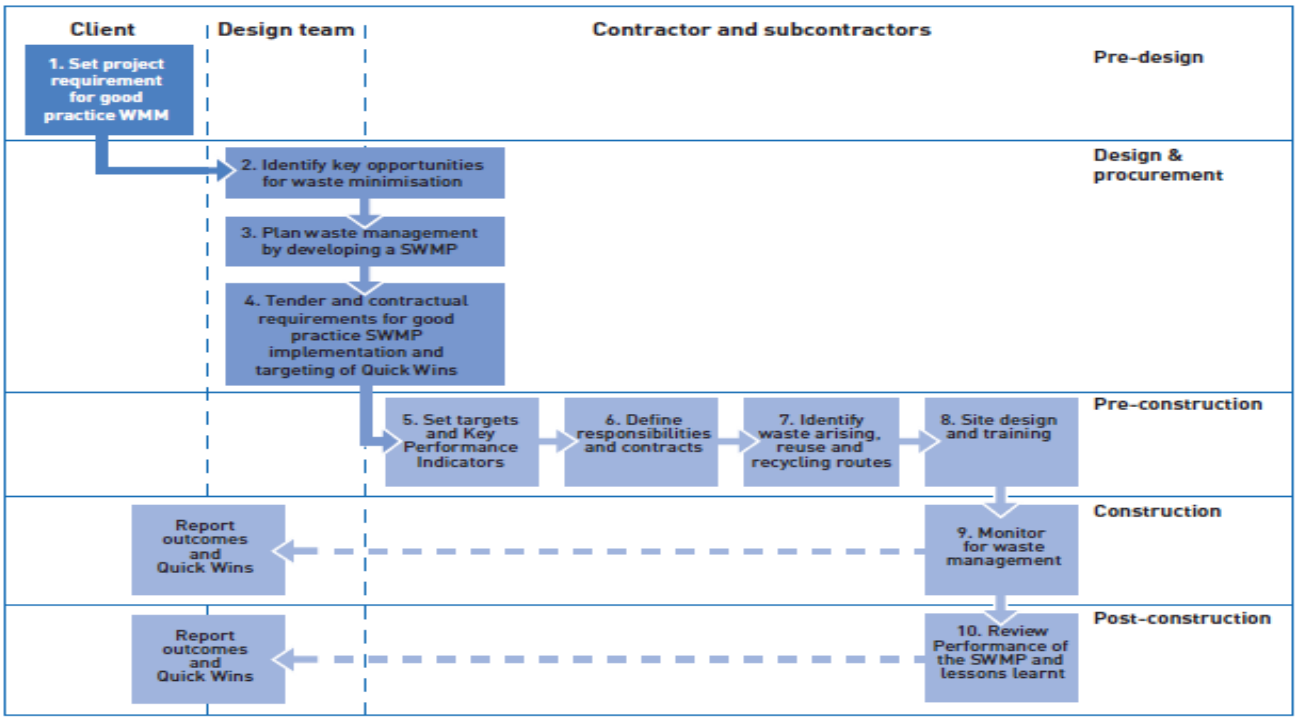


Fig 5.3 Delivering Good Practice Waste Minimization and Management[10]

Duty of care	Standard	Good	Best
Documentation showing compliance with legal requirements	■	■	■
Responsibility for waste management			
One person designated as overall waste champion	■	■	■
Responsibility for individual areas designated to individuals	■	■	■
Waste management contractors			
Dialogue to establish opportunities for recycling	■	■	■
Contractual agreements with high recycling levels; partnerships	■	■	■
Subcontractors			
Agreements with subcontractors on how to manage waste	■	■	■
Contractual agreements with set targets and regular reviews	■	■	■

Fig 5.4 Obligation duty on part of contractors and subcontractors[11]

[10] **http://www.wrap.org.uk/sites/files/wrap/Waste%20man%20technical1.pdf**

Contracting Types

Outsourcing is a common practice of contracting out waste management functions and processes to third party providers. The benefits of outsourcing can be substantial - from cost savings and efficiency gains to greater competitive advantage.

Insourcing isthe practice of using an organization's own personnel or other resources to accomplish a task of waste management

5.4. Demand Management

The need for sustainable practices to protect the environment has increasingly placed pressure on policy makers, specifically in the area of waste management. In recent years there has been a steady flow of legislation that focuses on reducing the environmental impact of waste in India be it with regard to Plastic Waste Management (Amendment) Rules, 2018, Solid waste management and handling rules, 2016, e-wastes management rules, 2016. Demand management is necessary for developing efficient processes, which reduces energy and resource usage.

[11] **http://www.wrap.org.uk/sites/files/wrap/Waste%20man%20technical1.pdf**

Case Studies

India: Social dialogue for green jobs promotion

In 2009, the Ministry of Labour and Employment, India established the first multi-stakeholder Task Force on Green Jobs and Climate Change to address employment and labour market dimensions of environment related policies and strategies. This process has been supported by the International Labour Organization, among others, through the identification and bridging of knowledge gaps. In India, the pursuit of an inclusive growth strategy for poverty reduction and the search for environmentally sustainable paths are key concerns in the country's development trajectory. With the Green Jobs Initiative, the ILO and its partner's seeked to address and build on the relation between these goals, by promoting economies and enterprises with a reduced environmental impact that generate meaningful employment and the regeneration of natural resources.

Source: International Labour Organization, *https://www.ilo.org/global/topics/green-jobs/projects/asia/WCMS_218887/lang--en/index.htm*

National Capacity Building Project under the Clean India Mission (Swacch Bharat Mission SBM) launched in 2015 is the only dedicated program by Ministry of Urban Development (MOUD) and Ministry of Environment, Forests and Climate Change (MOEF&CC) which is targeted at strengthening implementation of six WM rules in 70 Cities of India. The program aims to build awareness of diverse stakeholders like Urban Local Bodies, NGOs, industries, etc. about the applicability of rules, duties of different authorities and their mandates. Since the program is awareness oriented, the program curriculum is generic and does not build specialized or targeted technical skills of stakeholders working at different levels and domains in the waste sector.

Source: Clean India Mission, 2015

Germany has a National Vocational Education and Training (NVET) system in the area of Waste Management. Vocational training for environmental occupations is regulated by *'Verordnungüber die Berufsausbildung in den umwelttechnischenBerufen*' (Regulation on vocational training in environmental occupations). The regulation provides rules and overarching framework for specialization in a) water supply technology, b) wastewater technology, c) recycling and waste management and d) for pipe, sewer and industrial services. The recycling and waste management specialist course offers three options: a) Waste disposal and treatment, b) waste recycling and treatment, c) Logistics, collection and sales. Germany has a dual training system; therefore, these pieces of training combine vocational education at a vocational school and apprenticeship at an industry or company. The certificate is issued to candidates who complete the three-year training and pass the exams which include both written tests and hands-related tasks on WM processes. This three-year training forms the basis for state-approved environmental technology experts. The training prepares the candidate for technician level jobs (independent planning, implementation and monitoring in the context of the intended occupation).

Source: https://yourstory.com/mystory/2d5025530b-lessons-on-capacity-bu

Creation of green jobs in Fiji's waste management sector

A pilot collaboration programme between the ILO, JICA (Japan International Cooperation Agency), waste collectors and townspeople in the western towns of Nadi and Lautoka in Fiji, was undertaken in 2010 and 2011 to establish safer and greener waste collection systems.

A participatory, action-oriented training approach was followed to promote the use of greener techniques with occupational safety and health (OSH) standards amongst waste collectors and their managers. This training approach concluded in the elaboration of the WARM (Work Adjustment for Recycling and Managing Waste) training manual. A manual that aims to improve the safety, health and efficiency of waste collection workers. It uses many illustrations of good examples that waste collectors and managers can put to immediate use and it promotes practical collaborative actions between waster collectors and the community for establishing safety and efficient waste collection systems in Fiji and other countries. The new WARM approach has been widely adopted since by the town councils.

Source: ILO-JICA agreement to improve Pacific Islands waste management; https://www.ilo.org/global/topics/green-jobs/projects/asia/WCMS_218889/lang--en/index.html

5.5. Questionnaire survey and Worksheets

Table 5.1 Education, Green Jobs and Training

Questionnaire	Agree	Strongly Agree	Disagree	Strongly disagree
Education system in my country is generally well-prepared to provide education for the green economy				
Training system of education needs to be improved in order to meet the requirements of the labour market for green jobs				
The demand for green jobs in my country is higher than the supply of trained professionals				
Training for the green economy should be primarily the responsibility of the employer				
Training for the green economy should be primarily the responsibility of the employers and the government working in close collaboration				

Table 5.2 Green skills, Training, Sustainability and Waste Management

Questionnaire	Organization 1	Organization 2	Organization 3	Organization 4	Organization 5
What is unique about the organization? How is it becoming 'green' and sustainable?					
Is it investing in training of its employees on green skill development or sustainability?					
What is the intensity of training (days/employee) etc.?					
Does the organization has induction programme on sustainability & waste management after employee joins the organization?					

Summary

After going through this unit, you must be able to understand:

- To identify specific areas of skill development within waste management as a project management.
- To understand how companies seek staff to manage waste streams by in-sourcing, or sometimes outsource their work
- To contracting, sub-contracting of various components of waste management and how thee feed into one another to achieve a circular economy.

Further Reading

- Methodologies for assessing green jobs:https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_176462.pdf
- Role of public sector in waste management- https://www.coursera.org/lecture/solid-waste-management/2-2-the-role-of-the-public-sector-4MoU1
- Role of private sector in waste management - https://www.coursera.org/lecture/solid-waste-management/2-3-the-role-of-the-private-sector-z7xNy
- Integrating the informal sector in waste management- https://www.coursera.org/lecture/solid-waste-management/2-4-integrating-the-informal-sector-usCL4
- Role of community workers in waste management -https://www.coursera.org/lecture/solid-waste-management/2-5-the-role-of-community-members-pt4pt

Video Links

- Industrial waste and Recycling: https://www.youtube.com/watch?v=xppOc3hDMNs
- TED X talk by Adrew Dent, Material innovator: To eliminate waste, we need to rediscover thrift- https://www.ted.com/talks/andrew_dent_to_eliminate_waste_we_need_to_rediscover_thrift

Chapter6
Project Management of Waste

Objectives

- To learn project management of waste with focus on waste management plan costing and affordability and market requirements
- To know details on analytical/statistical framework approach for waste management – PERT, CPM, SWOT analysis and Gantt Chart
- To understand application of GPS and GIS for managing and mapping waste management is also dealt in this chapter

Structure

6.1 Waste Management Plan – Costing/Affordability, market requirement
6.2 PERT (Program Evaluation and Review Technique), CPM (Critical Path Method)
6.3 Application of GIS in Solid Waste Management
6.4 GPS and GIS based approach of managing wastes

To Do Activities

- Facilitate the discussion with an open discussion about Google maps. Ask them what they understand about GIS. How does the app 'Google Maps' track you down as you travel or visit places.
- Introduce the concept of GIS using the workflow concept chart for GPS and GIS. If students have no prior knowledge of GIS and GPS, invite a subject expert to interact with the students.
- After this basic class, ask students how they can use GIS and GPS for waste management. Add to their suggestions, correct them where required and bring together a list of ways in which GIS / GPRS can be used as a tool for modern day waste management. Allow the students minds to cover all the topics they have learnt in different courses, or encourage them to look through the list of their favourite topics from every course to arrive at a conclusion regarding the applicability of GIS in their field of interest.
- Discuss what topics each student is interested in, scope out possibilities of career development, research or internship opportunities**.**

6.1. Waste Management Plan - Costing/Affordability, Market Requirement

For any given project management for wastes, the main aim of project is commitment to implement hierarchy of waste management with focus on waste prevention, reuse, recycling, recovery and elimination. The residual waste must be discarded as per the legislative and regulatory framework of the country.Waste management as project management must have the goal of being "SMART" – Specific, Measurable, Achievable, Relevant and Timely. From the conventional mode of project waste management, a new concept of lean project waste management is being look as the way towards increasing efficiency, reducing

costs, adding value and increased product quality and its recovery and reuse. From the cradle to grave approach, the project management has now turned to become cradle to cradle approach. Lean project management is to maximize value while minimizing waste.TaiichiOhno, of Toyota Motor Corporation is considered as one of the founding fathers of lean manufacturing.

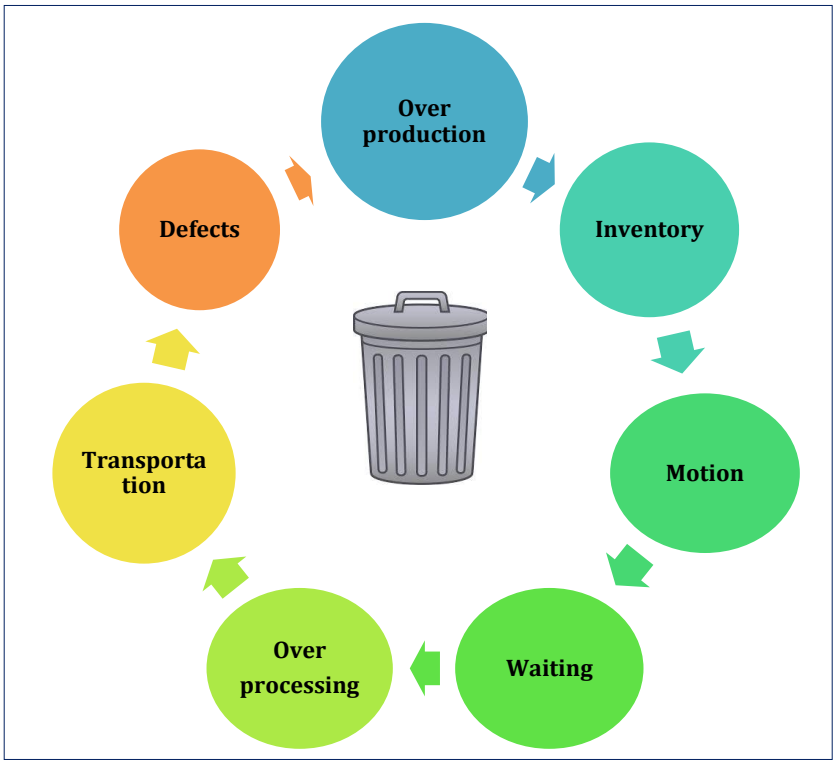


Fig 6.1 Lean Wastes

The concept of lean project management is applied to

- Reduced lead times
- Lower inventories
- Decreased costs
- Improved productivity
- Higher profit margins
- Increased product quality

There are 3 concepts of wastes as per the Japanese way of waste management.

1. Mudra
2. Muri
3. Muda

Muda refers to activities that consume resources. Muri refers to practices that involve over processing and over working or over using of machinery beyond capacity which results in decreasing efficiency and productivity. And Muda refers to operational "unevenness"

Project Methodologies

With the principles of Lean thinking, one can look at how three of the main lean methodologies—the Deming Cycle, Six Sigma, and Kanban can be applied to approach project management for eliminating wastes and value creation.

Costing and Affordability

Waste management service providers / municipalities incur a majority of their cost in salaries of employees and contract workers. Municipalities in partnership with waste picker organizations for collection incur additional labor costs in sourcing waste. They also incur material cost and transportation cost for sourced waste. Other cost factors include cost of recycling machinery.The financial viability and sustainability of project waste management depends on the efficiency of wastecollection fees, increased sale of recycled and refurbished stuffs across the value chain, and diversifying the revenue streams and financing mechanisms. Leveraging with processors and recyclers to assess and adopt options to optimize the resource recovery process across the value chain increases product life cycle and also is cost saving option. For example, India-based Ecoreco has developed its own technology that combines high-tech automation and manual processing methods to sort, dismantle and shred e-waste. This result in precious metal recovery including copper, aluminum, silver, and gold from complicated e-waste[12]. Also to maintain financial viability choice of in-house and outsourced activities, and obtaining finances from different sources is done, along with public private partnership (PPP) for waste management.

[12]Ecoreco: http://ecoreco.com/services-weee-recycling.aspx; WEEE 2020 Raw Material Partnership

Fig 6.2Costing and Affordability in Project Waste Management

Table 6.1 Estimated Solid Waste Management Cost 2010 and 2050[13]

Estimated Solid Waste Management Costs 2010 and 2025

Country Income Group	2010 Cost[6]	2025 Cost
Low Income Countries[7]	$1.5 billion	$7.7 billion
Lower Middle Income Countries[8]	$20.1 billion	$84.1 billion
Upper Middle Income Countries[9]	$24.5 billion	$63.5 billion
High Income Countries[10]	$159.3 billion	$220.2 billion
Total Global Cost (US$)	**$205.4 billion**	**$375 billion**

When planning waste management advances, municipalities need to think of investment costs immediately and source the financing. If advances are small, the costs will be reasonable and rather easy to estimate, including equipment that the municipality itself is familiar with such as compactor trucks, containers needed for collection or equipment needed for the day-to-day operation of the landfill. When a more significant change is planned, such as introduction of transfer station, reshaping the disposal site and introducing new modern disposal practices, leachate treatment, collection of gas and treatment technologies, careful planning is needed and expertise needs to be brought in as municipalities may not be familiar with the new investments.

Costing Structure in Project Preparation Stage

Table 6.2 Costing Structure

Costing category	Concepts / notes
Feasibility and technical design	Investment cost in detailed technical designing
Permission and clearance (EIA and other statutory requirement	On procedures and compliance.
Market Research	Necessary as an integral part of feasibility study
Setting up the Financing Scheme	Financing options
Contracting and sub-contracting	When investments are delivered by third part other

[13] Sprung (2012) World Bank, https://www.businessinsider.com/waste-management-costs-2012-7?IR=T , This is how much it will cost to get rid of trash in the future

	than municipality
Stakeholder engagement and citizen participation and satisfaction	It's a long process, starts early at planning stage and moves ahead with design and implementation. Here communities need to embrace the concept implemented and participate for developing and improvising future trajectories in waste management

Table 6.3 Operation Cost Structure in Project Waste Management

Operational Stage	Description
Direct Costs	
• Labour • Fuel • Energy and Utilities • Maintenance and Repairs • Replacement costs • Disposal of Rejects • Feedstock Costs • Consumables	Labour costs include normal salaries and wages, bonuses, overtime costs, allowances, fringe benefits and social contributions, etc. Some technologies may have the need for highly specialized personnel; various technologies can include phases/departments that can be either labour intensive or fully mechanized, depending on local factors. Typical labour requirements may include heavy equipment operators, maintenance personnel, instrumentation/ computer operators, administrative support and management.
Hidden costs	
• Overheads • Promotion and awareness training • Taxes • Capacity building	Overhead costs and recurring hidden costs are part of operation and often left unaccounted. This list shows the cost categories and budget lines that belong to operation costs but sometimes get lost in other municipal budget lines.
Costs involving client assistance in municipality for waste management	
• Contracting out services to • operators • Monitoring of service • performance • Administering fines • Controlling and managing • revenue collection	The municipality as the authority responsible for waste management needs to ensure a good quality service to the citizens, keeping the city clean and protecting public health and the environment either through PPP, contracting /outsourcing the waste management work.

Methodologies for establishing project waste management costing are usually set at national or municipal and based on a set of principles. The principles usually used to design methodologies include:

- Cost recovery
- Affordability
- Equity and fairness
- Polluter pays
- Behaviour change

6.2. PERT (Program Evaluation and Review Technique), CPM (Critical Path Method)

Project waste management is a complex activity and needs problem areas to be identified and objective decisions to be made in coordination with workforce, machinery and other resources for an effective

outcome. Project management aims to address all the specifications and achieve quality standards.The techniques used in project management are Gantt Chart, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), SWOT and Gantt chart.

Program Evaluation and Review Technique (PERT) is a method used to plan and control projects. It allows having close review of information before making decision. It includes periodical updating of information as and when the project progresses. Four basic steps in applying PERT to a project include:

- A project diagram called network
- Time estimates
- Network analysis
- Review and addressing critical issues at priority on schedule

Critical path method (CPM) has been used for planning and scheduling in project management. CPM provides an easy method for evaluating the effects of technical and procedural changes that occur on the overall project schedule. CPM enables the most economical planning of all operations to meet desirable project completion dates.CPM and PERT are older techniques, however we still lack a project scheduling system with calibrated and validated distributions and without requiring complex user input. Modern decision support systems (DSS) for project management are more sophisticated and comprehensive than PERT/CPM. However in terms of stochastic analysis, they show insufficient progress. PERT offers a radically different stochastic analysis for projects, based on relevant and validated theory.

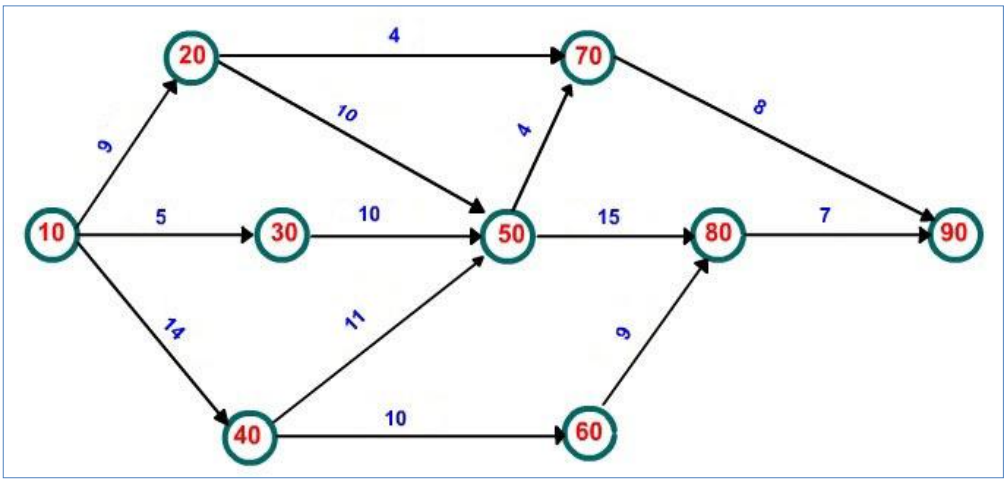


Fig6.4PERT Schematic Overview

The objective of the PERT calculations is to estimate an elapsed duration from start to end of an activity or project and establish the probability of achieving that end date. To achieve this three durations are estimated for each activity in the network; they are:

- **Optimistic** – the least time needed for the work
- **Most Likely** – the expected time needed for the work
- **Pessimistic** – the maximum time needed for the work

Analysis: SWOT

SWOT analysis is a strategic planning tool that can be used by Waste Management, to do a situational analysis. It is a useful technique to map out the Strengths (S), Weakness (W), Opportunities (O) & Threats (T) in Waste Management project. SWOT is performed based on analyzing information obtained from field observations, reports, literature, and questionnaire distribution among community and a series of focus interviews with major stakeholders concerned. According to the overall results of SWOT analysis process, established location of the solid waste management centre, regular waste collection, establishment of waste purchasing and recycling centers, conducting strong awareness and training programmes on promoting municipal solid waste management (MSWM), waste taxation and availability of finance could be found by ways of strengths while identifying weaknesses could be through analyzing low management of waste dumping, inefficient food waste sorting, shortcomings in compost manufacturing process, lack of recycling option.

Table 6.4SWOT Analysis[14]

[14]Source: SWOT analysis on Hellenic LAs adopting state-of-the-art SWM schemes.http://www.hia21.eu/dwnld/20131229_Developing%20a%20holistic%20strategy%20for%20integrated%20waste%20management%20within.pdf

SWOT ANALYSIS

STRENGTHS	WEAKNESSES
Direct day-to-day contact with waste producers Charging leverage over municipal waste producers Status of authority Monitoring efficiency Awareness raising potential Increasing procurement capacities Availability over a range of vehicles and indirect influence of other fleets as well	Political influence at local level Priority conflict at local level Capacity gaps and shortfalls Urban LAs not caring about disposal sites they do not operate, but just mainly about collection Implementation of imposed policies (with enough tangible effects) Partial or no understanding of real own emissions and external costs
OPPORTUNITIES	**THREATS**
Funding schemes (national, EU, private sector) Outreach potential (sleeping giant) to civilians and hosted businesses Public Private Partnerships Clustering/grouping PAYT "mix" CAMS	Business as usual mentality Fines for non-compliance on waste and contaminated site management. PAYT failure leading to increased littering Urban: High cost of transfer Rural: High cost of disposal Improper recycling behavior Improper grey recycling Acidification Global Warming Fires Strikes Vandals Disinterested citizens

Gantt chart

A Gantt chart is a type of plot bar chart that can be used to show a project schedule with start and finish dates and key milestones during the project. They have become a common technique for representing the phases, activities and individual tasks of a project, so that they can be understood by a wide network of people.

Table 6.5 Example of Gantt chart – Waste Management Campaign and Event[15]

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Activity	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Research																		
Baseline monitoring																		
Operational performance (tonnage collections etc)																		
Participation monitoring																		
Contamination monitoring																		
Desk research																		
Market research (incl procuring an agency)																		
Strategic planning																		
Initial tactical planning																		
Draft plan for internal comment/review			x															
Final plan submitted to committee for budget approval				x														
Management approval				x														
Procurement procedure (for external contractors eg marketing or advertising agencies, canvassers)																		
Detailed tactical/delivery planning																		
Develop core campaign collateral (information and promotional materials)																		
Event planning and delivery																		
Launch (start campaign activity)																		
Plastic bottle collection campaign																		
New collections start										x								
Design and produce 'teaser' leaflet																		
Decide on distribution method. Procure delivery agent if required																		
Distribute teaser leaflet																		
Design new calendar and revised recycling scheme information leaflet																		
Obtain all round and collection information for calendars																		
Print																		
Deliver to households										x								
Evaluate success of campaign																		
Advertising																		
Secure airtime on local radio station																		
Produce adverts (with local radio station)																		
Broadcast adverts																		
Roadshows and community events																		
Identify suitable locations/venues for roadshows and/ or events																		
Book/arrange space and liaise with site owners re event planning																		
Decide on event format/activities																		
Prepare promotional materials																		
Location recce																		
Final planning																		
Deliver event/s									TBC	TBC	TBC	TBC						
Evaluate success of campaign																		

[15]**Sample data Source**:http://www.wasteauthority.wa.gov.au/programs/communication-guidelines/3-tool0-=-techniques/15-planning-gantt-charts/

6.3 Application of GIS in Solid waste Management

Mapping of Resources

Global Positioning System (GPS): A satellite system that projects information to GPS receivers on the ground, enabling users to determine geographic coordinates of a location in terms latitude and longitude, and elevation of the location.

Example: A waste sector personnel/environmental specialist may use a handheld GPS receiver to determine the latitude and longitude coordinates of a location/dump yard/landfill/collection sites.

Geographical Information System (GIS): Software program that enable users to store and manipulate large amounts raster and vector data from obtained from satellites, field works, GPS and other sources.

Example: Following a fire at landfill site, maps can be obtained from a GIS system that can reveal details of the site that should be protected during response and recovery phases and to stop further damage.

GPS Data Gathering

Depending on the make and model of the unit of GPS device, the number of satellites available, and the quality of (unobstructed) signals, GPS receivers can collect information such as latitude and longitude coordinates (time-in-place or point location), "Real Time" position andelevation.

With GIS software, information from a GPS unit may be combined with data such as

- SOI topographical maps
- USGS topographical maps
- Digital elevation models
- Critical infrastructure maps
- Aerial photography
- Satellite images
- Census maps

Geographical Information system is a tool to generate spatial data layers generate a new output layer by applying spatial analysis techniques. The resulting output map/layer may be agriculture, forest, soils, waterbodies road network, and water potential zones. GIS information and maps have a variety of applications in land use and land cover, forestry sector, agriculture sector, transport and infrastructure, military and surveillance, defense sector, health and water sectoretc. including the potential to assist preparedness, response, recovery, and mitigation efforts in disaster management.

6.4 GPS and GIS Based Approach of Managing Wastes

In every waste management plan and project, collection of waste is very crucial. Container or waste bins are most pertinent way of collecting waste. However most of the collection systems are associated with problems like overflow of waste containers, illegal dumping or indiscriminate duping at unauthorized places. The spatial dispersal of these problem activities presents potential contamination challenges to water resources. Spatial information on waste collection and dump sites is essential for waste management decision making, collection route planning and cleaning up the dump sites. Integration of Global Positioning System (GPS) and geographic

information systems (GIS) present a unique platform to capture, map and analyze spatial waste management issues. The objective of having GPS and GIS based waste management is to develop a strategy for inclusive waste management system and if done properly, shall assist in building capacities of key players who are engaged in various processes related to waste management. Also help in establishing integrated resource recovery centres which in turn shall strengthen recycling both organic as well as inorganic.

By applying GPS and GIS approach muncipal authorities are able to

- Location of suitable water dumping yeards,
- Track, monitor, plan and manage waste collection vehicles
- Planning trips
- Route planning for improving collection efficiency
- Clean up timing of bins
- Monitoring of waste operators
- Status through RFID reader and tags
- Active and inactive vehicles
- A forum with citizen complain page
- MIS

The benefits of such applications are:

- Real time information about collection
- Better utilization of resources and manpower
- Cleaner and better managed city.

Advantages of GPS are:

- GPS is used to identify or define the geographical co-ordinates associated with satellite imagery.
- GPS reduces distortions and improves the positional accuracy by providing coordinates.
- GPS can be used in the ground truthing of satellite images.

Geographical information system (GIS)

GIS is mainly an information system that deals with spatial data. As almost all municipal and land use and land cover data has spatial relevance. GIS provides input, co-ordinates registration, management, query, analysis, modeling, map composition and production of cartographic and maps. GIS does not hold maps or pictures – it holds a database. The database concept is central to GIS. The advantage of GIS is in data handling and inferring. The integrated framework of Remote sensing techniques and GIS framework greatly reduces time, effort and expenses in using geographical data. Global positioning

The GIS data used are classified as:

- Topographical data
- Thematic data
- Collateral data

The topographical and thematic data are classified as spatial data and the collateral data as attribute data.

Topographic Maps Generation

Raw geographical data are obtainable in different analogue and digital formats such as toposheets, aerial photographs, satellite imageries and tables. The information of city like slope, elevation, settlements, drainage networks, water bodies and other land use class types is required. Both spatial and non-spatial information are brought together.

- The maps containing the spatial information.
- The information was about the location of waste bins
- .The third is the attribute information. The attribute data gives the information about the spatial elements.
- The other information source was through interview, questionnaires and online source.

For example: the location of solid waste bins for an area symbol are created in the ArcGIS 9.0 and tracked (by walk and vehicle). It locates the different features (Settlement, dust bin locations). The GPS measured geographical co-ordinates are used as input data withthe number of settlements. Using the co-ordinates and the settlement data maps are created. The images are converted into raster forms and then the image is projected using geographic latitude and longitude over raster level, new layer is digitized with special points. The entire layer is saved as shape file. Thematic map are generated by classifying waste generation.

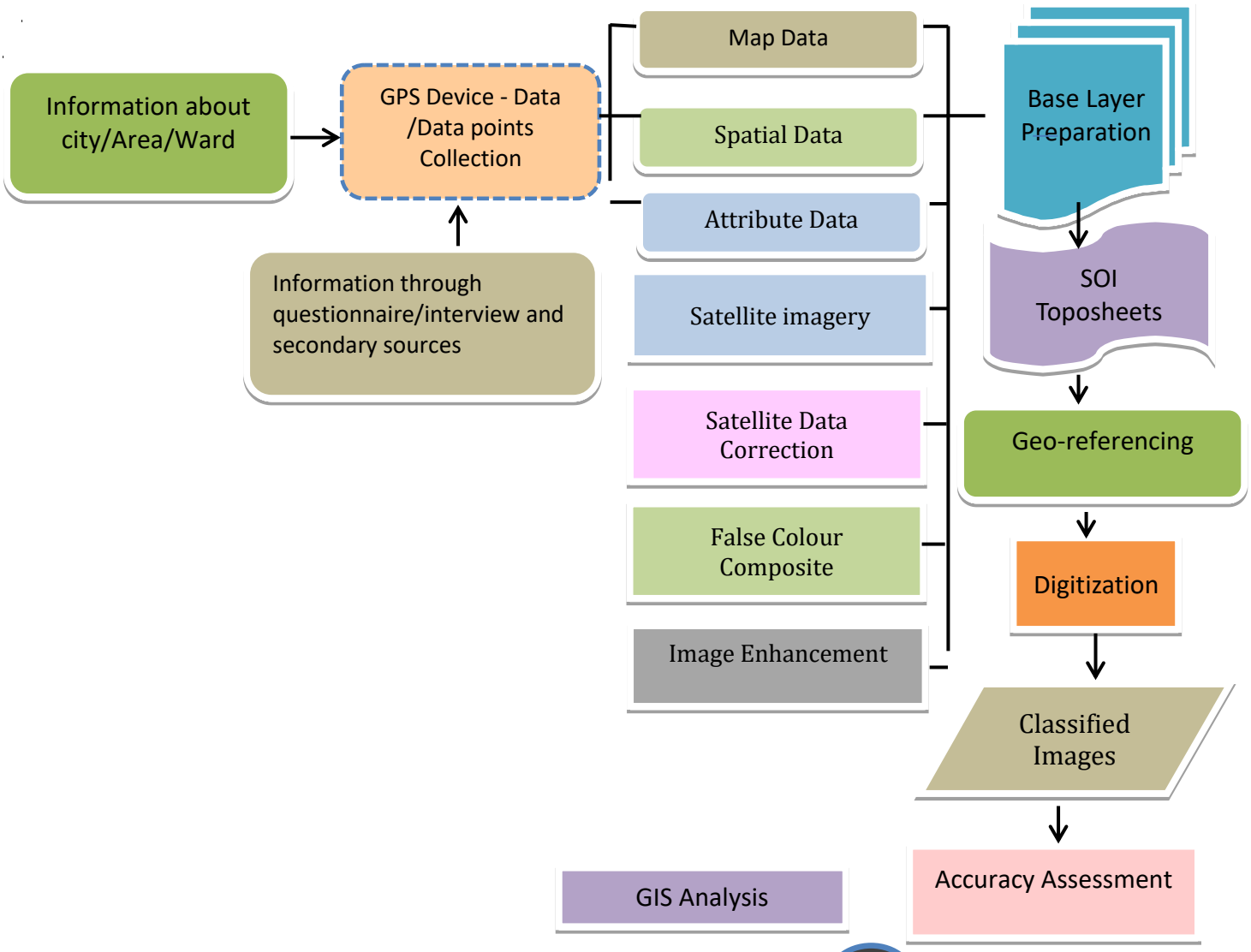


Fig 6.3Work Flow Concept of GPS and GIS

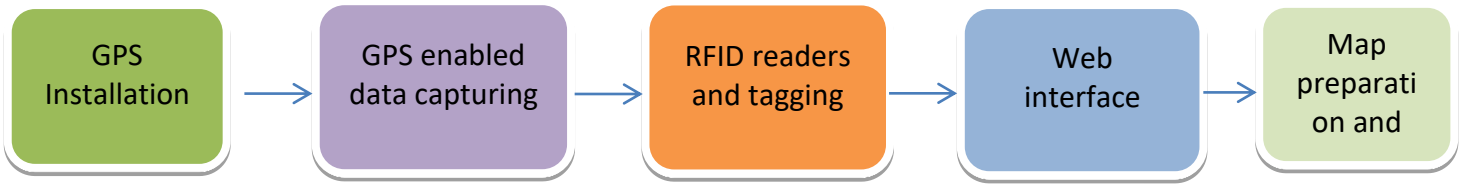


Fig 6.4 Smart Waste Bin Sensors

GPS Installation

All the vehicles and machines involved in waste collection process are fitted with high quality GPS devices. These vehicles are then assigned the wards and routes they are supposed to serve

GIS Data Capturing

Capturing bin locations and routing data with the help of handheld GPS devices. This data is displayed on the maps.

RFID Reader installations and Bin Tagging

All the waste collecting vehicles are fitted with RFID readers (Radio Frequency Identification Readers), also the bins are tagged with RFID tags and their geo-location in different ward is added into the System. Through this type of smart senor based system, with the help of GPS, RFID readers and RFID tags remote monitoring of whole waste collection process is done.

Web Interface

A highly scalable and secure application monitors all the stages of waste management, starting from collection to disposal. The smart waste bin sensor transmits data it collects in real time through wireless networks. Route optimization and predictive analytics to generate the best routes and estimate the time of containers becomes full is being applied. These tools eliminate hours spent on manual routing, maximize productivity, optimize equipment and staff allocations, and allows to gain better control over waste management operations.

After going through this unit, you must be able to understand:

- Market requirements for Waste Management.
- How to carry out a CBA to decide whether or not a project is profitable.
- Analytical techniques Gantt chart, SWOT analysis, PERT and Critical Path Method.
- How to map resources using GIS technology, GPS Data gathering as well as a GIS based waste management method, with the help of cloud computing and Internet of Tings (IoT)

Self Assessment Questions

1. Describe waste reuse programs which your Corporation /government/PPP/NGOoperate or plan to operate?
2. Describe waste recycling operation conducted by Corporation /government/PPP/NGO. In your place?

Further Readings

3. GIS applications in selection of solid waste disposal sites
   https://www.powershow.com/viewfl/8c497-ZDc1Z/GIS_APPLICATIONS_IN_SELECTION_OF_SOLID_WASTE_DISPOSAL_SITES_powerpoint_ppt_presentation

4. GPS Tracking Case Study: Lexington Waste Disposal Management
   https://www.youtube.com/watch?v=h52q8D4iW6Y

Video Links

1. Waste Management and Recycling Technology of Japan - Toward a Sustainable Society
   https://www.youtube.com/watch?v=kwTl2wy4UcM
2. Financial mechanism
   Municipal solid waste management in developing countries
   https://www.coursera.org/lecture/solid-waste-management/2-7-financing-mechanisms-part-1-8XXDX
   https://www.coursera.org/lecture/solid-waste-management/2-8-financing-mechanisms-part-2-NyowN
3. Smart Cities : https://india.smartcitiescouncil.com/article/kota-maps-its-waste-route-gis-and-gps
4. https://brage.bibsys.no/xmlui/bitstream/handle/11250/2507019/Zenebe%20Hailu%20Taye%20-%20MPSVDEV%20-%20v%C3%A5r%202018.pdf?sequence=1&isAllowed=y

References

1. Baud, I., Grafakos, S., Hordijk, M., Post J., 2001. Quality of Life and Alliances in Solid Waste Management: Contributions to Urban Sustainable Development Cities 18 (1), 3–12.
2. C.P. Balde, R. Kuehr, K. Blumenthal, S. Fondeur Gill, M. Kern, P. Micheli, E. Magpantay, J. Huisman (2015), *E-waste statistics: Guidelines on classifications, reporting and indicators*. United Nations University, IAS - SCYCLE, Bonn, Germany.
3. Cheremisinoff N. Handbook of solid waste management and waste minimization technologies. Amsterdam: Butterworth-Heinemann, 2003, 98.
4. Christensen T. Solid waste technology & management, Chichester, West Sussex, U.K.: Wiley, 2011, 108.
5. CPCB (Central pollution Control Board). 2000. Management of municipal solid waste in Delhi. http://www.cpcb.nic.in/divisionsofheadoffice/pcp/MSW_Report.pdf
6. D. Hoornweg, P. Bhada-Tata (2012), *What a Waste: A Global Review of Solid Waste Management*. The World Bank, Urban Development & Local Government Unit, Washington, USA.
7. Delivering good practice waste minimization and management http://www.wrap.org.uk/sites/files/wrap/Waste%20man%20technical1.pdf
8. Ecoreco: http://ecoreco.com/services-weee-recycling.aspx; WEEE 2020 Raw Material Partnership
9. Ellen MacArthur Foundation : Circular Economy https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Circular-economy-in-India_5-Dec_2016.pdf
10. Ellen MacArthur Foundation https://www.ellenmacarthurfoundation.org/publications/india
11. Fairbridge R. Book Review: KanarischeInseln: Lanzarote, Fuerteventura, Gran Canaria, Tenerife, Gomera, La Palma, Hierro (second edition). The Holocene 1998; 8(3):370-372.
12. Frost & Sullivan: Outlook of Indian Waste Management and Recycling Market, 2017
13. Guivarch C, Hallegatte S. 2C or not 2C?. Global Environmental Change 2013; 23(1):179-192.
14. Hamsalyer , Observer Research Foundation,; Case Study of Mumbai ; Decentralized Solid Waste Management Procedia Environmental Sciences 35 (2016) 101 – 109
15. He R, Liu X, Zhang Z, Shen D. Characteristics of the bioreactor landfill system using an anaerobic–aerobic process for nitrogen removal. Bioresource Technology 2007; 98(13):2526-2532.
16. Hernandez-Atonal F, Ryu C, Sharifi V, Swithenbank J. Combustion of refuse-derived fuel in a fluidised bed. Chemical Engineering Science 2007; 62(1-2):627-635.

http://www.frost.com/sublib/display-report.do?id=P940-01-00-00-00&bdata=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS9AfkBCYWNrQH5AMTUzODEzMDA2MDIxNw%3D%3D

17. How technology can help informal waste pickers solve India's recycling problem https://nextbillion.net/from-trash-to-resource-how-technology-can-help-informal-waste-pickers-solve-indias-recycling-problem/
18. Inclusive Innovations, Editors are Elaine Tinsley and Natalia, Researched and developed by Intellecaphttps://www.innovationpolicyplatform.org/system/files/4%20Integrated%20Waste%20Management_Apr6.pdf
19. International Labour Organization (2012), *working towards sustainable development: opportunities for decent work and social inclusion in a green economy*. International Labour Office, Geneva, Switzerland.
20. Metcalfe A, Riley M, Barr S, Tudor T, Robinson G, Guilbert S. Food waste bins: bridging infrastructures and practices. The Sociological Review 2012; 60:135-155.
21. Rada E, Ragazzi M, Fedrizzi P. Web-GIS oriented systems viability for municipal solid waste selective collection optimization in developed and transient economies. Waste Management. 2013; 33(4):785-792.

22. Salhofer, S., Isaac, N., 1999. Importance of public relations in recycling strategies: principles and case studies. Environmental Management 30 (1), 68–76.
23. Sarc R, Lorber K. Production, quality and quality assurance of Refuse Derived Fuels (RDFs). Waste Management 2013; 33(9):1825-1834.
24. United Nations Environment Programme (2015), *Global Waste Management Outlook*. UNEP-IETC, Nairobi, Kenya.
25. United Nations, Department of Economic and Social Affairs, Population Division (2013). World Population Prospects: The 2012 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.227. p.15, 20.
26. Waste Management : http://www.businessdictionary.com/definition/waste-management.html
27. World Economic Forum https://www.weforum.org
28. Dewan, JM and Sudarshan, KN, Solid waste Management, Discovery Publishing Private Limited, New Delhi. 1999.
29. Palnitkar, 2002 Manual of Soli Waste Management, AIILSG, Mumbai, pp.9
30. Shaleen S & Suneel P., 2001, Solid waste Management in India:Status and future directions. In: TERI Information Monitor on Environmental Science 2001
31. CPHEEO (2000), Manual on Municipal Solid Waste Management, pp. 219-227, Central Pubic Health and Environmental Enginneering, New Delhi, India.

Annexure – I

UN Sustainable Development Goal 12: Responsible consumption and production

Ensure sustainable consumption and production patterns

Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.

Targets

- Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries.

- By 2030, achieve the sustainable management and efficient use of natural resources.

- *By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

- *By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

- *By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
- Promote public procurement practices that are sustainable, in accordance with national policies and priorities.
- By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.
- Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.
- Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.
- *Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities

Annexure II

Stages	Key characteristics
Waste Prevention	Awareness and education
	Knowledge outreach and willingness*** to change *behavior
	Cradle to cradle approach, innovative product design
	Product responsibility
	Sustainable consumption practices
	Shared value creation through collaborative practices
	Extended product lifespan through repair and reuse
	Market creation
Waste Management	New infrastructure (deposit bins, recycling centres/hubs
	Decentralized recycling and resource recovery centres
	Efficient waste collection services
	Waste incentives (levy, taxes, token, etc.)
	Pay as you throw principle
	Community participation
	Eco-friendly waste treatment solutions
	Regulations on restricted use of landfill and waste-to-energy (WTE)
Monitoring and assessment	Reliable waste data
	Performance evaluation, waste audit and assessment

Priority Areas in Waste Management	% of respondents who either agree, strongly agree, disagree or strongly disagree			
	Agree	Strongly Agree	Disagree	Strongly disagree
Awareness and education				
Knowledge outreach and willingness to change behavior				
Cradle to cradle approach, innovative product design				
Product responsibility				
Sustainable consumption practices				
Shared value creation through collaborative practices				
Extended product lifespan through repair and reuse				
Market creation				
New infrastructure (deposit bins, recycling centres/hubs				
Decentralized recycling and resource recovery centres				
Efficient waste collection services				
Waste incentives (levy, taxes, token, etc.)				
Pay as you throw principle				
Community participation				
Eco-friendly waste treatment solutions				
Regulations on restricted use of landfill and waste-to-energy (WTE)				
Reliable waste data				
Performance evaluation, waste audit and assessment				

Annexure III

Student Take away – Knowledge tool kit

1. An interactive knowledge repository, transfer and exchange platform to inform, empower and connect http://knowwaste.net/
2. Asia waste management outlook, 2017
   http://knowwaste.net/Documents/Asia%20Waste%20Management%20Outlook%20SEP%202017_131527007771045828.pdf

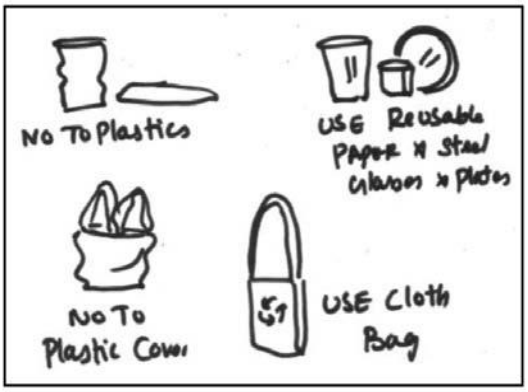
Tool Kit

- Making waste work : A tool kit : https://ciwm-journal.co.uk/downloads/Making-Waste-Work_Toolkit-Vol-1.pdf
- Tool kit for solid waste management Jawaharlal Nehru National Urban Renewal; November, 2012Missionhttp://www.indiawaterportal.org/sites/indiawaterportal.org/files/tool_kit_on_solid_waste_management.pdf
- Tool kit for implementation of solid waste management rules, 2016http://www.npcindia.gov.in/wp-content/uploads/2017/11/Guidelines-of-implementation-for-SWM-Rules-2016.pdf
- Toolkit for Public Private Partnership frameworks in Municipal Solid Waste Management https://smartnet.niua.org/sites/default/files/resources/India_SolidWasteMgmt_PPP_Tookit-Volume-I_EN.pdf
- Tool kit for implementation of solid waste management rules, 2016, http://www.npcindia.gov.in/wp-content/uploads/2017/08/Tool-kit-on-Plastic-Waste-Management-Rules-2016.pdf
- Tool kit on e-waste management rules, 2016. http://www.npcindia.gov.in/wp-content/uploads/2017/08/Tool-Kit-on-e-Waste-Management-Rules-2016.pdf

Exercises

1. Have you noticed an increased interest in varied sectors to improve recycling? Exercise/workout
2. Do you sort your waste and dispose it in special containers for: (if such opportunity is not available in your city, would you be willing to sort your waste and dispose it in special containers for):
   Glass ❑ Yes ❑ No
   Paper ❑ Yes ❑ No
   Plastic ❑ Yes ❑ No
   Batteries ❑ Yes ❑ No
   Metal ❑ Yes ❑ No
   Textiles ❑ Yes ❑ No
3. Do you find illegal dumping a problem in your city, if it exists? If yes, please state the reasons.
4. Would you be interested in being more actively involved in decision-making process on waste management? If yes, what would be the best way of doing it?
5. What are the key challenges for better waste management for a company?
   Low profitability of improved waste management ❑ Yes ❑ No
   Lack of waste management facilities ❑ Yes ❑ No
   Lack of market for recycled waste ❑ Yes ❑ No
   Lack of financial incentives ❑ Yes ❑ No

Financial constraints of your company ❑ Yes ❑ No
Poor legislation ❑ Yes ❑ No
Poor monitoring and enforcement of legislation ❑Yes❑ No
Frequent changes in legislation ❑ Yes ❑ No
Lack of municipal waste management strategy ❑ Yes ❑ No



Books for Reference

1. Environmental Engineering Series - Environmental Management by T.V.Rama Chandra & Vijay Kulkarni
2. Text book of Solid Wastes Management by Naved Ahsan & Iqbal H.khan
3. Wealth from Waste - Agricultural food and chemical Processing Waste by S.C.Bhatia
4. Integrated Solid Waste Management, Engineering Principles and Management Issues by George Teho Banglous Hilary Theisen Samuel A. Vigal
5. Solid Waste Management of Municipalities Dr P.S Ajith & Dr P.N. Hari Kumar
6. Solid Waste Management - Present and Future Challenges - Jagbir Singh & AL Ramanathan
7. Smart Cities - Transforming India - Prof M.P Dube
8. Environmental Engineering Series - Management of Municipal Solid Waste - T.V.Rama Chandra
9. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha
10. Environmental Studies by R. Rajagopalan
11. Environmental pollution control engineering by C.S. Rao
12. Waste Management Practices by John Pichtel
13. Solid wastes management by Stephen Burnley
14. Eco-Economy: Building an Economy For The Earth by Lester R.Brown
15. Not in My Backyard - Solid Waste Mgmt in Indian Cities by Sunita Narain & Swati Singh Sambyal

Course 7 Entrepreneurship in Waste Management

PG Diploma in
Waste Management & Environmental Hygiene

Mahatma Gandhi National Council of Rural Education
Hyderabad - 500004

Foreword

Waste Management is a mammoth task in India, which stands complicated with the increase in urbanization, changing lifestyles, and increase in consumer behavior. The current practice of uncontrolled dumping of waste in open areas has created serious environmental and public health problems. Financial constraints, institutional weaknesses, insufficient manpower, poor collection systems, technology constraints, and lack of public awareness have made the situation worse.

An infinitely durable product does not exist. India produces about 40 million tonnes of municipal solid waste annually at present with an annual increase in waste generation of about 5% each year. However, the collection efficiency is between 50% and 90% of solid waste generated. The onus is upon us, either to innovate in the field of Waste Management and Environmental Hygiene or to keep continuing the existing polluting methods of waste disposal. However, this field has lot of challenges and persistence is the key. To solve this immense challenge, smart minds need to come up with innovative solutions. Infrastructure, awareness and incentives are the most important steps in this strategy and should be handled with utmost care.Although more NGOs have come forward to clean up the discarded wastes through routine management, scheduled collection, proper segregation and disposal, the rate of waste generation is ever increasing, adding to more problems in the collection schedules. Sensitization programs coupled with methods for management of all types of waste would be a boon to India.

Entrepreneurs in the field of waste management need to realize that this field is no exception and economics is the driving factor. Constant flow of revenue is needed to make projects sustainable. The revenue can come in the form of payments made for services offered or through funds from national and international governments, corporate, philanthropy and other welfare organizations under various programmes. Entrepreneurs should be imaginative and far-reaching in securing funds from sources. When relying on funds, a proper risk analysis should be conducted and alternative sources should be tapped for continuous and timely availability of funds.

This course on Entrepreneurship in Waste Management is suitable for students of all streams - Commerce, Humanities, Science, Management, Journalism, Mass Media, Healthcare services (B Pharm, Social Work), Education, and Engineering. The extent of environmental damage and the innovations in combating the issues require scientific understanding of the subject.

The subject has vast possibilities and several interlinking themes. There is extensive scope to explore and experience different aspects of sanitation, pollution, environmental hygiene and waste management during classroom learning, practical experiments in field and laboratory, internship and dissertation. There is a sea of opportunity in this field of waste management and environmental hygiene, and an urgent need of skilled as well as dedicated workers to make our country clean and green.

Nature has interlinked realms. Similarly, subjects dealt in this course cannot be compartmentalized. They necessarily have to merge with one another. It is therefore important that students try to make these linkages in their minds rather than treating subjects in isolation. Students can make the most of this learning opportunity as they prepare to launch their careers in a field that holds great premise.

Dr. W G Prasanna Kumar

Chairman, MGNCRE

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This Post Graduate Diploma course on Waste Management and Environmental Hygiene is a cumulative effort of several sincere and committed visionaries and academicians. Envisioned by Shri VLVSS Subba Rao, Senior Economic Advisor, MHRD, the curriculum took shape under his keen guidance.

The sincerity with which the course curriculum was completed and published can be assessed from the fact that a prior National Consultation Workshop was held with several subject matter experts and academicians across the country, to review the contents of the course material.

The workshop was held to familiarize Central, State and Private Universities, local and social bodies with the contents of the curriculum and to discuss and share feedback on ways to improve the course curriculum. The workshop also focused on building industry–academia partnerships in Waste Management and Environmental Hygiene through an intellectual interaction. The findings and inputs of the consultation were subsequently incorporated in the course material.

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Contents

List of Tables

List of Figures

Objective

- To provide practical experience in establishing and running a Waste Management operation or facility taking into consideration current and futuristic needs.
- To build capacity for development of entrepreneurial skills and qualities in the sector of Waste Management.

Rationale

Waste management and environmental hygiene is the need of the hour and needs to be addressed across all sectors and communities. The course on Waste Management and Environmental Hygiene gives the student an overview of waste management including collection, transfer, transport, and disposal along with methods of processing, basic disposal facilities, disposal options, recycling, project management and GIS applications, reclamation and remediation, entrepreneurship and job opportunities in waste sector. In addition, this course provides the student with relevant information about waste markets, recycling trends, cost and affordability of waste management practices, and incentive based concepts. This course is therefore essential for the students who wish to pursue a career in waste sector as moving ahead, waste management will become an infrastructural necessity.

Competency

The course will be taught and implemented with the objective to develop required skills sets in the students so that they are able to acquire following competency: Plan segregation, collection, transportation, recycling and disposal of wastes, know recycling trends and available waste markets, acquire skill development and know the scope and entrepreneurship opportunities in the waste management sector.

Methodology

The theory will be taught and practicality of the course will be addressed through questionnaires, self-assessment and dissertation. The course will be through class room lectures, guest lectures, field visits, audio – video learning mode, brainstorming sessions, seminars and Q&A. A lecture series will strengthen students' understanding of waste management which will help in acquiring different learning outcomes in rational and theory to practice approach. Competency that will be gained as part of course outcome includes - understanding, learning, applying and implementing skills, knowing career prospects in waste management sector, and internship and placement opportunities in.

Topics Covered

- Organised and Unorganised sectors Government Schemes Local Bodies
- Case studies of successful models across the countryPPP, Community driven waste management
- RPs: All Waste Handlers including CBOs and NGOs Institutions in Swachhta, Companies, Bankers
- Rural case studiesModel Project ReportsTerm ProjectsPrototypes or Turnkey Projects

Entrepreneurship in Waste Management – An Introduction

A typical value chain of a product consists predominantly of the following stages: consumers, retailers, wholesalers/distributors, manufacturers and component/raw material suppliers. Waste is generated at every stage of the value chain, but disposal methods for solid waste generated are only at the customer consumption stage. A simple and efficient waste recycling mechanism is required to manage the waste generated at all levels of product manufacture. For example, cigarette stubs are collected at various locations and then directly sent by the cigarette consumer to the recycling centre.

Recycling programmes are usually funded by those who will benefit from implementing the programmes. Resources can be provided by waste management companies who offer to provide their services in transporting waste to the recycling centre's, or by brand partners who subsidize collection services or centres. Government organisations and local municipalities are a great resource for labour and infrastructure.

Generating awareness is the real challenge in making a person aware of the problems associated with solid waste management. People need to be really motivated to contribute to the solutions.Knowing things is different from doing things. Awareness about solid waste management should start from an early age in schools and rules should be enforced strictly. Solid waste management should be an involuntary action and a habit. More than awareness, it is thought that is most important—the thought of sustainability, conserving the environment and the urge to be a part of it.

Direct and Indirect incentives can be drivingfactors. People are rewarded directly with money or through other things of value for the amount of recycling they achieved. With indirect recycling, charities of recyclers choice are funded for the amount of recycling achieved. A risk-analysis for incentive projects should be made, so that it does not aggravate the problem once incentives are taken off.Information technology and marketing strategies can help improve communications as well as facilitate smooth transfer of information between all the stages of supply chain.

In India, kabadiwallas and waste pickers contribute to the deep and entrenched habit of recycling and the recycling supply chain. As most of the waste is processed by the informal sector, this is a strong and unique challenge for entrepreneurs in the areas of solid waste management. Innovative solutions are required for the disposal of organic and degradable waste.Composting and anaerobic digestion technologies need to be applied for the disposal of degradable components. Companies that have applied composting techniques include Daily Dump from Bengaluru and Pelican Biotech from Kerala. Green Tech Life from Bengaluru and Biotech from Kerala have anaerobic digestion technology to fasten the degradation process.Eco-Wise Waste Management Pvt Ltd of Noida deals with collection, transportation, segregation, treatment and disposal of all types of waste.

Managing waste in the sea as almost all products' waste ends up in the sea is a potential area of entrepreneurship. With a robust strategy and the right infrastructure, awareness and incentives, along with marketing, a bigger impact can be created.

Chapter 1

An Overview of Entrepreneurship

Objective

- To understand model of entrepreneurship, its nature, factors influencing entrepreneurship, process and qualities of an entrepreneur.

Structure

1.1 Model of Entrepreneurship
1.2 Nature of Entrepreneurship
1.3 Factors Influencing Entrepreneurship
1.4 Classification of Entrepreneurs
1.5 Qualities of an Entrepreneur

To Do Activities

- Have an open discussion on entrepreneurship and its functions
- Show film on successful entrepreneurs and reflect on the qualities of entrepreneurs
- Bring a local entrepreneur and discuss on the process, functions, difficulties, challenges faced by entrepreneurs.

1.1 Model of Entrepreneurship

Entrepreneurship is the attempt to generate value of a business opportunity, through risk management, management of skills to mobilize resources (human, financial and material) necessary to bring a project to fruition(Kao and Stevenson, 1984). The word, 'Entrepreneurship' means the function of identifying investment and production opportunity, embark up on new production process, arrangingthe supply of raw materials and labour, raising capital, finding location, introducing novel techniques, discovering new sources of raw materials and selecting managers for day to day operations of the enterprise (Higgins, 1997).Kao, J.J (1989) developed a conceptual model of entrepreneurship which is represented in the below figure (fig 1.1).

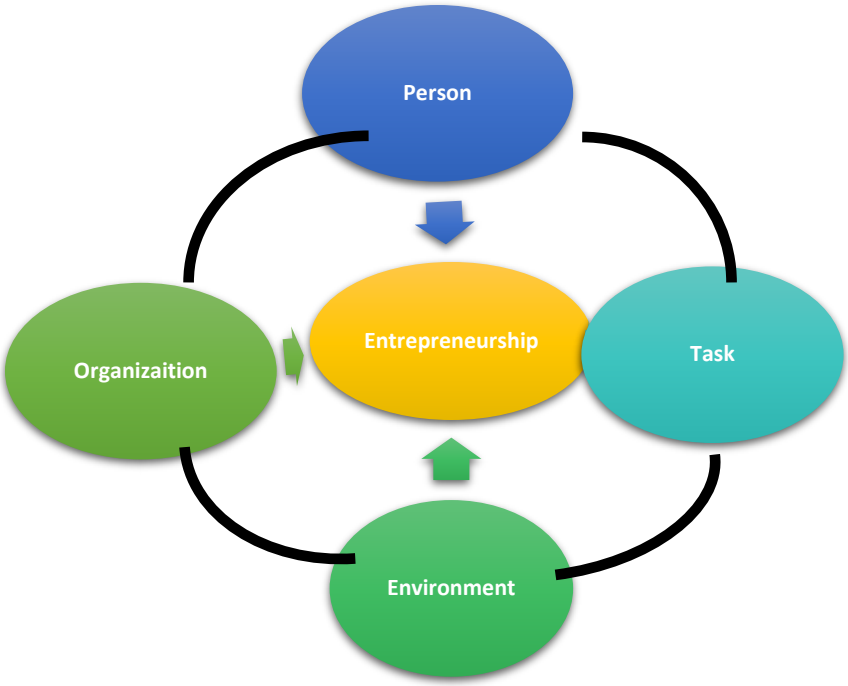


Fig 1.1 Conceptual Model of Entrepreneurship

The above model has four critical aspects. One is overall success of an enterprise depends upon the skills, qualities, traits, and determination of the person involved. Second, major task of an entrepreneur is to recognise and exploit opportunities. Third is entrepreneurial environment which involves availability of resources, infrastructure, competitive pressures, social values, rules and regulations, etc. The fourth is organisational context, which involves the structure, rules, policies, culture, human resources and communication system. Kao (1989) also emphasizes that the most successful entrepreneur would be the one who adapts himself / herself to the changing needs of the environment and makes it cordial for the growth of the business enterprise.

Brief Overview of Entrepreneurship Models in Recyclable Solid Waste Management

Wecyclers Corporation: The operating area of Wecyclers is Nigeria, which is an underdeveloped country, and the company caters to the poorest communities. Wecyclers encourages, people from these communities to segregate and store waste of value, like paper, plastic, etc. The waste collected can be exchanged for something of value. The corporation is funded by MIT Ideas Global Challenge, Coca Cola and other organizations.

Terra Cycle: Terra Cycle, mostly operates in developed countries, where infrastructure is developed and where already people have awareness and motivation. Terra Cycle works with various stakeholders in the supply chain to create and provide logistics for the smooth flow of recyclables, along with incentivising recycling activity. Operations are mostly subsidized by the corporations and brand partners, thereby providing a constant stream of revenues, which will also benefit them in building their image. Terra Cycle collects around a million waste articles every three to four hours from 23 countries. Items are collected by approximately 50 million people.

1.2 Nature of Entrepreneurship

The main characteristics of Entrepreneurship are given in the below figure (fig 1.2).

Fig 1.2 Nature of Entrepreneurship

1.3 Factors Influencing Entrepreneurship

According to Dr. Robert Owen, the 'Father of Co-operation' and Environmental Economist, the environment in which an individual is exposed has a strong influence in shaping his or her character. There is a need for considering aspects such as social and cultural variables such as family background, individual climate, personal skills, etc…. in order to identify the factors influencing entrepreneurship.

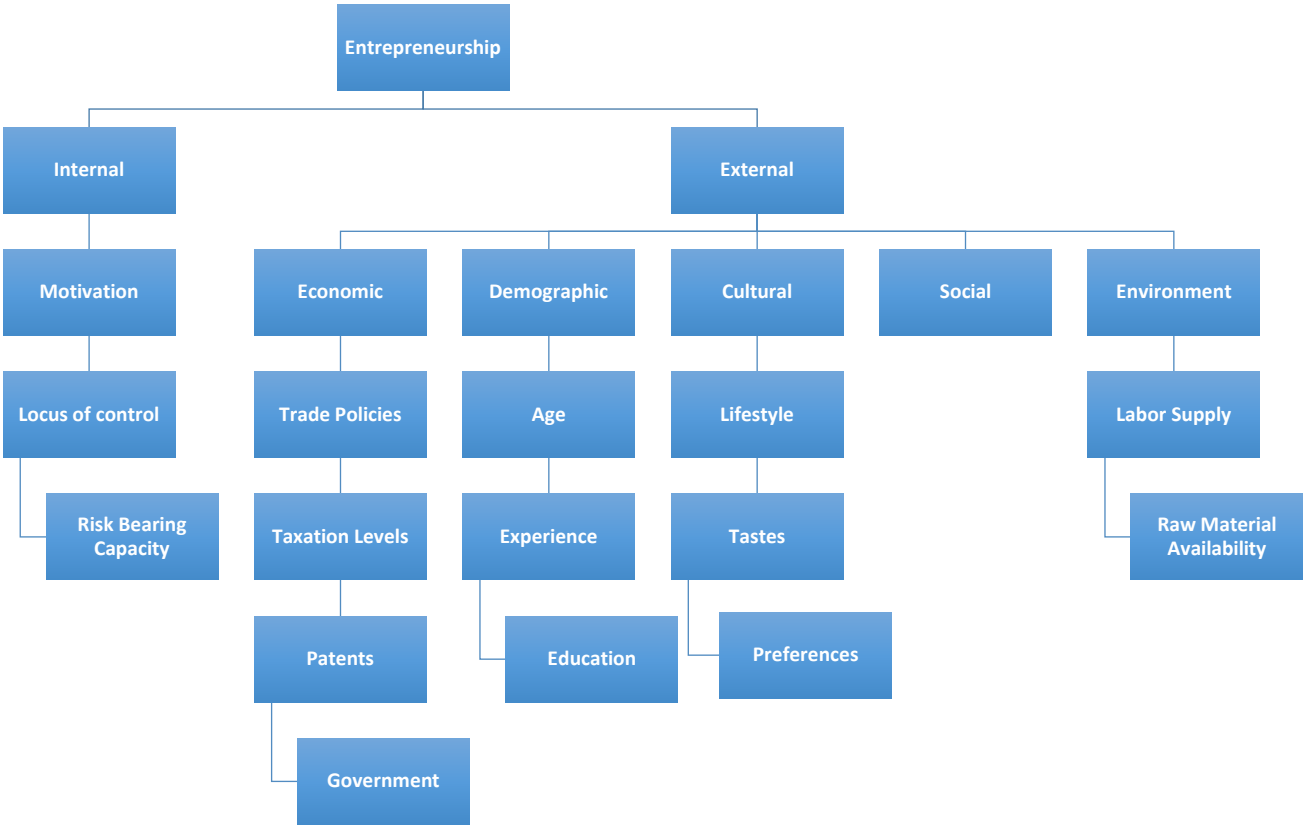


Fig 1.3 Factors Influencing Entrepreneurship (Chandrashekar et al., 2014)

1.4 Classification of Entrepreneurs

The word "entrepreneur" has been derived from French word, *entreprendre* which means "to undertake". Entrepreneur is a person who starts and runs the business. Entrepreneurs are individuals who initiate, plan, organize, manage and control the affairs of a business unit. Peter Drucker, father of modern management defines entrepreneurship as "one who always searches for changes, responds to it and exploits an opportunity". According to Professor Howard Stevenson, the Sarofim-Rock Baker Foundation Professor Emeritus at Harvard University, entrepreneurship is the "pursuit of opportunity beyond resources controlled." The definition has three important elements. One is Pursuit, second is Opportunity and third is beyond resources controlled.

Pursuit

It refers to determined and persistent focus displayed by entrepreneurs. Entrepreneurs are aware of the fact that opportunities would be available for a short time; and hence have to work with limited resources and with urgency to make substantial progress.

Opportunity

It refers to an offering that is novel which creates values such as creation of an innovative product, developing a new business model, improvising on the existing product or service, and attracting new customers for existing products.

Beyond Resources Controlled

It refers to resource constraints. Majority of the entrepreneurs will have to work with limited resources and will have to invest their personal resources in the start-up until it becomes self-sustaining. In certain cases, the founders have to look for resources beyond their control.

The below figure explains three classifications of entrepreneurship. A brief on each type of entrepreneur is presented below.

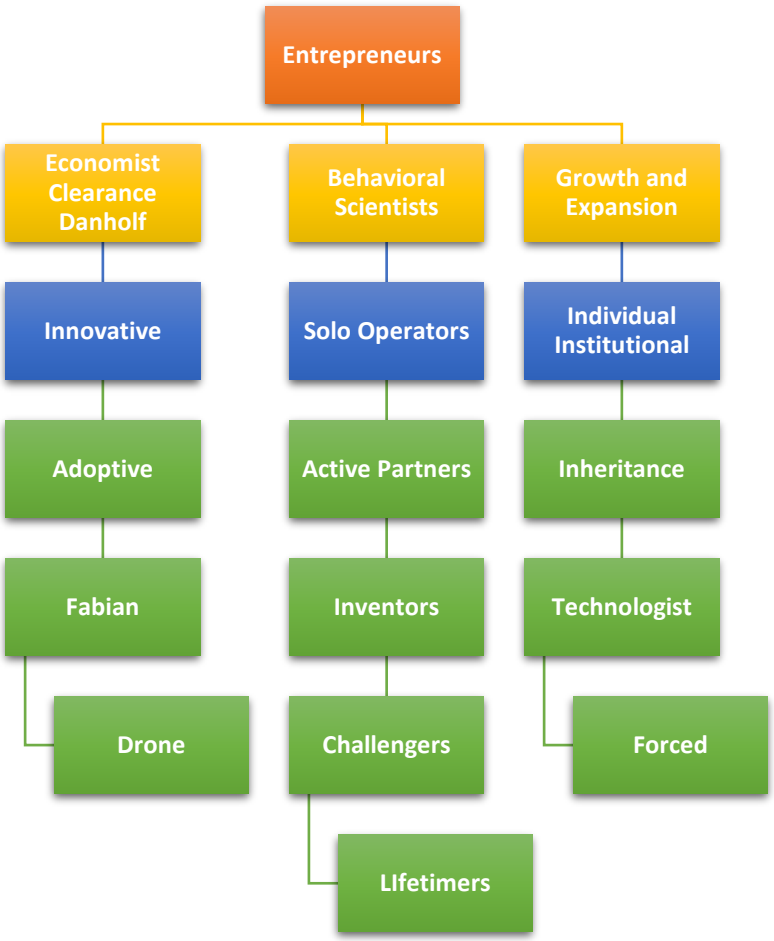


Fig 1.4 Classification of Entrepreneurs

1. **Based on Economist Clearance Danholf**

a. **Innovative -** The one who invents new ideas, new products, new production methods or processes, discover potential markets and reorganize organisational structure.

b. **Adoptive –** They do not make any innovations by themselves but copy other processes, methods and technology.

c. **Fabian-** They are skeptical about the changes in the environment. They will follow inventions only after it gets successful.

d. **Drone-** These types of entrepreneurs are reluctant to change and are happy with present mode of business. They won't change their existing business operations even if it is running under loss.

2. **Behavioral Scientists**
   a. **Solo Operators –** In the initial stages, the entrepreneur establishes the business alone.
   b. **Active Partners –** Individual who funds and actively participates in the day to day operations of the business.
   c. **Inventors –** Those individuals who have the willingness to research and do innovative activities and introduce new products into the market.
   d. **Challengers –** Individuals are knowledge driven. Those who look for challenging environment in the business. When such challenge gets met, they keep looking for newer challenges.
   e. **Lifetimers –** Those individuals who carry out activities as an integral part of their life.

3. **Growth and Expansion**
   a. **Individual and Institutional Entrepreneurs-** Individual entrepreneurs are those who establish, operate and control an organization whereas institutional entrepreneurs are group of entrepreneurs who handle complex network of decision making. Decisions, amount of capital employed are taken together by the group of promoters. Individual and Institutional entrepreneurs co-exist and support each other.
   b. **By Inheritance-** Those individuals who become entrepreneurs through inheritance of their family property. Firms get passed on from one generation to next generation.
   c. **Technologist-** The one who is the active in developing new technological knowledge through research community.

Forced –Many individuals become entrepreneurs by force of events or circumstances.

1.5 Qualities of an Entrepreneur

Fig 1.4 Qualities of an Entrepreneur (Heller, R. 2006)

Summary

Entrepreneurship is an asset. It is the desirable quality for utilizing the available resources in an optimal way for the benefit of the society and the nation. It is the benefit of recognizing new possibilities, new markets, and new customers. Entrepreneurs are the catalysts for the economic growth of the country. Entrepreneurship in waste management is a niche area. The consumption of current world ends up in the waste stream. The onus is on us either to identify opportunities in the field of waste management or to keep polluting the environment. Though entrepreneurship in waste management has lot of challenges and difficulties to face;with persistence, persuasion and determination of an individual(s), enormous opportunities could be identified to pursue individuals to become entrepreneurs in waste management. Chapter 2 would provide an understanding of the opportunities that exist in waste management sector.

SelfAssessment Questions

1. Define Entrepreneurship, its nature and factors.
2. Discuss aboutthe type of entrepreneur suitable in waste management sector.

Further Reading

1. Eisenmann, T R (2013), 'Entrepreneurship: A Working Definition', HBR, https://hbr.org/2013/01/what-is-entrepreneurship (Accessed on Nov 19, 2018 @ 12:37 pm).
2. Heller, R (2006), 'Nine qualities that make a great entrepreneur', https://www.leadershipreview.net/nine-qualities-make-great-entrepreneur, Accessed on Nov 19, 2018 at 16:16.

Chapter 2
Entrepreneurial Opportunities in Waste Management Sector

Objective

- To provide an introduction to entrepreneurship in waste management, major trends and challenges, future prospects of waste management sector
- To show where entrepreneurs can fit in order to create efficient facilities

Structure

2.1 Entrepreneurship in waste management
2.2 Major trends, challenges and future prospects of waste management sector
2.3 Overview of Reports of Commissions and Committees

To Do Activities

- Analyze case studies of entrepreneurship in waste management
- Provide topics to students and make them present individually / group
- Visit a waste management enterprise
- Invite guest speakers from industry experts in waste management sector to talk on entrepreneurial opportunities in waste management sector

2.1 Entrepreneurship in Waste Management

Waste management is a common challenge.While there are a number of solutions and technological advancements to manage wastes, the efficacy with which manpower is being involved in waste management provides a window to how best implementation is done. Ineffective and sustainable waste management practices the implementation plan of action requires seamless transition and proper handling and managing of wastes at various stages – generation to collection, disposal, treatment, recovery and reuse. Government, municipal corporations, public sector, private sector, civil societies, social enterprises and other stakeholders have over the years recognised the need and have adopted models that work across the 3Rs – Reduce, Reuse and Recycle concept and in bringing an integrated approach for waste management. This includes working together with regard to collection, segregation, transport, treatment, reuse and recycling. However there still exists a wide gap between the informal waste management service providers and the formal ones. This probably hinders the very ethos of waste management. Enterprises classify business models and encourage reduction of wastes before generation, provide efficient end-to-end waste management services and aim to minimize the burden on landfills. Such enterprises also help recover value from wastes in the process.

Waste management can be used as an entrepreneurship platform for sustainable youth empowerment as informal waste handlers, workers and segregators can be formally inducted through capacity building, training and skill development. There are multitude of job opportunities that can be created across waste hierarchy at various skill and stage level with the objective of not just improving the livelihoods of informal workers but also bringing them into mainstream for a sustained period and possible growth opportunities along with effective waste management. From collection, sorting to recycling we have manpower to work upon; however what is important is how strategically we avail their work efficiencies in waste hierarchy. Although technological advancement has lessened the human effort with application of GPS, GIS and integrated approach in waste

management, there shall be requirement of workers, operators, manufacturers, retailers, and other stakeholders to be an integral part of supply chain of waste management insolving waste issues via cradle-to-grave approach. The challenges involved in waste management lies when inefficiencies sneak in as different workers manage different components of waste value chain and due to lack or limited interaction and engagement amongst different stakeholders.If we see waste management and recycling as a transforming and innovative opportunity from business perspective the following are the way forward opportunities represented schematically in fig2.1.

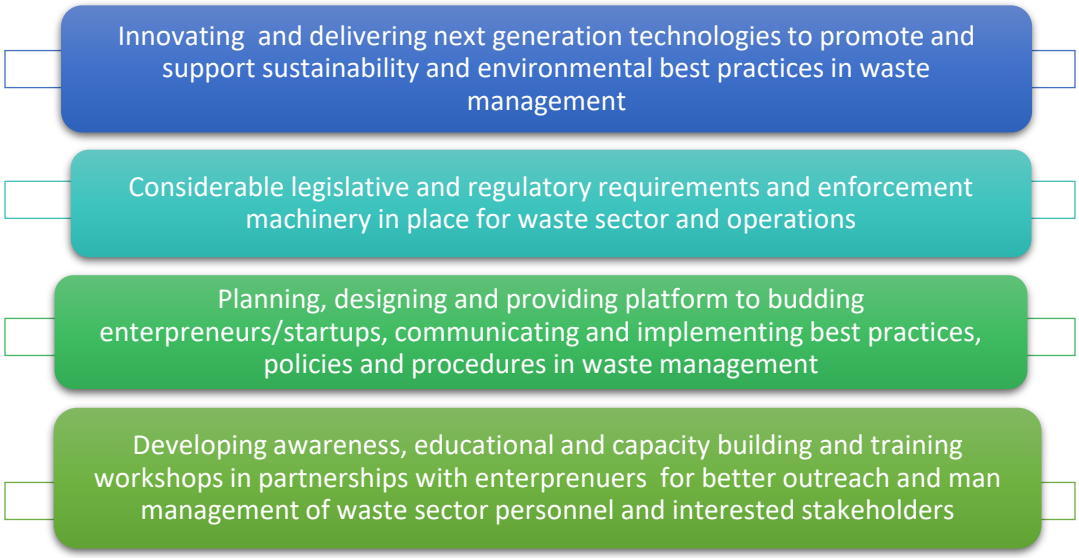


Fig2.1 Transformative and Innovative Opportunity from Business Perspective in Waste Management Sector

A good environmental stewardship program in waste management sector aims to move or make transition from business perspective to building strongest and strategic approaches and initiate programmes in response to regulatory compliances, stakeholder engagement and public perspective and support while implementing waste management measures.

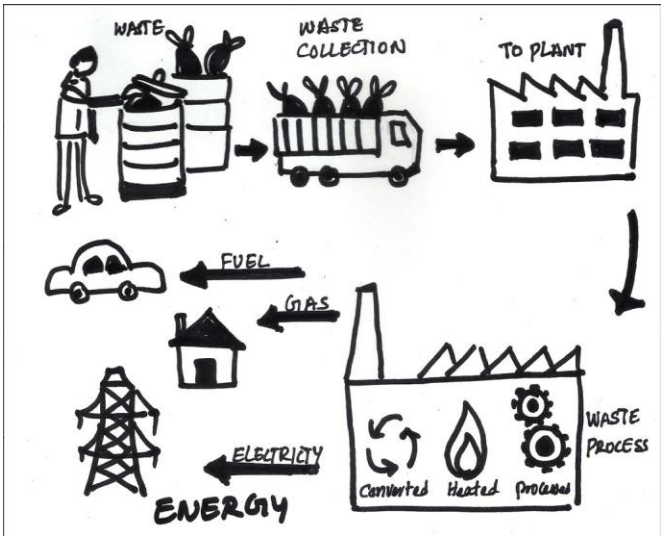
What makes entrepreneurship in waste management sector as drivers of change?

- Role of stake holders (media and civil society)
- Landfill costs – providing opportunities for entrepreneurs to provide solutions to lessen the reach of wastes to landfills as much as possible via gas recovery, waste to energy options
- Local government regulations on recycling and the introduction of penalties
- Supply chain reductions / customer requirements / ISO14001:2015
- Convenience, cost, legislation and market variables
- Overseas market influences
- Green policies and tax regime on waste
- Changes in market expectations

As mentioned in the preceding paragraph, the informal sector is responsible for waste collection and disposal and is unaware and ill-informed in most cases in developing countries.So theyare not aware of the available waste recycling markets. This adds to the impact on environment. Also as with other startups in the domain of IT, energy and energy utilities, funding and investment opportunities are not well extended as they should be

ideally. Newer opportunities in terms of recycling technology, reverse logistics, bioremediation of industrial, agricultural and waste water wastes, composting, waste to energy are being created by entrepreneurs and are providing one stop solutions in collaboration with government, public and private entities, NGOs and self-help groups.

Entrepreneurship provides a perfect platform as a promising alternative career to the youth who are looking for opportunities to create a positive impact on society and environment. There is an immediate need for social entrepreneurs to tackle the issues and find new and innovative solutions in waste management sector.



Also if incentive concept from government such as subsidies, land and cost effective financing is provided, it would co-create an effective waste management sector with maximized shared value and stakeholder engagement. Another important aspect is, if curriculum subject on entrepreneurship in waste management is provided and awareness on the possible opportunities in waste sector is given, and then there shall be wider scope for increased employment in this sector, who are well equipped to provide sustainable solutions and there will be increase in investments in startups with positive capital gains.

2.2 Major trends, Challenges and Future Prospects of Waste Management Sector

The future of waste management with ever so burgeoning population, it is imminent that waste management system may certainly crumble to the test of global economic decline. With the global population, GDP per capita, the amount of waste generated shall bound to increase. Our waste management system and market conditions even with the best available technologies shall remain incapable of handling wastes. So a paradigm shift in attitude, awareness and capacity building with right mix of technology, co-operation and governance need to be embraced to control the plethora of uncontrolled dumpsites, especially in developing world economy.

Amount of wastes is mainly determined by the following factors:

- Population
- Consumption patterns
- Gross Domestic Product per capita (GDP)

According to the UN, between now and 2025, the world population will increase by 20% to reach 8 billion inhabitants (from 6.5b today). Jeffrey Sachs has estimated that in developing countries the GDP/consumption will be around $40,000 in 2050, which is the same as the USA GDP/consumption in 2005. With increased GDP

per capita, advanced effective waste management systems and technologies have come up resulting in increased newer landfills, efficient collection systems and waste to energy facilities.

Any waste management future prospects are planned keeping in mind the following deliverables:

- Reduced waste generation
- Receive better rebates for all recyclable materials
- Provide eco-friendly options
- Cost neutral for metals and other recoverable materials
- Meeting all legislative requirements
- Waste management projects- As CSR initiatives

Fig 2.2 Opportunities in Waste Management Sector[1]

[1] https://www.entrepreneurindia.co

2.3 Overview of Scenario Building for Future Waste Policy

Scenario building and quantitative analysis are prerequisite for government machinery and policy makers to review waste policies from time to time and provide a guidance framework towards long term policy making. Though scenarios are not the accurate, yet they provide a realistic benchmarking on the basis of baseline data to predict future scenarios. Also qualitative approach along with quantitative model provides a collaborative platform for building future waste management trajectories. Scenario building depends upon robustness of baseline and projection data which considers the following (fig 2.3) as key parameters. An entrepreneur should keep a tab on the following data parameters to look for opportunities while scanning the environment.

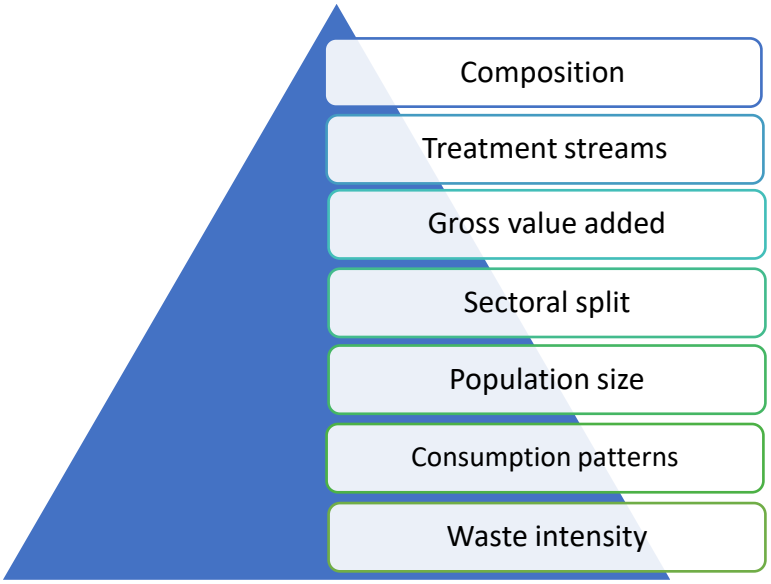


Fig 2.3 Parameters for Baseline Data Development

Base line data together with key factors Vs reference case projections constitute scenario development for future waste policy.

Table 2.1 Key factors Vs. Reference projections – Waste scenario development

Key Factors	Reference Case Projection
Demographics	Stable population growth
Socio-economic condition	Growing affluence
Economy structure	Continuous shift in services
Consumption patterns	Good and bad attitude towards wastes
Environmental behaviour	Diverse approaches
Corporate eco behaviour	Shift to renewables
Energy systems and energy from waste capacities /technologies	Small scale energy from wastes

Commodity markets/ other interventions	Support and participation
Recycling and Reuse capacities	Tax increase
Landfill development taxes	Legislative machinery

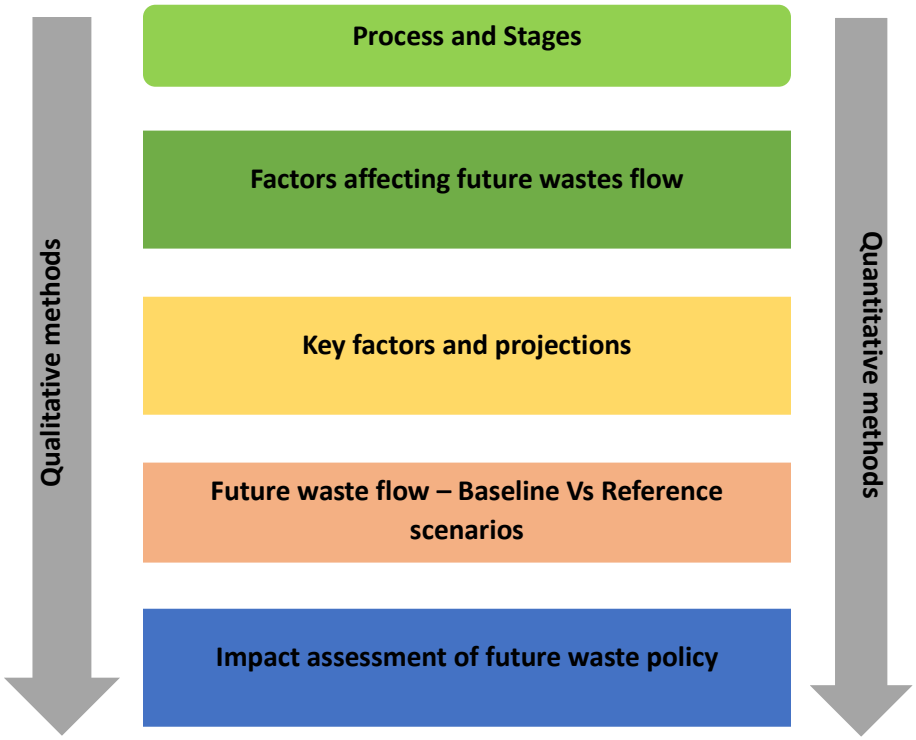


Fig2.4 Overview of process and stages in scenario development (as per WRI, DEFRA, 2011)

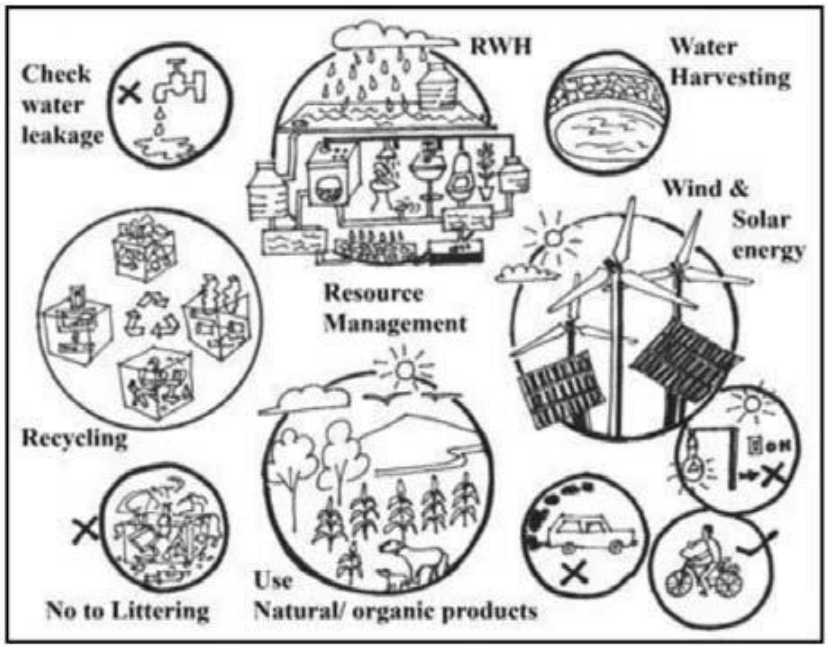
As per the Indian Constitution, the responsibility for solid waste management falls under the purview of the state government and the urban local bodies (ULBs). Municipal solid waste management is governed by the Municipal Solid Waste Management and Handling Rules, 2016. The rules designate ULBs as solely responsible to manage solid waste in their area and direct for the implementation of the provisions of these rules, and for any infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid wastes. Along with it the recently amended e-waste management handling rules, 2016 has brought into mainstream a wider market for wastes to be brought into purview of value creation, through recovery, reuse and recycling. Under the flagship programme such as the "Smart City Mission" and the "Swachh Bharat Mission" currently waste management issues being addressed with regard to waste segregation, collection, disposal and treatment, recovery and recycling.What is now required is the data of the groundwork done to be transformed into a primary input or baseline for building future scenario development and waste policies

As per the report, "India's Urban Awakening-2010" and as mentioned in the ASSOCHAM and PWC report Waste Management in India - Shifting Gearson infrastructure need assessment of India forecasted an investment requirement of 1.2 trillion USD in the next 20 years, which accounts to roughly 134 USD per capita per annum out of which the share on waste management sector has been estimated at 15 USD per capita.

With the present population of around 1.2 billion, the investment estimated by 2030 is almost 18 billion USD. Similar investment requirements have been echoed in the report on infrastructure in India under the High Powered Expert Committee (HPEC) which projected aninvestment of 771.65 billion USD(2009 statistics data) (39.2 lakh crore INR)over a horizon of 20 years. The investment requirement under the waste management sector hasbeen roughly estimated at 9.56 billion USD (0.49lakh crore INR).The report estimated an additional requirement of 391.73billion USD (19.9 lakh crore (INR) to be apportioned forO&M cost for infrastructure. The cost for O&M in municipal solid waste management sector has been estimated at 53.9 billion USD (2.7 lakh crore INR) for the time period of 20 years.

Waste management has an infrastructure necessity and sets a platform for waste sector as a future green entrepreneurship and employment providing sector with deep rooted mission of serving environment and society.Also, if we look from the global perspective, World waste production is expected to be approximately 27 billion tonnes per year by 2050, one-third of which will come from Asia, with major contributions from China and India (Modak P*etal*, 2010).Waste generation in urban areas of India will be 0.7 kg per person per day in 2025, approximately four to six times higher than in 1999. The problems associated with waste become more acute as the size of communities increase and this provides opportunities for decentralized waste management by self-help groups and NGOs (Kumar JS, *et al*, 2014). The waste produced in urban areas of India is approximately 1,70, 000 tonnes per day, equivalent to about 62 million tonnes per year, and this is expected to increase by 5% per year owing to increases in population and changing lifestyles (Planning Commission, GOI, 2014). Urban India generated 31.6 million tonnes of waste in 2001 and is currently generating 47.3 million tonnes. By 2041, waste generation is predicted to be 161 million tonnes, a fivefold increase in four decades (Annepu RK. 2012).

Currently most of the focus is towards waste collection, segregation and treatment. What is now required is a gradual shift towards waste avoidance/reduction in waste with a complete policy and industry focus in developing approaches to waste management with minimized reach to landfills and maximized reach as recovered and fit for reuse products with a resilient long term development strategy.



Caselets

The lists of few notable entrepreneurs who through their entrepreneurship ventures have actively worked and contributed to waste management sector across India are mentioned in the form of case studies below:

1. **Eco-Wise**: Headquartered at Noida,provides comprehensive waste management services to a variety of establishments including residential, commercial and industrial entities. They ensure that, the wastes collected by them are treated and disposed in accordance with waste management rules. Eco-wise is an ISO 90001, 14001 and 18001 certificates.
2. **Vermigold**: It is an on-site organic waste recycling Systems Company which combines advanced vermiculture biotechnology with cutting edge engineering to enable end users to recycle organic waste in a trouble free and eco-friendly manner. Vermigoldecotech has won the 2013 Energy Globe award from India. It is India's first and only internationally certified waste management system that certifies their system as best in class and kindest to the environment.
3. **Antony Waste Handling Cell Pvt., Ltd:** Antony waste handling cell, an offshoot of Antony group of companies, Mumbai is one of the leading players in the field of Solid waste management services in the country, since the past 8 years. It has features like Engineered Sanitary land filling, Refuse transfer stations, etc.
4. **Lets` Recycle:** It is an initiative of NEPRA Resource management Pvt. Ltd., a social enterprise that operates in segment of Dry Waste Management and Recycling, where it collects Dry Waste from Waste generators and segregates the recyclables and sends to authorized recyclers. It currently provides employment to 302 employees, comprising of 76 women. It has rag pickers of 1076. It provides environmental benefit- diverted over 3000+ MT towards recycling. (Source: Dr. Vani Ramesh, 2016).
5. **Waste to Watts:** When SreekrishnaSankar and Mainak Chakraborty graduated from IIM-Bangalore in 2010, they decided to give themselves a year to figure out which social and environmental problem they should tackle, using technology. With Bengaluru facing a perennial garbage disposal challenge, they turned their attention to how they could make waste valuable and come up with a solution that would be relevant in

urban areas. They spent close to a year ideating and travelling to understand both the waste and technology aspects before starting up GPS (Green Power Systems) Renewables.

6. **Karma Recycling:** The company has designed a cloud-based interface called Exchange Hub that can be used to value the devices, and that value can then be worked into a discount in the new device. Karma Recycling is working with 200 such stores across the country and has so far bought and sold 20,000 phones.

Summary

Waste management in India is a huge environmental challenge to be addressed. India generates huge volumes of waste and inadequate system of collection, transport, treatment and disposal which is a major environmental issue to be dealt with. It impacts public health too. The challenges and barriers to address the problems in current systems in India are very difficult. This can be solved only by growth of entrepreneurs in this niche area of business. It has a huge scope for the entrepreneurship as was seen in the chapter. Chapter 3 would provide role of various bodies involved in waste management.

Self Assessment Questions

1. Write the Entrepreneurship venture of any entrepreneur in waste management sector and how it is implementing best practices in waste management.?
2. Write a review on different entrepreneurship organizations in waste management sector in India.

Further Reading

1.Introducing How to Start a Recycling Business. Start small business with 50 recycling business ideas in 2016-17 https://www.youtube.com/watch?v=ZnZe-P-9D0w&pbjreload=10

2. Entrepreneurship and Sustainabilityhttps://www.youtube.com/watch?v=Heo8exQrnbI

3. Entrepreneur turns textile waste into fashionable footwear
https://www.youtube.com/watch?v=50d3GXfIdX0

4. Sustainable Business - Wealth from Waste Documentary on how business is creating a circular economy
https://www.youtube.com/watch?v=VJ95arxbz24

5. Entrepreneurial Opportunities in Waste Management Sector,
https://www.entrepreneurindia.co/Document/Download/List%20of%20Profitable%20Business%20Ideas%20in%20Waste%20Management,%20Disposal%20and%20Recycling%20Industry.-501392-.pdf

Chapter 3
Role of Various Bodies in Waste Management

Objectives

- To learn about various sectors, government and private agencies involved in waste management.
- To understand details of organized and unorganized sector and their role in waste management and recycling, various government schemes and local bodies' roles.

Structure

3.1 Role of government and private agencies in waste management
3.2 Role of Organised Sector
3.3 Role of Unorganised Sector
3.4 Government schemes and local bodies

To Do Activities

- Do an analysis of Caselets
- Invite guest speakers/industry experts in waste management sector and facilitate the discussion on various bodies that support entrepreneurship
- Discuss role play of various bodies and their functions

3.1 Role of Government and Private Agencies in Waste Management

Central Government

- Ministry of Environment and Forests and Climate change – regulation through rules, regulations and guidance materials.
- Ministry of Urban Development: Funding of projects through National Flagship Projects
- Technical Assistance through specialized teams imparting capacity to the state and ULBs.
- Ministry of New and Renewable Energy.
- Ministry of Finance through Department of Economic Affairs.

State

- Responsible for implementation of funding through State Finance Commissions.
- State Urban development departments as state nodal body
- Co-ordination between various ULBs / LBs (Urban Local Bodies / Local bodies) for various schemes and imparting training

Urban Local Bodies

- Implementation Responsibility
- Implement through set of bye-laws governing waste management
- Responsible for manpower and staffing
- Responsible for preparing and implementing the municipal rules
- Funding through ULB's own resource & Public Private Partnerships

Private /ULBs

- Assist ULBs in implementation of waste management activity in the capacity of advisors, execution agencies, etc.
- Non-governmental organizations play an important role in collection and transportation and organizing the informal sector. In some cases, NGOs have done good work in end-to-end waste management.

Informal Sectorial workers

- Scavenging and rag picking.
- Informal waste recycling

Institutions

- Government
  - NITIAayogPlans and Financial Support
  - DEA (Department of Economic Affairs)
- Structure and Framework & Financial Support
- NIUA - Capacity Building
- BARC - Technology

Multi-Lateral/bilateral funding agencies:

- Capacity building and financing

Table 3.1 Waste Management in India[2]

Waste Management value chain	Private sector involvement	Contractual arrangements
Primary collection	• Primary door-to-door collection of municipal solid waste	• Service management contract
	• Service management contract	
Secondary collection & transportation	• Construction and management of Community bins	• BOT and its variance and/or Separate EPC and O&M Contract
	• Transportation of waste	• Management contract/O&M contract
Transfer station management & Processing site	• Setting up and running transfer station	• DBOT/ BOT (long term)EPC with 5–7 years O&M contract
	• Processing using composting/ RDF / recoverable/ recycle projects	• Built operate transfer (BOT)
	• Waste to energy	
Waste disposal	• Disposal in an engineered landfill site	Design build operate and transfer (DBOT), EPC with O&M Contract on renewal basis

3.2 Role of Organized Sector

Organized Sector includes employment terms which are fixed and regular, and the employees get assured work. *Unorganized sector* is one where the employment terms are not fixed and regular, as well as the

[2]Waste Management in India - Shifting Gears, ASSOCHAM, PWC, March 2017

enterprises are not registered with the government.The organized and unorganized sectors play a major part in the waste management and recycling system.

The organized sectors consist of enterprises, which are officially recognized, protected, and supported because they are registered or have given a license by the local government or municipality. The organized sector is the sector that operates with unregistered, unregulated or casual labour. Most studies on the unorganized sector in India, especially during recent years, have focused on waste pickers, and have discussed issues such as waste retrieved from footpaths or transfer stations, the participation of municipal staff in selling waste, the sale of refuse to farmers near dump sites for composting or for fuel, dump scavenging, and the various arrangements negotiated among pickers, itinerant buyers, waste buyers and wholesalers in the waste exchange networks.

Door-to door collection of waste is only a decade old in the country. Prior to this new method in waste management, waste in cities was dumped in large bins in residential areas and cleared at regular intervals by the Municipality. 'Municipal Solid Waste Management' is the responsibility of the Municipality or the local body. Entry 6 of List II (or the 'State List') to the Seventh Schedule of the Indian Constitution vests in state governments, powers over "public health and sanitation". Though a tedious task, most states have not set up a separate department to deal with waste management and continue to undertake waste management activities through the health department. Besides, over the years, the local bodies/municipalities have not revamped their methods, infrastructure and budget to meet the growing demands of waste generation and land filling. Unable to cope, several municipalities in large metros have only now resorted to partial privatisation, where certain wards have been contracted to private actors for door-to-door collection of waste. Thus, the only evident shift has been the contracting out of waste collection and transportation to third parties, while earlier the work was carried out by municipal workers employed by the municipality.

3.3 Role of Unorganised Sector

The unorganised sector has a key role in extracting value from waste, with approximately 90% of residual waste currently dumped rather than properly landfilled (Narayan T. 2008). There is an urgent need to move unorganised sector to be brought into mainstream for sustainable waste management, and for this to happen new management systems and waste management facilities are required.

The unorganised sector is characterized by small-scale, labour-intensive, largely unregulated and unregistered low-technology manufacturing or provision of materials and services (Wilson, *etal*, 2006) Waste pickers collect household or commercial/industrial waste and many hundreds of thousands of waste pickers in India depend on waste for an income, despite the associated health and social issues. Pickers extract potential value from waste bins, trucks, streets, waterways and dumpsites. Some work in recycling plants owned by cooperatives or waste picker associations. Waste picking is often the only source of income for families, providing a livelihood for significant numbers of urban poor and usable materials to other enterprises. A recent study of six Indian cities found that waste pickers recovered approximately 20% of waste, with 80,000 people involved in

recycling approximately three million tonnes. It is estimated that every tonne of recyclable material collected saved the ULB approximately INR 24,500 per annum and avoided the emission of 721 kg CO_2 per annum (Annepu RK. 2012).

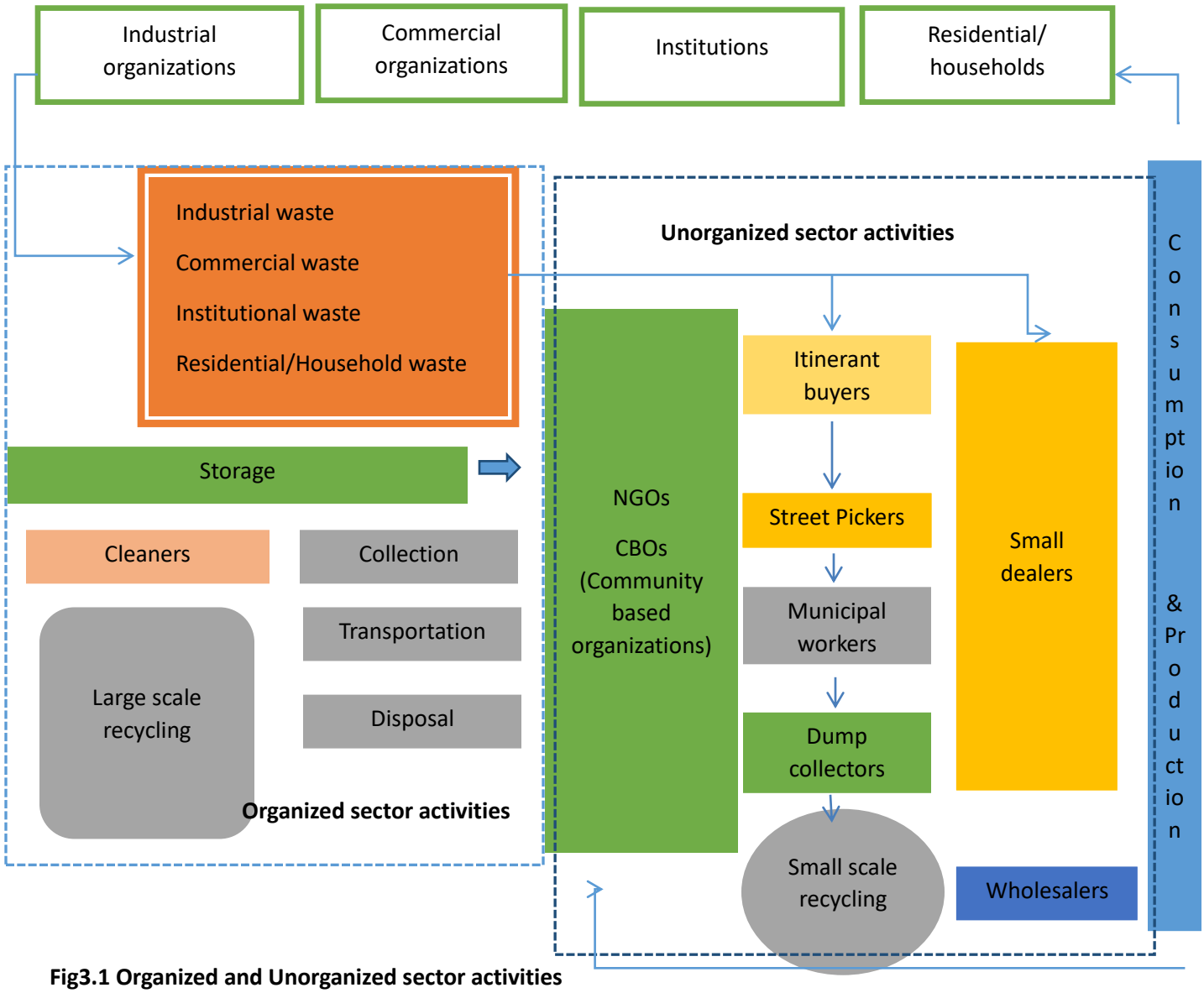


Fig3.1 Organized and Unorganized sector activities

Currently, there are 23 formal recycling and reprocessing units having environmentally sound management facilities which are registered with the Central Pollution Control Board (CPCB) located in Andhra Pradesh, Karnataka, Maharashtra, Haryana, Rajasthan, Tamil Nadu, Uttar Pradesh and Uttarakhand. The formal units perform collection, segregation, shredding and resource recovery employing automated, semi-automated or manual operations for the recycling of e-waste. Some of the viable recycling facilities in the formal sector are the Attero Recycling Plant in Roorkee, Uttarakhand, E-Wardd and E-Parisara in Bengaluru and Earth Sense in Hyderabad. Other recycling and re-processing units registered with the MoEF/CPCB are Ramky E-waste Recycling Facility (Ramky Engineers Ltd.) in Andhra Pradesh; Ash Recyclers, Unit-II, New Port Computer

Services (India) Private Limited, Surface Chem Finishers,E-R3 Solutions Pvt. Ltd. and Ash Recyclers, Unit-I in Karnataka; Eco Recycling Pvt. Ltd., Hi-Tech Recycling India (P) Ltd. in Maharashtra; Greenscrape eco Management Pvt. Ltd. in Rajasthan; Trishyiraya Recycling India Pvt. Ltd., TES AMM Private Ltd., Global E-waste Management and Services (GEMS), Victory Recovery & Recycle Technologies India Pvt. Ltd., Ultrust Solutions (India) Pvt. Ltd., INAA Enterprises in Tamil Nadu; TIC Group India Pvt. Ltd. in Uttar Pradesh and Jhagadia Copper Ltd. in Gujarat. There are also two other e-waste recyclers in Gujarat namely, MCT Enviro Infrastructure Ltd. and E-process House[3].

That the e-waste sector can be made into a viable business model is indicated by a Bengaluru-based successful conglomeration of 70 informal recyclers –kabariwala s- called the Harit Recyclers Union.The UNEP Report on "Recycling – from e-waste to Resources" recognizes that the unorganized collection system has been rather efficient in countries like India because the daily informal collectors can penetrate each community and city to collect waste from house to house. They are flexible with working hours and location; they pay a reasonable price to the consumers and are in charge of all the transportation work. This brings not only income to the informal collectors but contributes to the high collection rate without putting pressure on the consumers. Any future formal collection system has to take advantage of the "distributed informal collectors" (source: committee on e-waste', MAIT Annual Report 2009-10: A Review, p.14).

India is considered as the second largest e-waste generator in Asia. According to a MAIT – GTZ estimate, 83, India generated 330,000 lakh tonnes of e-waste in 2007[4], which is equivalent of 110 million laptops. More than 90 per cent of the e-waste generated in the country ends up in the unorganised market for recycling and disposal. The unorganized sector mainly consists of the urban slums of the metros and mini-metros, where recycling operations are carried out by the unskilled employees using the most rudimentary methods to reduce cost. A study by the Basel Action Network (BAN) in partnership with the Toxic Link reveals that e-waste is received and processed in India in similar manner as is done in China, or the condition could be even worse. The unorganized sector consists of an assortment of small and informal businesses not governed by any stringent health and environmental regulations.

E-waste economy in the organized sector: In July 2009, organized recyclers formed the e-waste recyclers' association but facing stiff competition from the unorganized sectors, they have been able to capture only 10 per cent of the total share of the e-waste market. A problem facing the organized sector is the lack of proper collection and disposal mechanisms and appropriate technologies in the face of a large informal sector. Due to lack of proper collection systems, households and institutions at times end up storing obsolete products in their warehouses or storerooms. Even when these are sold or exchanged, they are refurbished and then resold. Only a small proportion of obsolete electronics products actually find its way into the e-waste processing stream.

[3] http://www.cpcb.nic.in/divisionsofheadoffice/hwmd/e-waste.pdf
[4] https://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf

Case let 1[5]

In Bengaluru, the Silicon capital of India, e-waste recycling is a multi-crore market where e-waste is received in Gowripalya and Nayandahalli. The e-waste scrap dealers send the segregated and dismantled e-waste parts to Delhi and Mumbai every alternative day. The e-waste recyclers earn around Rs. 2-3 lakhs a month from selling the dismantled e-waste to Delhi. There are a few recycling centres in Karnataka like e- Wardd, e- Parisara, K.G. Nandini Recyclers, Ash Recyclers, New Port Computer Services India Pvt. Ltd. Recyclers and E-R3 Solutions Pvt. Ltd. in the organized sector. E-Parisara has been encouraged by the Central and State Pollution Control Board which would like it replicated in all major cities in the country. The Boards' initiative attempts to carefully recycle old computers, their components and other e-waste, generated by both IT companies and electronic manufacturers. The centre has equipment to recycle up to three tonnes of waste a day, but is dealing with around one tonne right now. According to the owner, many corporates such as IBM, Tate Elxsi, ABB and Phillips are among its clients.

The Ministry of New and Renewable Energy (MNRE) offers financial incentives to a proponent who plans to set up a waste-to-energy project as per the prevailing policies of the ministry. The incentives are given to both private as well as public sector entrepreneurs and investors having technical and managerial capabilities MNES gets the detailed project reports appraised by the financial institutions to ensure that the project is feasible, viable and sustainable. The incentives offered are:

- For commercial projects, financial assistance is provided by way of interest subsidy in order to reduce the rate of interest to 7.5%, capitalized with an annual discount rate of 12 %. The assistance is routed through financial institutions (FIs)/ Lead FI of the project, etc.

[5] https://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf

Table 3.2 Maximum Subsidy to Reduce the Interest Rate[6]

Type of Projects	Maximum Eligible Interest Subsidy to Reduce the Interest Rate to 7.5% (Rs. in Crore/ MWh)	
	Urban and Municipal Wastes	Industrial Waste
Waste to power	2.00	1.50
Waste to fuel	0.50	0.50
Fuel to power	1.00	1.00

For demonstration projects comprising innovative projects for generation of power from municipal solid wastes and selected industrial wastes, financial assistance up to 50% of capital cost of the project, limited to Rs. 3.00 crore per MW, is provided to the project proponent.

- For power generation through Sewage Treatment Plants (STPs), financial assistance up to 50% of the incremental capital cost for generation of power from biogas being generated at STPs is provided.
- In addition to the above, financial incentive at the rate of Rs. 15.00 lakh per MWe is given to Municipal Corporations/ Urban Local Bodies, for supplying the garbage free of cost at the project site and providing land on a long-term lease, viz. 30 years and above, at a nominal rent.
- State Nodal Agencies are given an incentive @ Rs.5.00 lakh per MWe of power for promotion, co-ordination and monitoring of projects.
- For financial institutions, a service charge of 2% of the actual subsidy channeled through them to the promoter or other FIs is allowed, subject to a maximum of Rs.2.00 lakh per project.
- There is also a provision for giving 50% of the cost of preparation of Detailed Project Reports (DPR) or Techno-economic Feasibility Reports, subject to a maximum of Rs.2.00 lakh per report to the project proponent.
- For promotional activities, assistance is available for organising of training courses, workshops and seminars, awareness generation and publicity.

Table 3.3Incentives under the National Program on Energy Recovery[7]

S. No	Project Description	Incentives
1	Power generation from MSW involving RDF	Rs. 15 million per MW
2	Power generation on high-rate biomethanation	Rs. 20 million per MW
3	Power from MSW on gasification-pyrolysis & plasma arc	Rs. 39 million per MW
4	Biomethanation technology for power generation from vegetable market waste, slaughterhouse waste above 250KW capacity	50% of project cost; max Rs 30 million per MW
5	Project development assistance per project	Up to Rs. 1 million

[6] http://www.eai.in/ref/ae/wte/pol/urban_waste_govt_support.html

[7] **http://www.eai.in/ref/ae/wte/pol/urban_waste_govt_support.html**

6	Capacity building initiatives	Rs 0.3 million per event

Carbon Credit Benefits from MSW to Energy

Solid waste management practices release high quantities of greenhouse gases in the atmosphere. This sector therefore creates significant opportunities for carbon mitigation, which could eventually become tradable carbon credits. Some waste to energy projects in India have already started earning carbon credits.

As of 2011, there is a total of 10 registered projects fetching about 889,358 CERs /annum (Corresponding to a revenue potential of 0.5 billion INR). Presently 32 CDM projects are under validation stage seeking for registration. These projects can generate more than 10 million CERs/annum (Corresponding to a revenue potential of around 6 billion INR) (Data as on Feb 2011).

Table 3.4 Examples for Carbon Credits Projects by the Indian Waste Management Industry

Project	Average Annual Emission Reduction (CERs)*
Bundled Waste Processing Facilities in India	158,077
Gorai Landfill closure and Gas Capture Project, Mumbai, India	124,028
Installation of Bundled Composting Project in the state of Tamil Nadu	115,162
Upgradation and expansion of APMC compost plant at Tikri, Delhi	35,329
Establishment of compost production unit of 100TPD at Lalganj	42,050
Upgradation, operation and maintenance of 200TPD composting facility at Okhla, New Delhi	33,461
Avoidance of methane emissions from MSW and food waste through composting	23,431
MSW based composting at Kolhapur, Maharashtra	30,430
The Timarpur-Okhla Waste Management Company PvtLtd's (TOWMCL) integrated waste to energy project in Delhi	262,791
SESL 6MW MSW based power project at Vijayawada & Guntur, Andhra Pradesh	64,599

Government Support for Sewage to Energy Projects

Projects Based on High Rate Biomethanation Technology

Financial assistance of Rs. 2.0 crore / MW to be provided for projects based on power generation from MSW through high rate biomethanation technology.

Power Generation at Sewage Treatment Plants

Financial assistance @ 40% of the project cost subject to a maximum of Rs 2.0 crore/MW shall be provided for projects for generation of power from biogas being produced at Sewage Treatment Plants. Project cost will include the cost of engine-genset, H_2S removal plant and other related equipment.

Carbon Credit Benefits of Sewage to Energy

Projects based on generation of electric power from biogas, which is being produced as a result of digestion of sludge in STPs, are eligible for CDM (Clean Development Mechanism), as it will help in reducing and stabilizing the emissions due to methane which is a greenhouse gas. Based on the potential of biogas/power generation

from STPs, expenditure on O&M can be offset by earning 'carbon credits' on recurring basis. Some sewage treatment plants in India are on the verge of getting the carbon credits for its efforts for reducing the carbon-dioxide emission in their sewage treatment plants.

Table 3.5Carbon Credits for Sewage Treatment Plants in India[8]

Sewage Treatment Project	Sewage Treatment Plant Capacity	CER's	Annual Revenue Estimated (INR)*
Chennai Sewage Treatment Plant with a capacity of 250 MLD	250 MLD	61,000	45.75 million
Surat Municipal Corporaation(SMC)	600 MLD	50,000	37.5 million
Delhi Jal Board (DJB)	2500 MLD	116,,256	87 million
Wastewater treatment for 1500 villages in Punjab with an average population	360 MLD	186,264	140 million

* EAI assumes that 1 CER to be approximately equal to USD 15 while the claims from each of these case studies below have taken the value of 1 CER to be USD 20 – 25

Swachh Bharat Abhiyan Scheme

The Swachh Bharat Abhiyan launched by Prime Minister in 2014, has set specific targets. For instance, all waste generators should segregate their waste at source; municipal bodies should provide solutions for dealing with segregated waste and create effective Solid Waste Management plants. In 2016, the Union Ministry of Environment, Forests and Climate Change came up with the new Solid Waste Management Rules (SWM). These rules are the sixth category of waste management rules and do not include plastic, e-waste, biomedical, hazardous and construction and demolition waste.

Urban Local Bodies and Gram Panchayats

Urban local bodies and gram panchayats will now have to train garbage collectors in solid waste management and ensure dry leaves are not burned, according to new rules framed by the Environment Ministry.

Under the new Solid Waste Management Rules 2016, released by the Ministry recently, the urban local authorities and panchayats will also prepare a plan for managing solid refuse within six months apart from arranging for door-to-door collection of such segregated waste.

[8]:http://www.eai.in/ref/ae/wte/pol/urban_waste_govt_support.html

"The local authorities and panchayats of census towns and urban agglomerations will direct street sweepers not to burn tree leaves collected from street sweeping and store them separately and handover to waste collectors or agency authorized by local authority. The authorities will also direct waste generators not to litter and to segregate waste at source before handing over to waste pickers while they have to set up material recovery or secondary storage facilities and provide access to waste pickers and recyclers for collection of such waste. Under the new rules, the local authorities will have to phase out the use of chemical fertilizers within two years and use compost in all parks and gardens maintained by them. Incentives may be provided to recycling initiatives by informal waste recycling sector. The local authorities and panchayats will also have to ensure that provisions for setting up of centres for collection, segregation and storage of waste are incorporated in building plan while granting approval of such a plan of a group housing society or a market complex.

Caselets[9]

The annual e-waste generation has been estimated for Hyderabad at 3,263,994 MT from computers, printers, television and mobile phones. The break up is as follows: 3111.25 MT from computers, 86.46 MT from printers, 61.0 MT from televisions and 5.284 MT from mobile phones. In 2010, the total e-waste projection for Hyderabad with a population of 74.42 lakh was 98,163 kgs. including 42,869 computers, 53,581 televisions and 1,713 mobile phones. In 2013, with a projected population of 81.8 lakh, the total e-waste volume is expected to reach 1,07,886kgs. including 47,117 computers, 58,890 televisions and 1,881 mobile phones. Most of the e-waste collectors and recyclers only do size reduction (shredding) and segregation. Earth Sense Recycle Pvt. Ltd. and Ramky E-waste Recycling Facility are two formal recycling units in Andhra Pradesh.(Source: Report on Inventorization of e-waste in two cities in Andhra Pradesh and Karnataka (Hyderabad and Bengaluru) sponsored by the World Health Organization (WHO), India Country Office, New Delhi; prepared by EnvironmentProtection Training & Research Institute (EPTRI), Hyderabad.

[9] https://economictimes.indiatimes.com/news/politics-and-nation/local-bodies-will-have-to-train-garbage-collectors-in-solid-waste-management/articleshow/51764252.cms

Integrating waste pickers in Brazil

A national programme to improve municipal solid waste management in Brazil, the Integrated Solid Waste and Carbon Finance Project, is developing strategies for incorporating waste pickers into local waste management systems. This effort involves multiple stakeholders—activists, academics, waste picker organizations, other affected groups, non-governmental organizations, and federal, state, and local government. The project is among the first World Bank–financed operations to include the issue of waste picking so early in the design phase—and as a central part of its basic objectives. A key focus is careful definition of the roles and responsibilities of the actors involved, including the municipality, the service provider, the financing institution, and the waste pickers. PPIAF support has been requested for developing new contractual models that will include obligations for concessionaires with respect to waste pickers. Brazil has one of the most progressive policy and institutional frameworks for waste-picking activities—and a vast range of municipal settings for investigating the dynamics of incorporating waste pickers into municipal solid waste management.

(Source: Peter Cohen, World Bank consultant, personal communication, 2008.)

Reducing child labour in waste picking

Children often engage in waste picking, to contribute to the family income or to survive on their own. Waste picking, particularly at open dumps, is among the worst forms of child labour. It can damage children's health and stunt their development. Brazil has had the most success in reducing this form of child labour, through a national campaign. Parents of child waste pickers were enrolled in *BolsaFamilia*, a conditional cash transfer programme that gives parents a monthly stipend as long as they send their children to school, get them vaccinated, and obtain prenatal care. The stipend compensates families for the loss of income from child labour. Thanks to this programme, supported by World Bank credits, more than 40,000 children left waste picking and now attend school.

(Source: Dias 2008; Medina 2007)

Kasa Rasa (Waste to Resources Centre), Ejipura

A legitimate space within an urban neighbourhood for waste management, "Kasa Rasa" waste to resources centre has been established in Ejipura, Bangalore on land provided by BBMP in January 2011 by CHF International in association with Centre for Social Action (an NGO of Christ University), SAAHAS and Bruhat Bengaluru MahanagaraPalike (BBMP). This centre is managed by SAAHAS with a capacity to process 1.5 tonnes of solid waste every day (Around 500 kgs of organic waste and 1000 kg of recyclable waste). CHF International /MythriSarvaSevaSamithi undertook a sample survey of formal and informal recyclers in Bangalore in February –April, 2011. Thiscentre has been established to demonstrate decentralized waste management systems providing a mechanism to improve waste segregation at source and recycling of waste.

Summary

The chapter provides an understanding of various bodies involved in resolving critical issues of waste management. The support from all statures is very crucial to run a successful enterprise. There is generally lack of public participation and responsibility towards waste management in the community. There is also lack of community awareness on the systems that exists in management of wastes. Chapter 4 would provide an understanding of waste pickers.

SelfAssessment Questions

1. Write an account on the organised and unorganised waste sector of your city.
2. How effectively do you participate in the waste segregation and practice waste reuse and give wastes for recycling at individual level?

Further Reading

- Sample Study of Informal Scrap Dealers and Recyclers in Bangalore February –April 2011 https://www.globalcommunities.org/publications/2011-India-Study-Scrap-Dealers-Recyclers.pdf
- Untapped Potential: Securing livelihoods dependent on 'Waste' A Review of Law and Policy in Indiahttps://swachcoop.com/pdf/WPandLaw.pdf
- Source:https://www.globalcommunities.org/publications/2011-India-Study-Scrap-Dealers-Recyclers.pdf

Chapter 4
Waste Organizers

Objectives

- Tolearn about organizing waste pickers and integrating them in waste management
- Toknow details of the various reports and commissions and committees in waste management

Structure

4.1 Improving Livelihoods – Organising Waste Pickers
4.2 The Dynamics of Organising and Integrating Waste Pickers in Waste Management
4.3 Overview of Reports of Commissions and Committees

To Do Activities

- Provide topics on waste pickers or on various commissions, committees in waste management to students and ask them to make a presentation
- Invite a waste picker and facilitate an interaction between students and waste picker
- Enact role play of waste picker

4.1 Improving Livelihoods – OrganisingWaste Pickers[10]

Usually, the organised sector is used to describe wage employment of a permanent nature in industries, government, commercial and other large-scale enterprises. Work positions in this sector are structured, differentiated by tasks and hierarchies and recorded. The conditions of work and the tenure and terms of employment are prescribed, regulated and protected by the law. Numerous economic activities that do not meet the criteria above are kept referred to as the unorganized sector. There are two opinions with respect to the relationship between the 'organised' sector and the 'unorganised' sector.

1. The unorganised sector is seen as performing the function of a buffer zone and that the fastest possible expansion of the organized sector will raise the standard of living of the poor.
2. The International Labour Organization (ILO) and the World Bank view the relationship as one of structural inequality. In their view, the flexibility, viability and adapted technology of viable activities are restricted by the favourable market conditions protected by political backing/support and government protection that are available to the organised sector.

Self Employed Women's Association (SEWA)first brought visibility to waste pickers through its publication of the Paper Pickers of Ahmedabad. The early approaches to organisation of waste pickers (1972-1991) encouraged waste pickers to transfer to work less demeaning to their dignity and less hazardous to their health. The key activities were formation of cooperatives for contract cleaning and housekeeping; collection of waste paper from government offices and institutions; and trade in waste papers (Chikarmane, P and Narayan, L, 1991).

[10] https://swachcoop.com/pdf/Recycling_Livelihoods_2008.pdf

Efforts for waste pickers include:

- Organization of waste pickers into trade union/co-operative/Self-Help Groups/ Associations
- Issue of photo-identity cards to waste pickers – in a few cities these have been endorsed by the municipalities
- Elimination of child labour in the sector and promotion of education among children of waste pickers and child waste pickers
- Increasing access to credit through self-help groups and credit co-operatives &market based interventions such as co-operative scrap stores
- Interventions to integrate waste pickers into solid waste management in order to improve their conditions of work of waste pickers
- Increasing access to social protection such as life insurance and medical insurance

Waste management and recycling pyramid hierarchy

- Re-processors/Recyclers (unorganized sector)
- Big Kabaris/Wholesale, scrap traders (unorganized sector)
- Small Kabaris/Retail Scrap Traders (unorganized sector)
- Itinerant Buyers (unorganized sector)
- Waste pickers (organized /unorganized sector)

The recycling sector is structured in the form of a pyramid, with the waste-pickers/scrap collectors at the base and the re-processors perched at the apex. The waste-pickers engage in the “free” collection of scrap from municipal garbage bins and dumps. Marginally above them are the itinerant buyers who purchase small quantities of scrap from households.

Organising for Empowerment

Waste picker organisations enter into informal agreements or formal contracts with businesses, industry, and neighborhood associations to gain access to recyclable materials or to sell materials or manufactured items. One of the main benefits of formalization is the possibility of entering into agreements or contracts for recycling programs with separation at source. Recovering materials that have been separated at source raises the productivity and incomes ofwaste pickers by freeing them from having to walk several miles a day in search of materials. By taking their work out of dumpsites, it also greatly reduces health risks from contact with waste. Source separation programs are becoming increasingly common in schools, businesses, office buildings, and residential neighbourhoods. The recyclables gathered are sold or given to waste picker organisations.

4.2. The Dynamics of Organisingand Integrating Waste Pickers in Waste Management

Scrap collection is the first stage in the recycling sector. In Asia, it is undertaken by two broad categories of workers, waste-pickers and itinerant buyers. Waste pickers retrieve paper, plastic; metal and glass scrap from garbage bins or receptacles that are provided by the municipalities for the disposal of garbage on the street, and from landfill sites where the collected garbage is transported and dumped. Itinerant waste buyers purchase small quantities of scrap from households, offices, shops and other small commercial establishments. Waste pickers can be categorized by what they collect, how they collect it and where they collect it from. Their earnings and conditions of work are circumscribed by the mode of collection. Since waste pickers are numerically the biggest category among collectors, henceforth in this study waste pickers will be the term used whenever there is generic reference to collectors.

Waste pickers can be categorized by what they collect, how they collect it and where they collect it from.

1. **Itinerant Waste Buyers (IWB)** – Generally men moving around with push carts and bicycles to buy small quantities of recyclable waste from households and small commercial establishments. In some cities, collectors would specialize in certain commodities.
2. **Informal refuse collectors -** Waste pickers and itinerant waste buyers who have been integrated into door to door collection of waste. They get a collection fee as well as the income from the sale of recyclables.
3. **Waste Pickers (WP)** –moving around foot on the streets and at garbage bins to retrieve and collect paper, plastic, metal, glass and other recyclable from household or commercial garbage.

Wage employees, municipal or contracted workers of the municipalities cannot be called waste pickers although they also retrieve recyclables from the garbage they collect in cities where garbage collection trucks move from block to block collecting garbage.

By getting organised, waste pickers can strengthen their bargaining position with industry and government, become actors in the development process, and overcome poverty through grassroots development. Working together, they can gain stability, higher incomes, and legalization of their activities. They can obtain better prices by circumventing middlemen and adding value to materials sold. Organised into co-operatives, they can

enter into contracts with industry or grant agreements. Legalizing waste-picking activities, preferably at the national level, is usually a first significant step toward improving the lot of waste pickers. This could be followed by a sequence of measures. A careful analysis of waste pickers' activities would provide reliable estimates of the number of people involved and their economic impact. A consultation process involving waste pickers and other key stakeholders could help design waste management systems that are inclusive, socially desirable, economically viable, and environmentally sound.

Thousands of microenterprises across the developing world serve neighbourhoods that lack municipal waste collection services while providing income opportunities for entrepreneurial individuals. Public-private partnerships for collecting waste and recyclables can benefit waste picker groups and the broader society. The international development organizations work to support the formalization and organisation of waste pickers in several regions. Here, legislation is an important instrument to address the all-important issue of recognition and protection for workers and employers in the unorganised economy. All workers, irrespective of employment status and place of work, should be able to enjoy, exercise and defend their rights as provided for in the ILO Declaration on Fundamental Principles and Rights at Work and its Follow-up and the Core Labour Standards. To ensure that labour legislation affords appropriate protection for all workers, governments should be encouraged to review how employment relationships have been evolving and to identify and adequately protect all workers."—ILO Resolution concerning decent work and the informal economy.

Integration efforts tend to highlight the economic aspects of waste management. The wealth in waste is something that business enterprises and smaller NGOs have begun to realize and explore. Although municipalities in India are getting into contracting and outsourcing arrangements, their ability to promote relatively transparent bidding processes and enforce contracts is not really very high.

Government schemes have been used to the advantage of waste pickers in promoting integration into waste management. The earnings from integration must be attractive enough to divert waste pickers from the streets and the landfills into integration initiatives. Diversion of waste from landfills through small scale decentralized organic waste processing plants. Also tendering and contracting arrangements with municipalities require recurring financial transactions which carry an element of risk.

4.3 Overview of reports of Commissions and Committees

- There has been a focus on the unorganised sector nationally and globally. The efficiency of the unorganised sector has been demonstrated time and again. At one side in the unorganised sector there is true entrepreneurship and at another end is fragmentation of the labour market. The integration of this sector now looks to be utilizing the entrepreneurial abilities of scrap collectors to create business models that can be accommodated within present economic paradigms without compromising the interests of labour.

- **JNNURM and CDP**
  The Government of India initiated a major urban renewal and reform program called the Jawaharlal Nehru Urban Renewal Mission in 2005. The program had two components, basic services for the urban poor and infrastructure development with focus incorporating public transport, solid waste management, slum redevelopment, sewage treatment and other civic infrastructure. The preparation of a city development plan was a pre-condition to consideration.

- **Global and national concerns with global warming**

The growing concern with global warming and the contribution of landfills to GHGs has also brought Waste Management onto the national agenda. Landfill diversion through waste processing technologies is supported by the Ministry of Non-Conventional Energy Resources of the Government of India. Although recycling of scrap paper, plastic, metal and glass contributes to less waste being disposed of in a landfill, Waste to Energy options such as pelletisation plants; Refuse Derived Fuel Plants (RDFs), plasma pyrolysis have been undertaken.

- **Clean development mechanism (CDM)** - CDM offers opportunities for the waste unorganized sector to benefit from carbon credits.

- **Public interest litigations:** Public interest litigations are often the case that landfills are located on the periphery of cities when they become operational.

- **Critical mass base**:The vertical and lateral organisation of waste pickers to city scale has provided the critical mass in terms of numbers and political strength.

- **Modalities of Engagement with the Municipality**: Municipal bodies are legal entities governed by laws and statutes that are prescriptive in terms of rules and procedures. They also have political and administrative structures that determine and implement policy. Due process requires that the integration process is approved by the administration as well the elected representatives. Of late, municipalities have been entering into arrangements with non-government organizations (NGOs), entrepreneurship organizations and startups in order to engage on a scale that is more than micro-level.

- **National Commission on Self Employed Women and Women in the Informal Sector 1988:**
  The report "Shramshakti" refers to the occupational group "Rag pickers working in the open elements and infected rubbish piles" recommended that
  1) Alternative income-generation schemes and training should be provided
  2) Effective medical facilities and protective equipment to be provided
- **The Bajaj Committee Report 1995**
  In 1995 the Planning Commission of India constituted the High Powered Committee on Urban Solid Waste Management Chaired by Mr J.S. Bajaj. The inspiration was the Rio Earth Summit and Agenda 21, where the connectivity of health, environment and sustainable development were articulated. The Bajaj Committee as it came to be called made a number of recommendations including waste segregation at source, primary collection of waste, levy of user charges, use of appropriate equipment and vehicles, focus on sanitary land filling and composting and encouraging private sector participation. The Committee strongly advocated for the inclusion of the unorganised sector in solid waste management.

- **Report on Solid Waste Management in Class I cities of India**
  At the national level it was the Public Interest Litigation (PIL) filed by Ms Almitra Patel,Convenor of the INTACH Waste Network versus the Union of India that focused national attention on the issue of solid waste management for a period of time. It was this that brought waste pickers and the unorganised waste sector onto the national agenda, rather than the activities of organisations working with waste pickers. The Hon. Supreme Court of India constituted an 8 member Expert Committee to study different aspects of Solid Waste Management across India and to make recommendations in respect of improvement.

- **The Report of the Second National Labour Commission, Ministry of Labour, Government of India, 2002**
  The Commission in its report stated that it "recognises the useful role played by the scrap collectors both in helping recycling activities as well as in maintaining civic hygiene. It is, therefore, essential that they should be protected from insecurity of various forms".

- **Jawaharlal Nehru Urban Renewal Mission (JNNURM), 2005**
  The Jawaharlal Nehru Urban Renewal Mission was launched on December 3rd, 2005. The primary objective of the JNUURM is to create economically productive, efficient, equitable and responsive cities. The JNNURM is a tremendous opportunity to integrate the informal sector into the city's work via the route of formal infrastructure. Solid waste management features in the list of infrastructure projects for the Sub-Mission on Urban Infrastructure and Governance. The physical and social infrastructure missions can be leveraged for financing infrastructure for the informal recycling sector. The size of the projects that it can fund requires re-organisation at the grassroots on a much larger scale, with groups that are large enough to work as an enterprise made up of several smaller enterprises. Currently, most initiatives in India that advocate on behalf of informal sector recyclers involve organising no more than a few thousand waste pickers.

Summary

Empowerment on the importance of waste management and various commissions that exist in support of these is very crucial. The chapter provides an understanding of various committees, commissions that proposed initiatives for a safer and cleaner environment. The next chapter would provide an understanding of public private partnership and how to mobilize support from the community .

SelfAssessment Questions

1. Write an account on various recycling schemes and technology available and being adopted by India?
2. Write an account on the waste pickers opportunities and challenges as a case study?

Further Reading

1. Just Recycling: Changing Minds about Waste Pickers http://www.wiego.org/content/sustainable-solid-waste-solutions-communities-and-climate-change-debate-marrakesh
2. The Waste Picking Community: Some Issues and Concernshttps://www.google.co.in/search?q=case+studies+on+waste+pickers&source=lnms&tbm=vid&sa=X&ved=0ahUKEwjI3-2TwbTeAhUKqI8KHWAVDHoQ_AUIECgD&biw=1242&bih=577
3. Integrating the informal sectorhttps://www.coursera.org/lecture/solid-waste-management/2-4-integrating-the-informal-sector-usCL4
4. Nohra Padilla organized Colombia's marginalized waste pickers to make recycling a legitimate part of waste management. http://www.wiego.org/resources/nohra-padilla-2013-goldman-environmental-prize-winner-colombia

Chapter 5
Public Private Partnerships and Community Driven Waste Management

Objectives

- To learn role of public private partnership in waste management, PPP – Project scoping and implementation in waste management
- To understand community based waste management (CBOs) and role of NGOs

Structure

5.1 Role of Public –private partnerships (PPPs) in waste management
5.2 PPP – Project scoping and implementation in waste management
5.3 Community based waste management (CBOs) and role of NGOs
5.4 List of Swachhta awarded institutions based on 2018 rankings
5.5 Financial and banking role in waste management

To Do Activities

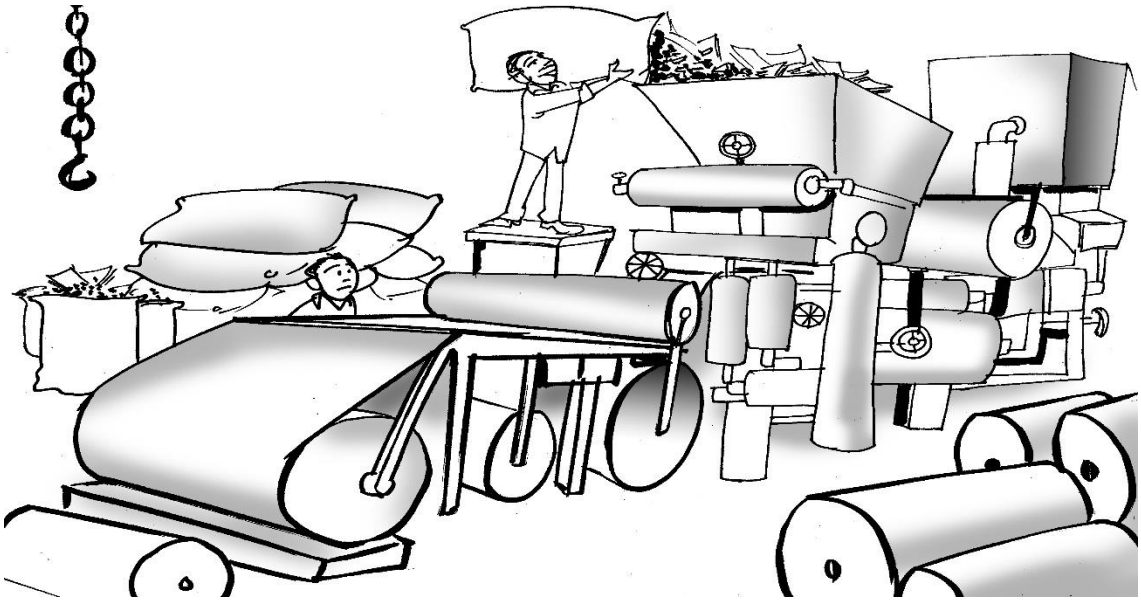
- Analyze cases studies of a public private partnership in waste management
- Facilitate group discussion on community based waste management
- Invite guest speakers from industry in waste management sector and facilitate discussion

5.1 Role of Public-Private Partnerships (PPPs) in Waste Management

The public–private partnerships (PPPs) are generally considered as an alternative to full privatisation in which government and private companies assume co-responsibility and co-ownership for the delivery of particular services. Through these partnerships, the benefits of the private sector—dynamism, access to finance, knowledge of technologies, managerial efficiency, and entrepreneurial spirit—are combined with the social responsibility, environmental awareness, local knowledge and job generation concerns of the public sector. PPPs could offer the best of both sectors, and one may believe that such alliances are naturally inclined to form.

The overall objective of involving the private sector is to achieve an improvement in performance indicators for the provision of waste management services and to extend coverage to the yet un-served. Delegating tasks and responsibilities to the private sector, however, also entails new challenges for all. All critical factors must be taken into account to prevent misuse or failure of private sector participation. The advantages and disadvantages of involving the private sector strongly depend on the manner in which the tasks and services are contracted out and on the way the daily operational procedures of collaboration between public and private sector are handled and ensured. In general, PPPs provide local bodies the following advantages apart from potential improvements in service delivery and bringing in external investment:

- **Flexibility:** Private participation improves flexibility in the system as the private sector tends to bring in more flexibility to hire qualified staff members and pay the salaries those experts demand, and in line with performance & productivity. Generally, this results in faster decision making process with minimal inter-departmental overlaps and coordination, and effective managerial processes and administration. (Source : GoI-ADB-PPP Initiative Improving delivery of MSWM services in India through PPPs – Overview and Process)



- **Managerial and technical know-how:** Private participation helps bring in areas of competence that may not be fully available with the ULB including access to technology & expertise, access to financial resources for new investments. While the ULB may also seek to acquire these over time, a PPP arrangement helps local bodies achieve service delivery results faster by leveraging complementary private sector competencies.

- **Contestability and Operational accountability:** Identifying a private operator through a bidding mechanism on a common scope of services and defined accountability for service performance helps ULBs acquire services in a cost-effective manner and creates incentives for good performance & service delivery.

Table 5.1 PPP Contracting Options[11]

S.No.	Scope	Public Private Partnership
1.	Door-to-door Collection	Service/Management contracts
2.	Street Sweeping	Service contracts
3.	Construction & Maintenance of Community Bins	BOT and its variance and/or Separate EPC and O&M Contract
4.	Transportation of Waste to integrated processing & disposal facility	Concession and/or O&M Contract
5.	Design, development, operations & maintenance of processing and treatment facility for MSW including special waste like vegetable market	BOT and its variance and/or Separate EPC and O&M Contract
6.	Design, development, operations & maintenance of sanitary landfill site	BOT and its variance and/or DFBOT and/or Separate EPC and O&M Contract

[11]GoI-ADB-PPP Initiative Improving delivery of MSWM services in India through PPPs Volume I – Overview and Process

5.2 PPP – Project Scoping and Implementation in Waste Management

Table 5.2 Project Scoping and Implementation

Options	Service contract *(Collect, transport, cleaning, disposal of MSW)*	Management Contract *(Collect, transport, cleaning, disposal of MSW)*	BOOT/ Concession *(Integrated MSWM/ Waste Processing)*
Asset Ownership	Ownership with ULB other than investment by private service provider in transportation fleet.	Ownership with ULB other than investment by private service provider in transportation fleet & related equipment.	Ownership with private developer during the contract period other than the land, and to be transferred back to ULB at the end of the contract.
Operation & Maintenance	Private service provider	Private service provider	Private developer
Capital Investment	Only in transportation fleet by private service provider.	Only in transportation fleet and related equipment by private service provider.	By private developer other than the land.
Commercial Risk	ULB or state agency	Partly with private service provider and with ULB	Completely with private developer
Duration	1-2 years	3-8 years	Above 10 years

1. **PPP for setting up Waste Processing and Land Fill facilities:** A local body could consider a PPP project focused on waste processing and land fill components when it has a reasonably good collection and transportation system and land available and earmarked for setting these facilities, but faces the following requirements and challenges:

    - Inadequate Technical & Managerial expertise for sustainable waste processing and disposal facilities
    - Inadequate funds for initial capital investment required for setting processing and disposal facilities
    - Lack of market linkages for recyclables & by-products (compost, RDF, power etc.)

2. **PPP for setting up Waste Processing:** A variant of the first model, an ULB could consider a PPP project focused on waste processing component alone when it has the above conditions, but has an existing landfill disposal facility which is more than 30 km from the city and requires decentralised processing to optimise transport expenditure. Under these circumstances, an ULB may choose to implement stand-alone processing facility (ies) on PPP.

3. **PPP for Collection and Transportation:** An ULB may choose to implement a PPP for waste collection and transportation when it is faced with the following requirements and challenges. Even if the ULB does not have a landfill/processing facility and wants to implement a PPP for this, it may choose to engage different operators for various components.

    - Inadequate manpower and equipment for collection & transportation
    - Inadequate technical & managerial expertise for sustainable waste management solution;
    - Lack of funds for initial capital investment requirement for equipment, vehicles etc.

4. **PPP for Mechanized Refuse Transfer Station (MRTS):** While it is very rare that a ULB goes in for a PPP arrangement only for managing a discrete facility like a Transfer station, such options become necessary/viable for large cities that require significantly large quantities of waste and require intermediate storage and sorting before taking the waste to processing/landfill. Such an arrangement is typically required when

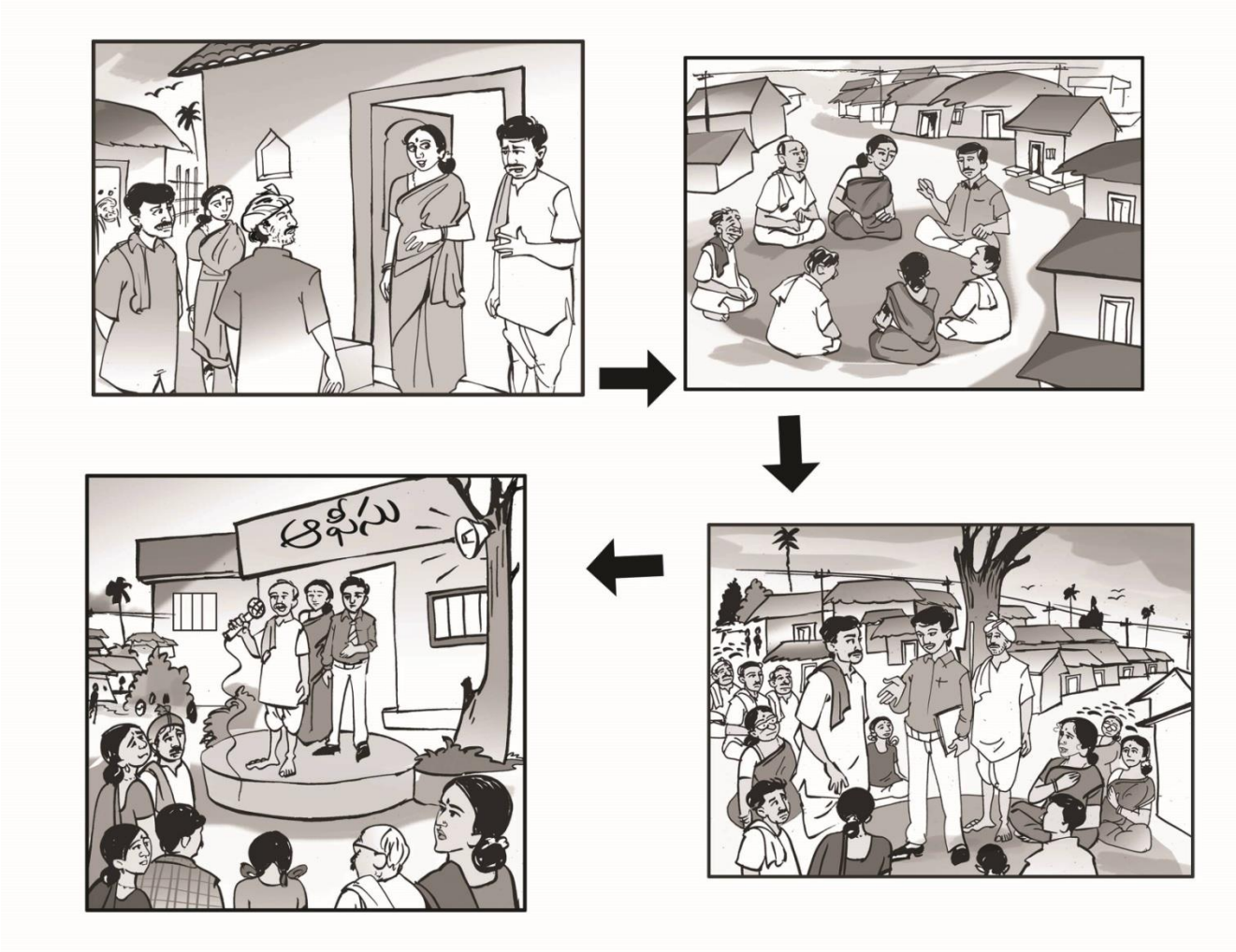
- Distance of processing /landfill is more than 20-25 km; thereby need for MRTS to gain transport efficiency.
- Quantity of waste is more than critical mass of 280 TPD;
- Lack of technical & managerial expertise for development and operations of MRTS;
- Lack of funds for initial capital investment requirement for equipment, vehicles, MRTS

etc.

5. PPP for Integrated SWM[12]: Integrated SWM involves handing all parts of the value chain either for the whole city (or) for parts of city linked to a specific processing and landfill facility. A Hybrid of this approach could include transportation and collection in one part of the city (rest managed by either the ULB or another operator) as well as the processing and disposal facility. Naturally, Integrated SWM contracts will tend to be complex, but when structured and tendered well to a capable operator presents potential for greater efficiencies.

- Lack of adequate manpower and equipment for collection & transportation
- Lack of technical & managerial expertise for sustainable waste management solution;
- Lack of funds for initial capital investment requirement for processing facility;
- Lack of market linkages for recyclables & by-products (compost, RDF, power etc.);
- Availability of land for setting up of processing facility and sanitary landfill

5.3 Community Based Waste Management (CBOs) and Role of NGOs



The role of community members begins from being wise to waste to participation in decision-making. Community members in communities play different roles in waste management. These roles correspond to different levels and extent of community participation. Community members can participate in waste management by showing proper sanitation behaviour along with the following key aspects

- Adapt daily habits to agreed solid waste system (rules, schedules, e.g. to offer it at the right time and place to the collection team)
- Bring garbage to communal collection point for transfer
- Store garbage in a plastic bag, a special bin etc.
- Co-operate in clean-up campaigns
- Keep house and immediate environment clean (drains, streets in front of the house)
- Separate waste in organic and non-organic, wet and dry, keep plastic, paper etc. apart
- Compost the organic fraction in own backyard

Participation in consultation may take place during assessment study through home visits and meetings organized by CBOs to talk about the needs and problems regarding waste management. It may include:

- Answer preparatory research questions

- Attend meetings
- Elect leaders, representatives who manage waste collection
- Elect members of micro-enterprises
- Give feedback about collection system/waste services to operating team or management

Participation in administration and management is a priority of utmost importance for community participation in waste management. It includes:

- Take part in committees
- Become member of a CBO involved in waste collection, environmental education, etc.
- Participate in decision-making during meetings

Management of waste services can be carried out by community-based organizations or by new committees particularly established for this purpose. Members of CBOs may also participate in the management committee of a waste service. The tasks of this management committee can be defined as follows:

- Performance control of services
- Administration of activities
- Engage personnel for operation
- Manage fee collection
- Keep treasury
- Decision-making on operation

Key points

Contact with the municipality can happen in different forms

- Communicate about the coordination of primary and secondary collection systems
- Forward complaints about performance service
- When no service is delivered to the area, or when certain equipment is needed, it can exercise political pressure on the municipality, the mayor, etc. Complaints on the secondary collection from households can be forwarded jointly by them to the municipality, or to the management committee when the complaints concern the primary collection system.

Other initiatives (Education and awareness)

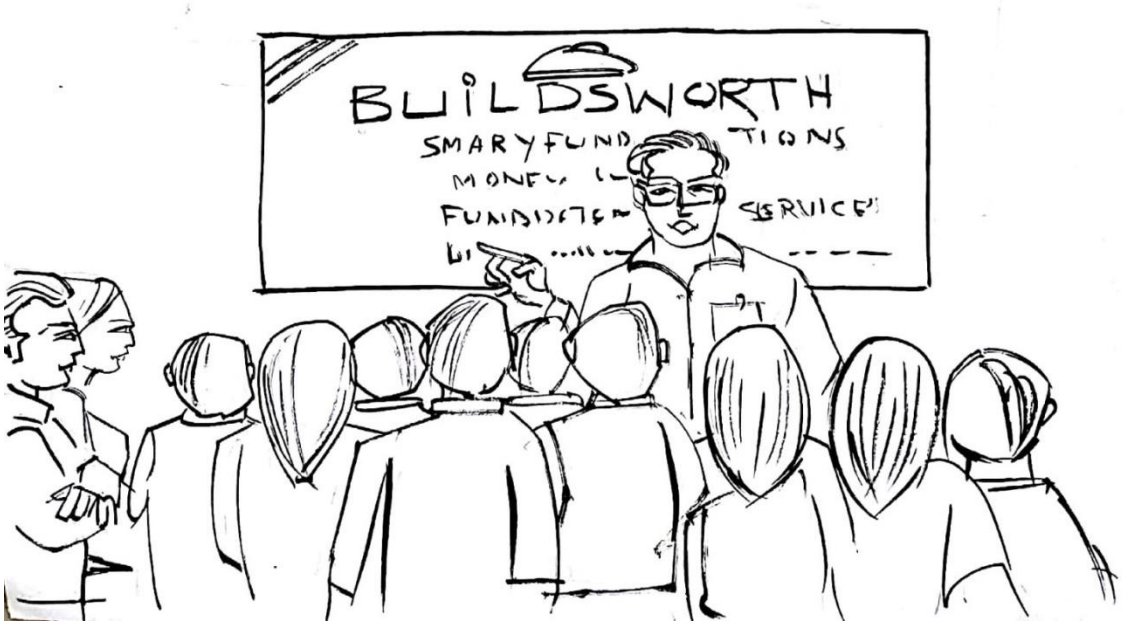
- Carrying out education and awareness drives and campaigns
- Sustainable consumption pattern
- Mobilize the community

A community-based organization may design and implement education campaigns, even if it is not directly involved in waste collection or treatment. Thus it can support collection services and change the behaviour of the citizens.

Micro-Enterprises and CBOs Working Together

Co-operation between micro-enterprises and community-based organizations is not uncommon. Micro-enterprises are co-operative enterprises with eight to twenty-five members who share responsibilities and income and who operate together a waste collection scheme, street sweeping, etc. Sometimes members of a micro-enterprise live in the neighbourhood where they operate a service, but this is not always the case. They are included as part of community management only, when the service is somehow controlled by community

members. Community-based organizations (CBOs) are organizations that derive their members from and operate in a specific neighbourhood (or village, in a rural context).
These two groups of people may work together to manage and operate a waste service in a neighbourhood, sometimes with separate objectives. A CBO usually works more from the perspective of a clean neighbourhood; while a micro-enterprise will generally focus more on its income generating aspects. Generally the CBO has management and supervision tasks, while the micro-enterprise is responsible for operating the service.



Governmental Institutions Assisting CBOs
It includes organizational structure of a community-based solid waste service through the involvement ofgovernmental institutions assisting CBOs. These institutions may be the governmental agency responsible for waste management or, which is more common, the local governmental authorities, either administrative bodies or government-led development committees. Usually these governmental institutions have relatively much autonomy towards the central government and their motivation comes from their need to control all community services. They are usually involved in the overall supervision of the solid waste service, but in some cases their participation extends to financial control or technical support, e.g. the provision of a refuse collection vehicle. In this organizational structure, operation and management of the service are carried out by several CBOs, either motivated by the generation of income or by the interest in a clean neighbourhood.

Non-Governmental Organizations and Waste Management
The term, "Non-Governmental Organization" or NGO, came into currency in 1945 because of the need for the UN to differentiate in its Charter between participation rights for inter-governmental specialized agencies and those for international private organisations.
Non-governmental organizations (NGOs) operate between the private and governmental territories. NGOs may provide important support to informal sector waste workers and enterprises, assisting them to organize themselves, to improve their working conditions and facilities, increase their earnings and extend their access to essential social services such as health care and schooling for their children.

NGOs may help to increase the community's capacity to manage waste collection:

- People's awareness of waste management problems
- Organizational capacity and the formation of community-based organizations (CBO)
- Channels of communication between CBO and government authorities
- CBOs voice in municipal planning and implementation processes
- Technical know-how of locally active CBO, and
- Access to credit facilities

Caselet

Waste Management and Clean Development Mechanisms

- Gorai Landfill Closure & Gas Capture Project, Mumbai
  Location: Western Suburbs of Mumbai under MCGM Area : 19.6 hectare Operational : Open dumping since 1972 Waste quantity : Approx. 2.34 mn. tons of waste was accumulated.
  PPP Structuring: 15 years PPP with construction and O&M Private Player : Consortium of UPL & Van Der Weil Strotgas BV Implementation Phase:
- Construction in 20 months at a cost of Rs. 500 million
- O&M estimated at Rs. 120 million (15 years of post-closure care) Clean Development Mechanism:
- Gorai is the 1st dumpsite closure from India to be registered at UNFCCC
- MCGM received a Carbon advance of Rs 25.0 crore against future delivery of carbon credits
- Advance from Asia Pacific Carbon fund of the Asian Development Bank Estimated Project Benefits:
- Reduce Greenhouse Gases by 1.2 million tons of CO_2 over a period of 10 years
- Power generation from Methane
- Expected CDM Revenues over 10 year period – Rs. 70.0 crore

Source: http://swachhbharaturban.gov.in/writereaddata/Tookit-Public.pdf

5.4 List of Swachhta Awarded Institutions as per 2018 ranking

Table 5.3 List of Swachhta Award Winners in 2018

Name of the Category	Name of the Institute
Government Institutions	MaharshiDayanand University (Rohtak, Haryana) Guru Nanak Dev University (Amritsar, Punjab) Institute of Liver and Biliary Sciences (Delhi, Delhi) Algappa University (Karaikudi, Tamil Nadu) Acharya Nagarjuna University (Guntur, Andhra Pradesh)
Technical Institutes	Amrita ViswaVidyapeetam (Coimbatore, Tamil Nadu) Indian Institute of Technology (Guwahati, Assam) Siksha 'O' Anusandhan University (Bhubaneswar, Odisha) Indian Institute of Information Technology (Delhi, Delhi)
Private Universities (Residential)	Symbiosis International University (Pune, Maharashtra) O. P. Jindal Global University (Sonepat, Haryana) K.L.E Academy of Higher Education and Research (Belgaum, Karnataka) Manipal University (Jaipur, Rajasthan)
Private Universities (Non-Residential)	ITM University (Raipur, Chhatisgarh) Northcap University (Gurugram, Haryana) Dr. C.V. Raman University (Bilaspur, Chhatisgarh)

5.5 Financial and Banking Role in Waste Management

It is a well-known fact that massive amount of waste critically affects public health, the environment, economic development and citizens' quality of life. Proper management of solid waste is achievable: a range of tools and technologies already exist. But the critical bottleneck lies in paying for them. In many lower income countries, municipalities already spend 20% to 50% of their budgets on solid waste management, yet only manage to provide services for less than half their citizens. A related major concern lies in long-term sustainability in the sector, which requires greater efforts to reduce, reuse, recycle and overall avoid waste.

A new report by the World Bank and the Global Partnership of Output-Based Aid (GPOBA) titled Results-Based Financing for Municipal Solid Waste looks at how to apply a results-based-financing (RBF) approach to the municipal solid waste sector. This is an innovative development finance tool that helps ensure that public funds are used efficiently and transparently. Under this approach, achieving and verifying a set of explicit, pre-determined performance targets is a condition to receive payment for services or certain behaviors.

Results Based Financing– where payments are tied to results – can play an important role in improving municipal solid waste services and outcomes. Some of the advantages of this approach include:

- Addressing some of the fundamental issues of the sector such as fee collection and behavior change toward recycling and source separation of organic waste;

- Providing access to basic services for the poor and reducing the adverse impact of uncollected or inappropriately disposed waste among low income residents;

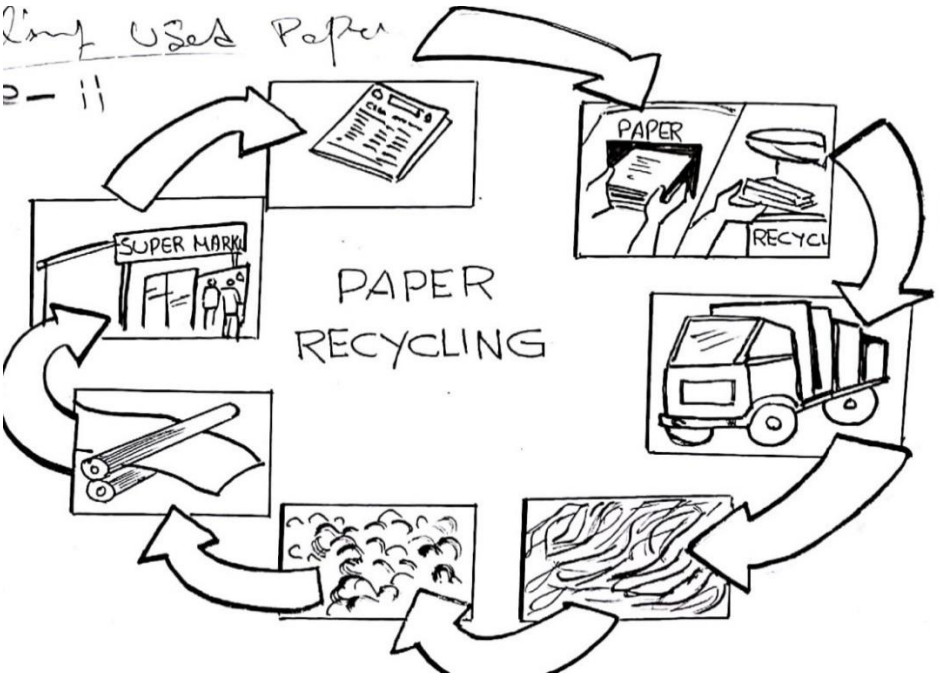
- Increasing transparency and accountability in the use of public funds through an independent verification process.

With a global shortfall in financing for the municipal solid waste sector, every investment counts. Each city, however, needs to look at its particular context to wisely choose how to best spend its resources.

Results Based Financing Design Grouped into Three Categories

1. **Improving solid waste service delivery and fee collection**
   This is an appropriate model for lower income countries where service delivery is poor or non-existent and where fee collection to support waste collection and disposal is a major challenge. It is also a helpful model to jump start solid waste services in fragile and post-conflict situations where the private sector may be reluctant to enter. Cities in Nepal and the West Bank are covered here.

2. **Promoting source separation and recycling**
   For middle income countries like China, Malaysia or Indonesia, where municipal solid waste collection rates are already high, government tends to focus on improving the financial and environmental sustainability of the sector. RBF can be used to design projects that provide incentives to households for waste separation and recycling.



3. **Strengthening waste collection and transport in under-served communities**
   This model is applicable to both low and middle income cities but is most relevant where the focus is to improve services in under-served and low income communities within cities, such as those examined in Tanzania, Jamaica and Mali. These project designs could be integrated into community and slum upgrading projects.

Rural Caselets(Waste Management)

The key issues of waste management in rural areas, and differences compared with urban areas are:

• Increasing quantity of waste generation: The quantity of waste generated is increasing in rural areas as a result of increased population, consumerism and commercial activities. It is estimated that 15,000 to 18,000 million liters of gray water and 0.3 to 0.4 million metric ton of solid waste are generated each day in rural areas (DDWS-UNICEF, 2008). Although the quantity of waste generated in rural areas is increasing, it is still relatively low compared with urban areas

• Rural/urban situation: Given the smaller size and relatively stronger community links in rural settings, initiatives for waste management are relatively easier to implement in rural areas compared with urban areas; and

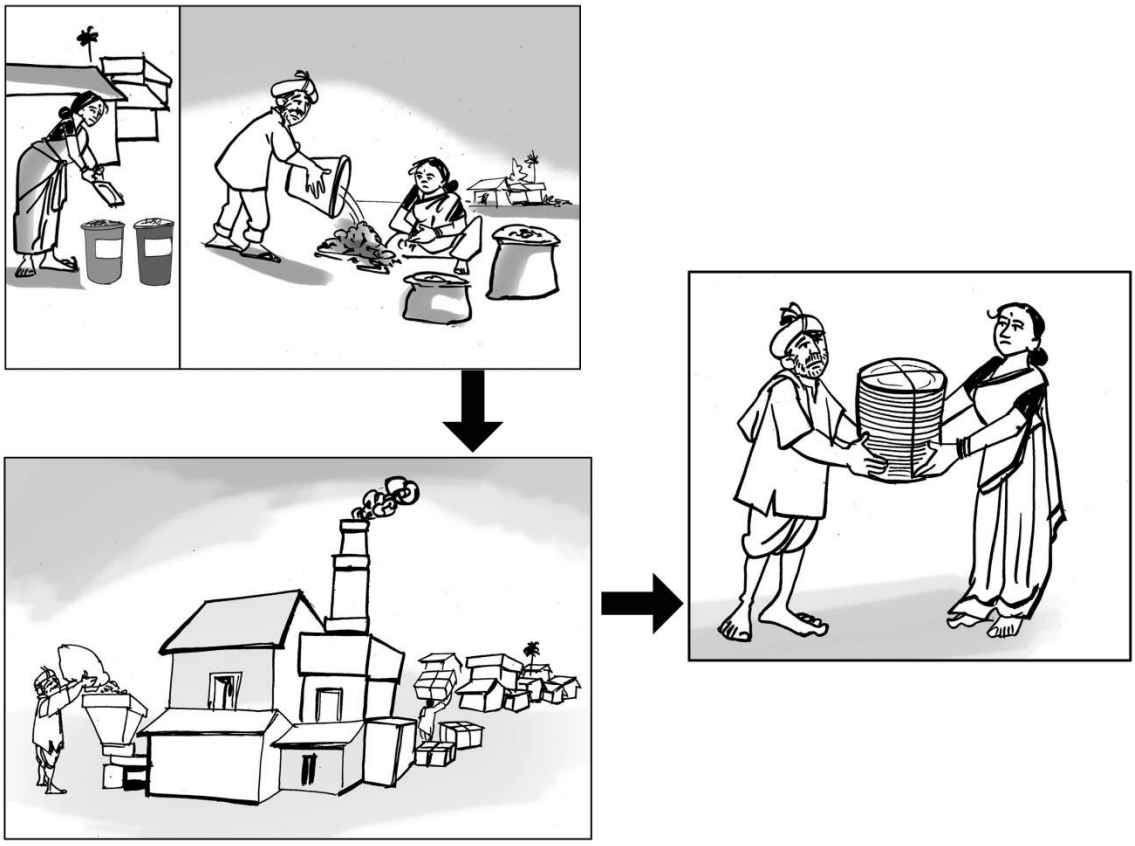
• Options for waste disposal: In rural areas, compared to urban ones, land availability is not often a constraint. Also, there are more options possible in rural areas for reuse of waste, such as composting of biodegradable material, which can be used in kitchen gardens, agricultural fields, etc.

Level	Organisation
State	Public Health Engineering Department
	Water Supply and Sanitation Department
	Communication and Capacity Development Unit
	Panchayati Raj and Rural Development Department
	Tribal Development Department
	State Pollution Control Board
District	Zila Panchayat
	SBM (G) Cell
	NGOs
	Private sector
Block	Block Development Officer
	Panchayat Raj Public Works
	Block Resource Centre
	NGOs
	Private sector
GP	Gram Sevak/Sachiv
	Panchayat Development Office
	Community based organisations
	SHGs
	Private sector/entrepreneurs
	Households

Source: Ministry of Drinking Water and Sanitation and Asian Development Bank (2014) Guidelines on Solid and Liquid Waste Management (SLWM) in Rural Areas. Government of India.

The State Governments through centrally sponsored schemes like Swachh Bharat Mission (Gramin) makes grants available for construction of facilities required for solid waste management. However, in the event of this fund being insufficient, GPs have approached CSR (for instance, Kurudampalayam GP, Coimbatore district, Tamil Nadu) and NGOs (for instance, Mudichur GP, Kancheepuram district, Tamil Nadu). There are also instances where the District administration and DRDA have found other sources of funds to assist setting up

solid waste management facilities. This is about initial investment. The real challenge is about covering the operational expenses (running cost) of the unit month after month, paying workers salary, maintaining collection vehicles etc. There are income sources in an SWM unit viz. sale of compost and service charge collection etc. One general complaint from GPs that are already involved in SWM is the irregularity in service charge payment - this irregularity is up to 30 %. Therefore, the income from sale of compost, and service charge cover only a portion of the expenditure. As mentioned elsewhere in this handbook, where GPs have taken up the task of SWM, they follow social enterprise model only – meaning the expenditure is offset by another confirmed source of income to the GP. For instance, in Mudichur GP in Tamil Nadu, they offset the loss incurred in 19 SWM against the income they earn from sale of drinking water through RO Plant.



Summary

Mobilising support from community is very important for addressing the problem of managing waste in India. Empowering and spreading awareness about the problems associated with waste dumping, and their repercussion on health is an issue to be dealt with. NGOs play a major role in bringing in transformation to the society as a whole to a cleaner environment. As it is said, “It is never late”, let us begin the process of educating the importance of proper waste disposal and management for conserving the environment for future generations.

Self Assessment Questions

1. Write a public private partnership successful model of waste management implemented in your city or rural area as a case study.
2. Create a database of NGOs and community based organizations in waste management? List them in tabular form with details of their area/level/stage of waste management.
3. Write an account on waste management practices in your city/town/village under the Swachh Bharat Mission. Also mention whether the practice is being funded and monitored as per the Abhiyan mission or not.
4. Write an account on the waste to energy being implemented /practices in rural areas.

Case Studies

1. Swachh Bharat Mission Exposure Workshops (May - October 2017) https://smartnet.niua.org/content/480f1fbd-2cd7-43ac-98ae-dcc87ff190f6
2. Best Practices on Solid Waste Management in India https://www.susana.org/en/knowledge-hub/regional-chapters/indian-chapter/library-indian-chapter/details/2939
3. Waste management http://www.infrastructurene.ws/2013/11/13/funding-proposals-for-effective-waste-management/
4. Making biogas user-friendly for cooking as solution to Urban Waste https://youtu.be/zMAWbXIwrXw
5. How to Finance Solid Waste Management http://www.worldbank.org/en/news/video/2014/10/30/how-to-finance-solid-waste-management
6. Case study of SWM Unit in Mudichur GP in Tamil Nadu, http://www.nird.org.in/nird_docs/sb/doc5.pdf

Further Reading

1. Public-Private Partnership (PPP) in Solid Waste Management in India https://www.youtube.com/watch?v=JfbeQm0KirI
2. The role of the private sector https://www.coursera.org/lecture/solid-waste-management/2-3-the-role-of-the-private-sector-z7xNy
3. Capacity building on waste management: http://cedindia.org/wp-content/uploads/2013/08/Capacity-Building-for-Solid-Waste-Management.pdf
4. The Role of Community Members in waste managementhttps://www.coursera.org/lecture/solid-waste-management/2-5-the-role-of-community-members-pt4pt
5. Municipal Solid Waste Management : Role of NGOs, Rag Pickers and Public Sectors https://www.powershow.com/view/402969-ODM5O/Municipal_Solid_Waste_Management__Role_of_NGOs_Rag_Pickers_and_Public_Sectors_powerpoint_ppt_presentation
6. Financing Solid Waste Management http://www.worldbank.org/en/news/feature/2014/10/30/how-to-finance-solid-waste-management

References

1. Annepu RK. 2012. Report on sustainable solid waste management in India. Waste-to-Energy Research and Technology Council (WTERT) 1-189. See http://swmindia.blogspot.in/
2. Chandrashekar et.al. (2014), 'Factors that influence Entrepreneurship in India- an Exploratory Study', Conference proceedings by 7th Annual EUROMED Academy of Business Conference, Norway, https://s3.amazonaws.com/academia.edu.documents/35271901/euromed2014-book-of-proceedings-2014-10-13-FINAL.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1542625120&Signature=Ih3zRI0ADt2inI262DJRal4AK7Y%3D&response-content-disposition=inline%3B%20filename%3DProceedings_of_the_7th_Annual_Conference.pdf#page=1349 , accessed on Nov 19, 2018 at 15:44)
3. Heller, R (2006), 'Nine qualities that make a great entrepreneur', https://www.leadershipreview.net/nine-qualities-make-great-entrepreneur, Accessed on Nov 19, 2018 at 16:16.
4. Higgins, B (1997), 'The Economic Development', p.219.
5. Kao, J and Stevenson, H (1984), 'Entrepreneurship-What it is and How to teach it', Harvard Business School, P.7.
6. Kao, J.J (1989), 'Entrepreneurship, Creativity and Organization: Text, Cases and Readings', Indiana University, Prentice Hall Publications.
7. Narayan T. 2008. Municipal solid waste management in India: from waste disposal to recovery of resources? Waste Manage. 29, 1163–1166. (doi:10.1016/j.wasman.2008.06.038)
8. Ramesh, V., 2016, Entrepreneurship as a Business Model "A Review on Indian Innovations and Practices in Waste Management" International Journal of Advances in Agricultural & Environmental Engg. (IJAAEE) Vol. 3, Issue 1 (2016) ISSN 2349-1523 EISSN 2349-1531.
9. Waste Management in India - Shifting Gears, Report by ASSOCHAM, PWC, March 2017
10. Wilson DC, Velis C, Cheeseman C. 2006. Role of informal sector recycling in waste management in developing countries. Habitat Int. 30, 797–808. (doi:10.1016/j.habitatint.2005.09.005)

Annexures

1. Toolkit for Public Private Partnership frameworks in Municipal Solid Waste Management http://swachhbharaturban.gov.in/writereaddata/Tookit-Public.pdf
2. Handbook onScaling up Solid and LiquidWaste Management in Rural Areashttp://swachhbharatmission.gov.in/sbmcms/writereaddata/images/pdf/technical-notes-manuals/Scaling-up-SLWM-in-Rural-areas.pdf

Books for Reference

1. Wealth from Waste - Agricultural food and chemical Processing Waste by S.C.Bhatia
2. Solid Waste Management - Present and Future Challenges - Jagbir Singh & AL Ramanathan
3. Smart Cities - Transforming India - Prof M.P Dube
4. Waste Management Practices by John Pichtel
5. Eco-Economy: Building an Economy For The Earth by Lester R.Brown
6. Not in My Backyard - Solid Waste Mgmt in Indian Cities by Sunita Narain & Swati Singh Sambyal

Course 8 Environmental Costs and Risk Management

PG Diploma in
Waste Management & Environmental Hygiene

Mahatma Gandhi National Council of Rural Education
Hyderabad - 500004

Foreword

The need of the hour is to move from reliance on waste dumps that offer no environmental protection to waste management systems that retain useful resources within the economy. India faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. The huge volume of waste generated by an increasing urban population is impacting the environment and public health. The challenges and barriers, though significant in magnitude, also offer hordes of opportunities. Waste segregation at source and use of specialized waste processing facilities to separate recyclable materials plays a key role. Key barriers are the shortage of qualified environmental professionals who can deliver improved waste management systems in India.

Waste disposal is a very costly and unending project. This compels individuals and institutions to take shortcuts. A risk problem highlights the source, pathways and receptors under potential threat. Then an assessment plan is needed to outline the data requirements for assessment and data collection and synthesis. Identifying risks and assessing the hazards should clearly define the harm to the environment and the magnitude of the risk. Suitable techniques need to be employed to analyse and understand uncertainties within the risk assessment when possible. The risk management options need to be taken into consideration by their positive and negative effects in the light of technical and economic factors, environmental security, social issues and organisational capabilities.

Most of the time, the strategy includes terminating, mitigating, transferring, exploiting or tolerating the risk. The risk should be controlled at acceptable heights. Moreover, a clear organisational and manpower framework is essential for ensuring accountabilities. Risk managementstrategies should be communicated to the public and need to highlight public responsibility and accountability.Decision makers use risk management ‘frameworks’ in organisationsas route maps and for structural guidance. These frameworks can be useful in explaining to stakeholders the process of environmental risk assessment and management. Risks require comprehensive and detailed assessment and subsequent analysis.

Business operations cause significant environmental damage and the costs are very high. Preventing environmental damage needs to be a social and corporate responsibility and policies should be in place to clearly outline the plans and strategies for protection of environment. Achieving these goals will increase the potential value of business operations. Environmental planning includes making assessments, studies, evaluating safety features and cost evaluations.

This course on Environmental Costs and Risk Management is suitable for students of all streams - Commerce, Humanities, Science, Management, Journalism, Mass Media, Healthcare services (B Pharm, Social Work), Education, and Engineering. The extent of environmental damage and the innovations in combating the issues require scientific understanding of the subject.

The subject has vast possibilities and several interlinking themes. There is extensive scope to explore and experience different aspects of sanitation, pollution, environmental hygiene and waste management during classroom learning, practical experiments in field and laboratory, internship and dissertation. There is a sea of opportunity in this field of waste management and environmental hygiene, and an urgent need of skilled as well as dedicated workers to make our country clean and green.

Nature has interlinked realms. Similarly, subjects dealt in this course cannot be compartmentalized. They necessarily have to merge with one another. It is therefore important that students try to make these

linkages in their minds rather than treating subjects in isolation. Students can make the most of this learning opportunity as they prepare to launch their careers in a field that holds great premise.

Dr. W G Prasanna Kumar

Chairman, MGNCRE

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This Post Graduate Diploma course on Waste Management and Environmental Hygiene is a cumulative effort of several sincere and committed visionaries and academicians. Envisioned by Shri VLVSS Subba Rao, Senior Economic Advisor, MHRD, the curriculum took shape under his keen guidance.

The sincerity with which the course curriculum was completed and published can be assessed from the fact that a prior National Consultation Workshop was held with several subject matter experts and academicians across the country, to review the contents of the course material.

The workshop was held to familiarize Central, State and Private Universities, local and social bodies with the contents of the curriculum and to discuss and share feedback on ways to improve the course curriculum. The workshop also focused on building industry–academia partnerships in Waste Management and Environmental Hygiene through an intellectual interaction. The findings and inputs of the consultation were subsequently incorporated in the course material.

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Contents

List of Figures

Objectives

- To calculate, study and report the socio-economics of neglecting waste management and environmental hygiene
- To understand cost to human health, the environment and the economy.

Rationale

Waste management and environmental hygiene is the need of the hour and needs to be addressed across all sectors and communities. The course on Waste Management and Environmental Hygiene gives the student an overview of waste management including collection, transfer, transport, and disposal along with methods of processing, basic disposal facilities, disposal options, recycling, project management and GIS applications, reclamation and remediation, entrepreneurship and job opportunities in waste sector. In addition, this course provides the student with relevant information about waste markets, recycling trends, cost and affordability of waste management practices, and incentive based concepts. This course is therefore essential for the students who wish to pursue a career in waste sector as moving ahead, waste management will become an infrastructural necessity.

Competency

The course will be taught and implemented with the objective to develop required skills sets in the students so that they are able to acquire following competencies: Plan segregation, collection, transportation, recycling and disposal of wastes, know recycling trends and available waste markets, acquire skill development and know the scope and entrepreneurship opportunities in the waste management sector.

Methodology

The theory will be taught and practicality of the course will be addressed through questionnaires, self-assessment and dissertation. The course will be through class room lectures, guest lectures, field visits, audio – video learning mode, brainstorming sessions, seminars and Q&A. A lecture series will strengthen students' understanding of waste management which will help in acquiring different learning outcomes in rational and theory to practice approach. Competency that will be gained as part of course outcome includes - understanding, learning, applying and implementing skills, knowing career prospects in waste management sector, and internship and placement opportunities in.

Topics Covered

- Environmental Costs
- Risk Assessment, DALY
- Economic Costs, Human Development Costs
- Social Costs: Vulnerability (who suffers most?)
- Air Pollution
- Issues of Long Term Sustainability

Environmental Costs and Risk Management – An Introduction

How would life be in the 'business as usual' scenario? What if we continue with our production and consumption, and throwing away our waste where it is out of sight? Will it really be out of sight and out of mind for long? We have read earlier about carrying capacity and assimilative capacity of the environment. Any waste within limits can be neutralized by Nature, unless it is a xenobiotic (that compound which is not naturally found in Nature). There also a possibility that a certain chemical is broken down to an extent, but then remains in the system in a more dangerous form. Often, scientists have invented certain useful chemicals and after many years of their widespread consumption, their environmental effects come to light, for instance ozone depletion due to refrigerator gases.

The speed with which our planet was urbanized was spectacular. The early part of the19th century saw a rapid growth of cities. From 734 million in 1950s, the world urban population tripled to more than 5 billion at the turn of the 21st century. Developing countries had an urban population of 448 million then, which has multiplied nearly 7 times to 3 billion, as per UN data.

In recent years, the world economy has achieved considerable economic and social development. The adoption of market-oriented policies and the active participation of the private sector have contributed immensely to this development process.

The first chapter in this course will throw light on the ecological effects of pollution caused by wastes. The repercussions are many, not all of which can be calculated in monetary terms. What price does Nature pay for human action will be explored.The second chapter discusses how the health of humans is affected by the laxity in waste management. The most vulnerable people are the first to succumb. The human cost of not managing waste is calculable. You will learn the methods.At first sight, consumerism-driven economic growth seems to be beneficial to economies. But on closer inspection, the fallacy of the economic model is visible. The third chapter in this course will elaborate on this. Then issues of sustainability will be delved into. If we continue with the business as usual, how far can we reach, and is it possible to extend the journey by making changes in our lifestyle- these will be discussed in Chapter 4. Risk assessment, resource efficiency and product stewardship are a few concepts being presented here. The last chapter deals with Environmental Impact Assessments and explains how they the process can be applied to our subject.At the end of each chapter is a note for the teacher, a few guidelines to teach the subject in class while blending classroom teaching with discussions, debates, experiments and fieldwork. The attempt throughout the course will be to prepare and launch the student into a career in environmental management.

Chapter 1

Ecological Cost of Not Managing Waste

Objectives

- To understand how solid waste contributes to climate change
- To know the ways in which pollution is affecting wildlife, forests and aquatic ecosystems
- To explore possible solutions to these pollution issues

Structure

1.1 An Overview
1.2 Green House Gas emissions and Global Warming
1.3 Air Pollution
1.4 Water Pollution
1.5 Loss of biodiversity

To Do Activities

- Show animation film on human activities.
- Discuss about air pollutants and greenhouse gases. Show videos of 4 degree temperature rise.
- Show videos on tyre burning and Deonar file.
- Explain the effects of plastic on wildlife and improper waste disposal on animal deaths, even species extinction. Show film on the plastic cow.
- Explain about biodiversity loss and animal extinction. Film on Year Zero may be screened.
- Organise a seminar of the mapping exercise reporting malpractices in waste disposal.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.
- Visit a wildlife area, tourism spot or zoological park. Find out the measures being taken for preventing plastic pollution. Write a report on the malpractices.
- Conduct a survey of any area of your city. Mark the spots where illegal dumping of sold waste takes place. What are the physical effects of the improper waste dumping? Photo-document your findings and share with the class.

Environment is no one's property to destroy; it's everyone's responsibility to protect.

– Mohith Agadi, Indian writer and Entrepreneur

1.1 An Overview

Although significant economic and social progress has been made, widespread degradation and depletion of our natural environment has taken place. This came into focus from the mid sixties with the writings of Rachel Carson (The Silent Spring) and Barry Commoner. The analysis of long term consequences of economic growth was shown in the form of natural resource limits in Malthusian scarcity (1798), Ricardian scarcity (1817), Mill's stationary state (1857) and Jevons's coal question.

The essence of the environmental problem is the economy-producer behaviour and consumer desires. Without the economy, most environmental issues are simply research questions of concern with no policy significance.

(Watch film: Human Activities that threaten biodiversity. Animated, Duration 13 min. https://www.youtube.com/watch?v=2RC3Hsk90t8)

Environmental Costs

Environmental costs are costs connected with the actual or potential deterioration of natural assets due to economic activities. Environmental full-cost accounting (EFCA) is a method of cost accounting that traces direct costs and allocates indirect costs by collecting and presenting information about the possible environmental, social and economical costs.

Direct costs are costs which are directly accountable to a cost object such as a particular project, facility, function or product.
These costs include:

- Direct materials used in manufacturing
- Direct labour
- Direct expenses, e.g. a royalty payment to a patent holder for a specific production process

Indirect costs are costs that are, but not necessarily, not directly accountable to a cost object such as a particular project, facility, function or product. It should be financially infeasible to do so for a cost to be labeled indirect. Indirect costs may be either fixed or variable. Indirect costs include administration, personnel and security costs.

Concept

The following list highlights the basic tenets of FCA:

1. Costs rather than outlays
2. Hidden costs and externalities
3. Overhead and indirect costs
4. Past and future outlays
5. Costs according to lifecycle of the product

Cost rather than outlays is the cash value of the resource as it is used. For example, an outlay is made when a vehicle is purchased, but the cost of the vehicle is incurred over its active life (e.g., 10 years). The cost of the vehicle must be allocated over a period of time because every year of its use contributes to the depreciation of the vehicle's value.

Hidden costs and externalities is value of goods and services that is reflected as a cost even if no cash outlay is involved. One community might receive a grant from a state, for example, to purchase equipment. This equipment has value, even though the community did not pay for it in cash.

Overhead and indirect costs might include legal services, administrative support, data processing, billing, and purchasing. Environmental costs as indirect costs include the full range of costs throughout the life-cycle of a product (Life cycle assessment), some of which even do not show up in the firm's bottom line. It also contains fixed overhead, fixed administration expense etc.

Past and future cash outlays often do not appear on annual budgets under cash accounting systems. Past (or upfront) costs are initial investments necessary to implement services such as the acquisition of vehicles, equipment, or facilities. Future (or back-end) outlays are costs incurred to complete operations such as facility closure and post closure care, equipment retirement, and post-employment health and retirement benefits.

Environmental Costs

Internal costs -

1. Conventional costs
2. Hidden costs
3. Contingent costs
4. Image and relationship costs

External costs –

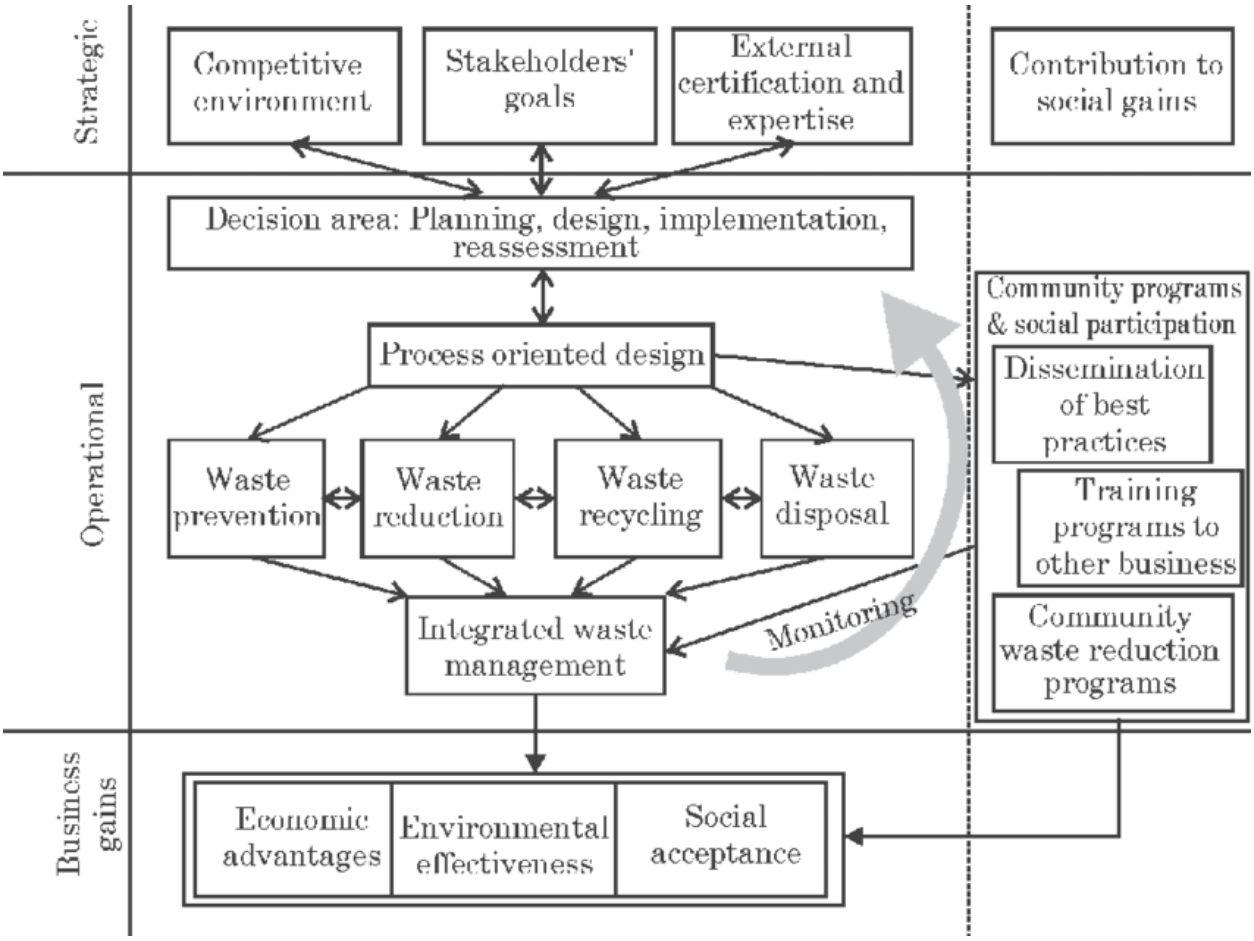
1. Environmental degradation costs
2. Human impact costs

Costs according to lifecycle of the product includes Environmental costs as indirect costs also include the full range of costs throughout the life-cycle of a product (Life cycle assessment), some of which even do not show up in the firm's bottom line. It also contains fixed overhead, fixed administration expense etc.

Waste Management

Integrated solid waste management systems consist of a variety of municipal solid waste (MSW) activities and paths. Activities are the building blocks of the system, which may include waste collection, operation of transfer stations, transport to waste management facilities, waste processing and disposal, and sale of by-products. Paths are the directions that MSW follows in the course of integrated solid waste management (i.e. the point of generation through processing and ultimate disposition) and include recycling, composting, waste-to-energy, and landfill disposal. The cost of some activities is shared between paths.

Understanding the costs of MSW activities is often necessary for compiling the costs of the entire solid waste system, and helps municipalities evaluate whether to provide a service itself or contract out for it. However, in considering changes that affect how much MSW ends up being recycled, composted, converted to energy, or land filled, the analyst should focus the costs of the different paths. Understanding the full costs of each MSW path is an essential first step in discussing whether to shift the flows of MSW one way another.



Source: researchgate.net

1.2 Greenhouse Gas Emissions and Global Warming

The international goal established by the Paris UNFCCC accords of 2016 regarding limiting of global warming to 2°C began to seem, to many of the world's most vulnerable nations as dramatically inadequate.

2°C has been called a genocidal level of warming and is already our inevitable future. Hundreds of millions of lives are in the balance, should the world warm more than 1.5 °C, which it will do by 2040, if current trends continue. Nearly all coral reefs would die out. Wildfires and heat waves would sweep across the planet annually, and the interplay between drought and flooding and temperature would mean that the world's food supply would become dramatically less secure.

UN's Intergovernmental Panel on Climate Change suggests that to keep the temperatures from rising by 1.5 degrees requires such a thorough transformation of the world's economy, agriculture, and culture that "there is no documented historical precedent."

We are coursing along a trajectory that leads to 4°C beyond pre-industrial levels by the end of the 21st century. The IPCC is right that two degrees marks a world of climate catastrophe.

A 2°C temperature rise will bring the melting of the Arctic ice sheets a tipping point of collapse, flooding dozens of the world's major cities this century and threatening, over many centuries, to elevate sea level as much as 200 feet. 40 million more people will suffer from water scarcity, and even in the northern latitudes heat waves will kill thousands each summer. It will be worse in the planet's equatorial band. In India, many cities would become too hot to live in. There would be 32 times as many extreme heat waves, each lasting five times as long and exposing, in total, 93 times more people. It is estimated that the per capita global GDP will be cut by 13 percent. 2°C is the absolute best-case climate scenario. Four degrees is twice as bad as that- a scenario we must avoid at all costs.

	Greenhouse Gas	Global Warming Potential (GWP)
1.	Carbon dioxide (CO_2)	1
2.	Methane (CH_4)	25
3.	Nitrous oxide(N_2O)	298
4.	Hydrofluorocarbons (HFCs)	124 to14,800
5.	Perfluorocarbons (PFCs)	7,390 to 12,200
6.	Sulfur hexafluoride (SF_6)	2,800
7.	Nitrogen trifluoride (NF_3) [3]	17200

Table 1.1 Global Warming Potential of various GHGs
Source: Kyoto Gases (IPCC 20072)

SWM- Global Warming Connection:

One among the causes of global warming is mismanagement of solid waste. Waste dumps, animal husbandry waste, biodegradable municipal waste, wastewater with very high BOD and incineration of waste (either for waste to energy or as open fires) , all of these release large volumes of carbon dioxide and methane gas, both of which are green house gases. However, considering the global warming potential (GWP) of carbon dioxide as 1, the GWP of methane is 25. Green house gases are called Kyoto Gases.

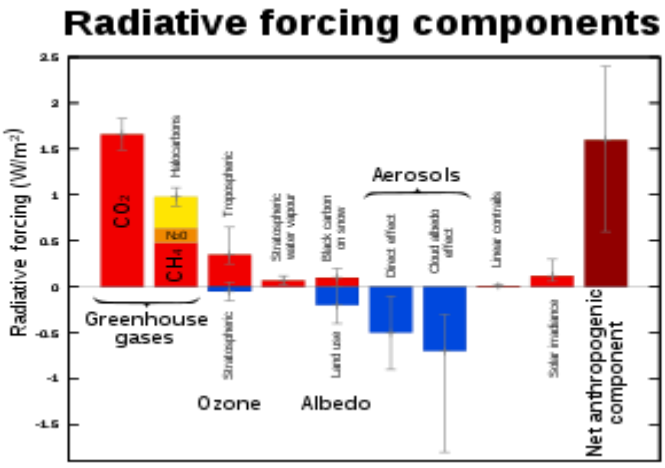


Fig 1.1 Radiative Forcing of various

Fig 1.2 Layers of Atmosphere

As is seen in Fig 1.1, there are factors that cause changes in global atmospheric temperatures. These causes can increase or decrease the temperatures. These factors force the climate to behave in a certain way. Therefore they are called climate forcing or radiative forcings.

Radiative forcing or climate forcing is the difference between insolation (sunlight) absorbed by the Earth and energy radiated back to space. The influences that cause changes to the Earth's climate system altering Earth's radioactive equilibrium, forcing temperatures to rise or fall, are called **climate forcings.** Positive radioactive forcing means Earth receives more incoming energy from sunlight than it radiates to space. This net gain of energy will cause warming. Conversely, negative radiative forcing means that Earth loses more energy to space than it receives from the sun, which produces cooling. Typically, radiative forcing is quantified at the tropopause or at the top of the atmosphere (often accounting for rapid adjustments in temperature) in units of watts per square meter of the Earth's surface.

There are a wide range of air pollutants generated by anthropogenic (human- made) activities which are directly responsible for global warming. Let us look at a few of these air pollutants, namely methane, black carbon (or soot), tropospheric ozone and HFCs.

A. Methane

Methane emissions from waste management are dominated by the decomposition of solid waste in municipal and industrial landfills. In countries managing scientific landfills, this methane is captured and put to other use.

Climate pollutants do not last long, but they are wreaking havoc on the Arctic. In the Arctic the average temperature is rising twice as fast as the rest of the world. Ice that blankets the Arctic region reflects the sun's rays (albedo) and helps regulate the Earth's climate. As it melts, the three-fold effect of sea-level rise, further increase in absorption of solar radiation, and a release of methane from thawing permafrost will occur. Warmer sea-water will allow dissolved oxygen and dissolved carbon dioxide to escape. This means less oxygen for marine creatures and more GHG in the atmosphere.

Methane, black carbon, tropospheric ozone and hydrofluorocarbons (HFCs) are potent pollutants. These are however, short lived- lasting a few weeks to a few years. Tackling the problems raised by these short-lived air pollutants could give us some time to deal with CO_2.

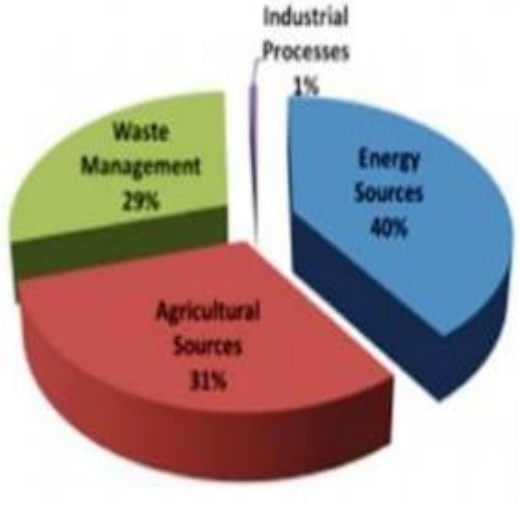


Fig 1.3 Sources of methane emissions
(Source: Earth System Research Laboratory)

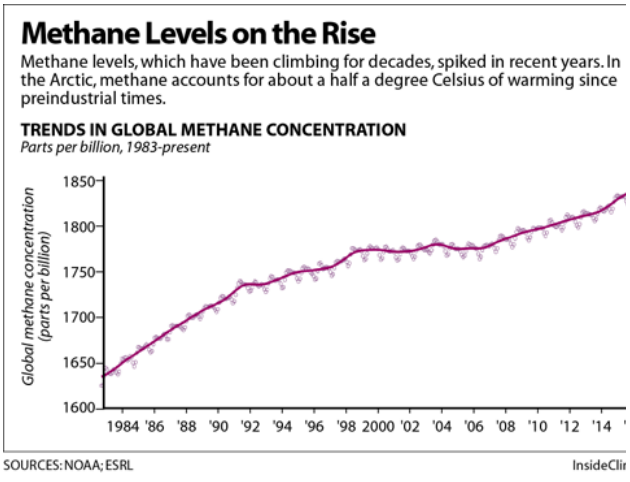


Fig 1.4 Trends in Global Methane Concentration

The solutions to waste generated methane are to use anaerobic digestors for farmyard manure, mixed with food waste to generate biogas, which can also be converted to bio-methane. These solutions have

been explained earlier. GHG emissions from waste management can be reduced. European Union brought down CO_2e annual emissions from 69 million tonnes in 1990 to 32 million tonnes per year in 2007.

B. Black Carbon

Black carbon is soot particles- particulate matter- that stays in the atmosphere for a few days to weeks. But its contribution to global warming is 100-2,000 times that of CO_2 on a 100 year scale. In climatology, black carbon is a climate forcing agent with the total forcing of 1.1 W/m^2. While it is airborne, black carbon can interact with clouds in various ways. Sometimes it causes clouds to evaporate, which leads to further warming, but sometimes it helps clouds form, which can help block incoming sunlight and cool the planet.

Smoke or soot was the first pollutant to be recognized as having significant environmental impact yet one of the last to be studied by the contemporary atmospheric research community. A lot of black carbon comes from agricultural waste burning and landfill fires. Black Carbon contains very fine carcinogens and is therefore particularly harmful.

China and India together account for 25-35% of global black carbon emissions. Black carbon emissions are highest in and around major source regions. This results in regional hotspots of atmospheric solar heating due to black carbon. The Indo-Gangetic Plains of India is one such hotspot.
Existing and well-tested technologies used by developed countries, such as clean diesel and clean coal, could be transferred to developing countries to reduce their emissions.

Farm Stubble Burning

Farm Stubble Burning has become common practice in Delhi and Haryana every November. This contributes to neary 30% of Delhi's smog at this time of the year. Nearly 120-130 million people are affected in North India (the regional hotspot for black carbon) due to air pollution. Despite a ban and a fine, straw burning has not been brought under control. There are many causes for it- removing straw is time and labour intensive, the introduction of the 'happy-seeder machine'.

Solution- Biochar

Black carbon is good for plants. Up to 30% of the total carbon stored in soils is contributed by black carbon. Especially for tropical soils black carbon serves as a reservoir for nutrients. Experiments showed that soils without high amounts of black carbon are significantly less fertile than soils that contain black carbon. This is the reason why slash and burn agriculture was successful. However, in the present scenario, 'slash and char' may be recommended. The agricultural residue is turned to char (like charcoal) and then buried into the soil.

Biochar is made by pyrolysis of straw or other farm waste at 300°C. Soil is then incubated with biochar (1.0 % w/w) for up to 50 weeks (one year). A significant decrease in soil pH is seen where the soils were alkaline, while CEC and nutrients (N, P and K) increase. Studies have proved that the application of wheat straw biochar produced at low temperature (WSB300) could be successfully used to improve soil properties and growth of plants in calcareous soils.

(Watch Films:

- *Say no to open burning of rice straw short film, Duration 5 min , https://www.youtube.com/watch?v=Vf6XgUJaQcM*
- *How To Make A Biochar Machine – TLUD, Duration: 6 min https://www.youtube.com/watch?v=YIbGkmt1VdE*
- *How to inoculate biochar. Duration 5 min:https://www.youtube.com/watch?v=f-yAq2LBVkU)*

This biochar-enriched soil is called terra preta, one of the richest soils o the planet and the only one known to regenerate itself. Slash and char method can sequester upto 50 % of the carbon in a highly stabilized form. This holds scope for carbon trading and supplementing farmers income while supporting sustainable agriculture.

C. Tropospheric Ozone

Tropospheric ozone is created when the sun interacts with methane, nitrogen oxides, volatile organic compounds (VOCs) and carbon monoxide in the atmosphere. Those precursor gases come from manmade sources like fossil fuel combustion and production, biofuel combustion, industrial processes and biomass burning. They're also caused by wildfires, natural emissions from soils and vegetation, and lightning. Manmade ozone is a greenhouse gas and short-lived climate pollutant that enhances global warming.

D. Hydrofluorocarbons (HFCs)

HFCs are an unintended side-effect of solving a problem. In the mid-1900s, scientists realized that compounds being used as coolants in refrigerators and air conditioners and as a propellant in foams—called chlorofluorocarbons (CFCs)—were also destroying the ozone layer. In 1987 a massive international effort to phase out ozone-depleting substances was launched with the signing of the Montreal Protocol by nearly 200 countries. It has been hailed as the world's most successful environmental agreement. CFCs were replaced by hydro fluorocarbons (HFCs). HFCs may not have the same impact on the ozone layer, but they are potent contributors to climate change.

HFCs are a super greenhouse gas that can live in the atmosphere for an average of 14 years, they are between 1,000 and 3,000 times stronger than CO_2.Though they are considered short-lived climate pollutants, they are in the atmosphere long enough to become generally mixed and evenly distributed across the atmosphere, much like methane. An update to the Montreal Protocol, called the Kigali Amendment, agreed on in 2016, requires all countries to slash production and consumption of HFCs by at least 80 percent over the next 30 years. The stakes for full implementation are high—the agreement is expected to prevent up to 80 billion tonnes of CO_2 equivalent emissions by 2050, which could prevent up to 0.5oC in warming.

Globally, a typical HFC commercial refrigeration supermarket system has an average annual leak rate of 30% annually, equivalent to the CO2 emissions from driving nearly 390 passenger vehicles for one year. Proper leak detection and maintenance can reduce leak rates to less than 10%, while conversions to

available low-GWP technologies would reduce direct greenhouse gas emissions of refrigeration systems to close to zero.

Globally, stationary A/C systems account for nearly 700 million metric tons of direct and indirect CO2-equivalent emissions (MMTCO2e) annually. Indirect emissions from electricity generation account for approximately 74% of this total, with direct emissions of HFC and hydrochlorofluorocarbon (HFC) refrigerants accounting for 7% and 19%, respectively.5,6 While electricity consumption is the largest driver of GHG emissions from A/C (i.e., indirect impacts), emissions of HCFC and HFC refrigerants have a disproportionately large global warming impact relative to their mass. Addressing direct emissions therefore offers an important path to substantially reducing A/C GHG emissions.

Solution: Transitioning to low-GWP refrigerants could eliminate the vast majority of direct emissions from A/C systems. The issue of waste and pollution are inseparable, when defined in a narrow sense. Solid wastes are the most visible form of pollution. It is argued that the source of most of the environmental problems lies in the inability of the economic system to take account of the valuable services the natural environment provides us. The provision of waste sinks to receive and assimilate all types of wastes from the economic system is such a service. African countries while prioritizing their environmental concerns has rated solid waste as the second most important problem after water quality since less than 30% of urban populations have some access to proper and regular garbage removal as per a report published by Senkoro, 2003.

(Watch film: What Could Happen in a World That's 4 Degrees Warmer | WIRED Brand Lab, Duration 15 min, https://www.youtube.com/watch?v=__Kt_oU9iss)

1.3 Air Pollution

Air pollution is the pollution of air by smoke and harmful gases, mainly oxides of carbon, sulphur and nitrogen. At that time, the air was thick with smoke from fires and the smell of sewers. Air pollution has been a danger to human health and Earth's many ecosystems for a long time. It is the atmosphere condition in which the presence of certain concentration produces harmful effects on man and his environment.

Causes and Effects of Air Pollution

Human activities release substances into the air, some of which can cause problems for humans, plants, and animals. The most common type of air pollution is the release of particulate matter from burning fossil fuels like petroleum products and coal for energy.

In most cases, air pollutants cannot be seen or smelled. However, that does not mean that they do not exist in high enough amounts to be a health hazard! Additionally, a number of gases are linked to the so-called "greenhouse effect", which means that those gases retain more heat and thus contribute to the overall global warming. The most common example of a greenhouse gas is carbon dioxide, which is emitted from many industrial processes. Another example is methane, which is also an explosive gas.

Primary pollutants: These are the pollutants which are emitted directly from the sources. Some examples are: Particulate Matter - Such as ash, smoke, dust, fumes etc.

Particulate matter: this includes dust, smoke, fumes etc.

- Soot: produced by incomplete combustion of carbonaceous fossils fuels such as coal, fuel oil, natural gas, wood etc in insufficient supply of oxygen.
- Metal particles: These are released by various metal finishing operation. The micro particles of toxic metal & SO_2 gas present in the polluted atmosphere get absorbed on the particles rendering them highly toxic.
- Metal oxides: They are generated by combustion of fuels containing metallic compounds.
- Lead salts: Their source is lead tetraethyl ($Pb(C_2H_5)_4$) which is added to gasoline to improve its antiknock property. In order to avoid deposition of PbO suitable amounts of $C_2H_4Cl_2$ & $C_2H_4Br_2$ are added to gasoline along with $Pb(C_2H_5)_4$.
- Fly ash: It originates from the combustion of high ash fossil. It contains partially burnt particles of the fuels.
- Asbestos dust: It originates from industrial units manufacturing asbestos sheets, gaskets ropes etc. Asbestos flowing & asbestos insulations also contribute towards asbestos dust in the atmosphere.
- Solid Hydrocarbons: These are emitted from petroleum refineries & comprise of paraffins, olefins & aromatics.
- Dust Particulates: Originate from natural, domestic, industrial or agricultural sources. These are thrown into atmosphere by volcanic eruptions, blowing of dust by wind, mining operations etc.
- Acid mist**:** Sulphuric acid mist is produced when SO_3 present in the atmosphere comes in contact with moisture. Nitric acid mist is produced when oxides of nitrogen, viz, NO & NO_2, undergo the series of reactions in the atmosphere and causes acid rain.
- Radioactive Material and many others.

Inorganic gases: Such as sulphur dioxide, carbon monoxide etc.

Sulphur dioxide**:**Sulphur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles is one the major cause of air pollution. Pollution emitting from vehicles including trucks, jeeps, cars, trains, airplanes cause immense amount of pollution.

Secondary Pollutants:
Secondary pollutants are formed in the atmosphere by chemical interaction among primary pollutants and normal atmospheric constituents. Some examples are sulphur trioxide, nitrogen dioxide, ozone, aldehyde, ketones, various sulphate and nitrate salts.

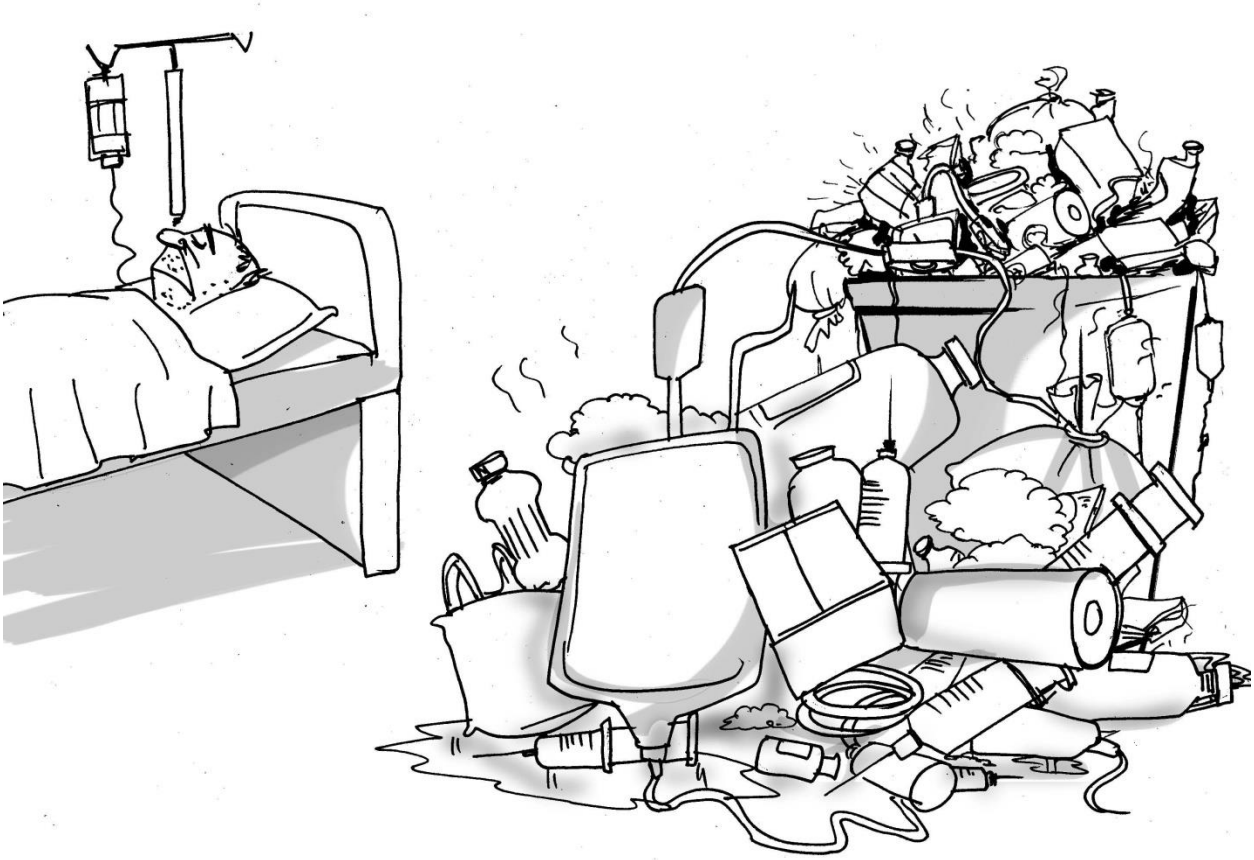
Air pollution is probably one of the most serious environmental problems confronting our civilization today. Most often, it **is** caused by human activities such as mining, construction, transportation, industrial work, agriculture, smelting, etc. However, natural processes such as volcanic eruptions and wildfires may also pollute the air, but their occurrence is rare and they usually have a local effect, unlike human activities that are ubiquitous causes of air pollution and contribute to the global pollution of the air every single day.

The Effects of Air Pollution on Human Health

Air pollution has serious effects on the human health. Depending on the level of exposure and the type of pollutant inhaled, these effects can vary, ranging from simple symptoms like coughing and the irritation of the respiratory tract to acute conditions like asthma and chronic lung diseases.

Skin problems and irritations can develop due to prolonged exposure to several air pollutants, and a variety of cancer forms may develop after inhaling air contaminants. Do not neglect potential diseases caused by air pollution. Air pollutants that have serious negative effects on the human health can be

classified as toxic and non-toxic. Stationary sources, like power plants, emit large amounts of pollution from a single location, these are also known as point sources of pollution.



Wind can move air pollutants short or very long distances before they cause harmful impacts. Parks downwind of power plants that lack modern pollution controls can have increased smog. Tailpipe emissions from cars and trucks, as well as industrial processes such as oil and gas development, give rise to elevated ozone concentrations. Summertime wildfires can also reduce visibility in NPs areas. There are even examples of pollutants that originated from other countries and were transported thousands of miles arriving at parks. The effects of this pollution can be seen as haze and through negative biological effects. Learn more about effects of air pollution on nature and visibility, and human health.

Air pollution is not defined by the activity that causes is but by the presence of pollutants in the air and their characteristics. Since many years, we are not able to dispose of solid waste completely in any scientific manner. Certain fractions of waste are segregated and put to re-use, but a good amount is left behind and gets collected over time. Many countries are using Waste to energy technology to incinerate the waste, produce useful energy out of it while also reducing the quantity of waste. By ensuring that the fumes are treated before release, they try to contain toxics from the air.

However, there are substantial risks of air pollution associated with W2E.

1. All incinerators (which include gasification, pyrolysis and plasma arc technologies) are a waste of energy. Due to the relatively low calorific value of waste, incinerators only make small amounts of energy while destroying large amounts of reusable materials.

2. Burning biogenic material such as agricultural biomass or the organic fraction of municipal waste still releases large volumes of CO_2 to the atmosphere. The atmosphere does not distinguish between fossil fuel based CO2 and biogenic CO_2.
3. W2E drives a climate changing cycle of new resources being extracted from the earth, processed and shipped around the world, and then wasted in incinerators.
4. Mercury, dioxins, lead, and other pollutants come from burning waste. In terms of climate impacts, incinerators emit more carbon dioxide (CO_2) per unit of electricity than coal-fired power plants.
5. Energy from incinerators is not renewable. Paper and metals come from finite natural resources and plastics and tires are fossil fuels. Burning these resources creates a demand for 'waste' and discourages real waste management solutions.
6. According to the IPCC Fourth Assessment report on Climate Change, "Waste minimization, recycling, and re-use represent an important and increasing potential for indirect reduction of GHG emissions through the conservation or raw materials, improved energy and resource efficiency and fossil fuel avoidance.

Air pollution confuses bees and other pollinating insects

Research shows that bees' ability to forage decreases as air pollution increases. This is because air pollutants interact with and break down plant-emitted scent molecules. The pollution-modified plant odors can confuse bees. The chemical interactions with **ozone** and other air pollutants decrease both the life span of the scent molecule and the distance it can travel. As a result, bees' foraging time increases and pollination efficiency decreases. Many insects have nests that are up to 3,000 feet away from their food source, which means that scents need to travel long distances before insects can detect them. The scent molecule alpha-pinene, which survives nearly 40 hours in an ozone-free environment, survived fewer than 10 hours when ozone rose to 60 parts per billion and only 1 hour when ozone was at 120 parts per billion. Another molecule, beta-myrcene, which travels more than 3,000 feet in an ozone-free, windy environment, traveled an average of 1,500 feet when ozone was 60 parts per billion and, when ozone rose to 120 parts per billion, most traveled fewer than 1,000 feet.

In an ozone-free environment, it took 10 minutes for 20 percent of foragers to find the scent molecule beta-caryophyllene. When ozone rose to only 20 parts per billion, it took 180 minutes for the same amount of bees to find the scent. When we confused the bees' environment by modifying the gases present in the atmosphere, they spent more time foraging and would bring back less food, which would affect their colonies.This in turn brings about a decline in pollinator – dependent wild plants, therefore an increase in populations of plants that do not need pollinators**.**

Disturbance in pollinator populations directly impacts crop yields and our own food security.

The Solution is 'zero-waste' practices such as conservation, re-design, reuse, recycling and composting.

Tyre Burning

Tyres take 50-80 years to degrade. They take up a lot of landfill space. Tyres have potential for fires which produce acid smoke harmful to humans and the environment as well as leaves behind a oily residue. Tyre fires are not extinguishable and in some instances burn for several weeks.

Burning of tyres as a cheap source of energy is common in many developing countries including India. While burning tyres does provide a cheap and efficient source of energy, the harmful effects of such burning far exceed the benefits.

Emissions from open tyre burning include "criteria" pollutants, such as particulates, carbon monoxide (CO), sulfur oxides (SOx), oxides of nitrogen (NOx), and volatile organic compounds (VOCs). They also include "non-criteria" hazardous air pollutants (HAPs), such as polynuclear aromatic hydrocarbons, dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs); and metals such as cadmium, nickel, zinc, mercury, chromium, and vanadium. Uncontrolled tyre burning has been proven to be 16 times more mutagenic, i.e capable of inducing genetic mutation, than traditional residential wood combustion in a fireplace, and 13,000 times more mutagenic than coal-fired utility emissions with good combustion efficiency and add-on controls

The National Green Tribunal (NGT) banned the burning of tyres at public places viz. roads, areas surrounded by residential buildings and also during protests by political and religious groups, as this leads to health hazards.

Tyres are 100% recyclable. The high quality of steel and rubber found in tires are easily reintegrated into the manufacturing process at very minimal or no change to existing manufacturing processes. Such products using recycled tires have proved to perform better than traditional materials. Sustainable scrap tyre management systems such as pyrolysis and crumb rubber production must be promoted.

Source: http://www.rerubber.com, https://salmanzafar.me/tyres-burning-health/

Watch Film: Recycling tyres: road to success - business planet, duration: 4 min, https://www.youtube.com/watch?v=6kD9YJ9iSfc

Mismanagement of Waste Dumps- Landfill Fires:

Landfill fires rage for days as methane trapped deep in the dump keeps providing the fuel. Two types of landfills fires are generally recognized.

- Surface Fires ,
- Deep Seated Fires.
    - Confined progression fires
    - Unconfined progression fires

Surface fires typically occur in underdeveloped countries that lack capacity to properly cover waste with inert daily and intermediate cover. Modern examples of such fires include the Deonar and Ghazipur Landfills in India, Cerro Patacon Landfill in Panama and the New Providence Landfill in the Bahamas.

Landfill Fires in India

Deonar dumping ground in Mumbai caught fire in January 2018. It took 8 fire engines and 7 water tankers to bring it into control. This has occurred before. In 2016, the smoke from Deonar, Asia's oldest and largest garbage dump, was visible from space, according to NASA images that were released days after the fire that was visible from across Mumbai.

The Dhapa landfill in Kolkata, where 4,000 tonnes of waste are dumped each day. Many make a living processing the city's rubbish amid severe pollution, fires – and even dead bodies. "The fires come on their own, from the garbage itself because of biogas," Workers observe referring to gasses produced as a result of fermentation of organic waste. "They burn all day and all night, every day of the year." These are just two examples among many across the country.

Source: The Guardian, Times of India.

(Watch film: Deonar fire, 3 min https://www.youtube.com/watch?v=2yeKYfhjviM)

In landfills that do not cover their waste with daily cover, air intrusion provides the oxygen required for increased biological activity decomposition that creates substantial heat and can cause material in the landfills to spontaneously combust. If unchecked, spontaneous combustion fires in particular tend to burn deeper into the waste mass, resulting in deep seated fires. Landfill fires are especially dangerous as they can emit dangerous fumes from the combustion of the wide range of materials contained within the landfill. Key parameters of concern are carbon monoxide, hydrogen sulphide, volatile organics, dioxins and furans.

Subsurface landfill fires are difficult to put out with water unless an overhaul operation is undertaken. They are similar to coal seam fires and peat fires. Deep-seated landfill fires can expand in two different ways known as 'confined' and 'unconfined' progression:

Confined landfills:
They are formed from multiple layers of waste deposited in thin strata which are compacted by a landfill compactor fitted with sheep's foot rollers. The rollers tend to re-align the waste into a form which is more permeable horizontally than vertically. These layers are sandwiched between layers of daily cover. In this case, a fire will tend to expand horizontally rather than vertically. A confined fire might be indicated by a shallow collapse, surrounded by tension cracks, at the surface.

Unconfined landfill fires occur in Construction and Demolition (C&D) sites. In this case there are no horizontal constraints and a fire will progress vertically upwards producing a dangerous sinkhole at the surface.

Oxygen intrusion control is the best method to prevent and fight subsurface landfill fires as long as the fire fighting team can be confident that all air entry pathways are effectively blocked. "Fuel quenching", by allowing landfill gas build-up, can work well, especially in conjunction with maintenance of the daily cover of soil or material places on landfills. The oxygen suppression method can fail if cracks develop in the soil cover due to settlement.

Nearby streams can be threatened by leachate pools which may form if water is used to extinguish fires in landfills. Recirculation of fire fighting water should be considered to minimize environmental impacts. There is also the danger that the landfill's membrane- a clay barrier, a barrier placed under most modern landfills to prevent contamination of the underlying ground, will be destroyed or penetrated by the fire itself. Normally this liner prevents harmful liquids contained within the landfill from escaping into the groundwater and nearby streams. Destruction of the liner therefore leads to serious environmental problems. Geotechnical engineers agree that a perforated basal containment system cannot be repaired at any reasonable cost.

1.4 Water Pollution

Municipal Solid Waste has tremendous potential for water pollution. Leachate pollution, surface runoff and drain digging are three major water related issues of Municipal Solid Waste.

Leachate

Leachate is produced when rain falls on waste, or if water is used to douse landfill fires. Landfill leachate is a very complex high-strength wastewater which contains suspended and dissolved materials removed from the decomposing waste in the landfill body. It consists of soluble organic and inorganic constituents. It is highly toxic and has detrimental effects on the environment.

The greatest environmental risks occur in the discharges from older sites constructed before modern engineering standards became mandatory and also from sites in the developing world where modern standards have not been applied. There are also substantial risks from illegal sites and ad-hoc sites used by organizations outside the law to dispose of waste materials. Leachate streams running directly into the aquatic environment have both an acute and chronic impact on the environment, which may be very severe and can severely diminish bio-diversity and greatly reduce populations of sensitive species. Where toxic metals and organics are present this can lead to chronic toxin accumulation in both local and far distant populations. Rivers impacted by leachate are often yellow in appearance and often support severe overgrowths of sewage fungus.

Leachate is not restricted to municipal solid waste. Coal mines, many factories and storage sites produce leachate during rains. Typically landfill leachate has slightly alkaline pH. Its conductivity and salinity are high, indicating elevated concentrations of ions and salts that are present. Ecotoxicity studies on landfill leachate supplement chemical data in assessing the ecological impacts of the leachate. Landfill leachate is so chemically complex that extensive chemical analyses are required to find out the major toxicant present. The ample supply of ammonical-nitrogen makes it seem like an attractive irrigation supplement.

Leachate Pollution in Bandhwari Landfill

The 27 acre Bandhwari landfill dump was releasing untreated leachate for a long time, polluting the groundwater as well as surface water bodies in the Aravallis. After much protest by activists and residents, a survey was conducted in 2015 by Rekha Singh, an approved Environment Expert from the Quality Council of India (Ministry of Environment, Forest & Climate Change).

Samples from a leachate pond inside the landfill had total dissolved solids (TDS) count of 6,950 mg/l, much higher than the permissible limit of 2,100mg/l, according to the Municipal Waste Management Rules, 2000. The contamination from the leachate pond has started polluting the groundwater, causing serious fluoride, phenolic compound, cadmium and mercury poisoning.

An LTP was set up by Ecogreen Energy. The first batch of water from the LTP was tested by a private laboratory on July 30, 2017. But it did not meet all the criteria specified in the Solid Waste Management Rules, 2015. TDS level in the LTP's output water dipped from 25,668mg/l to 5,194mg/l. The safe limit of 2,100mg/l was still beyond reach. The water could not be discharged into local water bodies, public sewers or even though TSS and pH values were in accordance with the rules. The tests did not take into account the presence of heavy metals and phenolic compounds.

It cannot be used in the operation of a power plant, as the TDS levels will cause 'scaling' issues in the boiler, lead to a reduction in heat, and therefore, increase electricity consumption, which is inefficient.

Ankit Aggarwal, CEO, Ecogreen Energy, said that the company was not obliged to build the LTP so soon into their contract with the MCG, "but taking cognizance of the problem, we went ahead with it first, before building the waste-to-energy plant."

Construction of the LTP began in December 2017 and was completed in April 2018, at a cost of ₹3.5 crore. "It will take about five months to completely mitigate the leachate problem," Aggarwal added.

Manoj Kaushik, a solid waste management consultant with the MCG, said, "With the plant up and running, the leachate issue is over."

The first batch of water from the leachate treatment plant (LTP) at Bandhwari landfill was obtained in Aug 2018, flagging off the plant's regular operations.At present, the plant is operating at a capacity of 150 kilolitres per day, from which about 140-odd kilolitres of treated water is being obtained.

The water is currently being stored on site and will be sent to the Behrampur sewage treatment plant for further processing. A site visit by a Hindustan Times team on Tuesday confirmed that the LTP is fully functional. "Eventually, we will use the water to construct the upcoming waste-to-energy (WTE) plant at Bandhwari," said Paresh Jindal, the deputy general manager (engineering) of Ecogreen Energy, the

Municipal Corporation of Gurugram's concessionaire for waste management. Once it meets standards, the water would be used in operating the WTE plant as well.

Seeking Leachate Management Solutions

Scientists are trying to find ways to use return the nutrients of leachate into the ecosystem without harming plants or the ground water.

Germination of *Brassica chinensis* (Chinese white cabbage) and *Loliumperenne* (perennial ryegrass) seeds has been proven to be very good surrogate model for the rapid evaluation of phytotoxicity. Instead of continuous leachate irrigation, alternating irrigation was found to be a better option.

Treated Leachate Application to Soil was done on select trees suited for leachate irrigation. 19 tree species were selected for the experiment. None showed growth retardation in the 90 day period vis-a vis water irrigation. The plant tissue and foliage showed increased foliar nitrogen content. Marked decrease in pH was observed in soil subject to prolonged leachate irrigation. This is attributed to release of bicarbonate ions (HCO3-), when nitrates are used. Soil enzyme activity could act as an integrated index of soil biological status. Studies are underway regarding possibilities of increasing soil nutrition with leachate, without increasing toxicity. Scientists are working in Poland with the willow tree, irrigating it with leachate in a manner that only enough leachate is applied for their irrigation, which will be lost through evapotranspiration, rather than excess leachate that could cause groundwater pollution.

Microplastics

Vembanad Lake

Microplastic pollution in Vembanad Lake, Kerala, India: The first report of microplastics in lake and estuarine sediments in India by ShiniSruthy and E V Ramasamy, MG University.

The Ramsar site Vembanad Lake in Kerala is suffering form microplastic pollution. The lake sediments abound with microplastics, around 250 particles per sq. m. Low density polythene is the most prevalent plastic. Clams and fish from Vembanad lake are a main source of protein for the locals. Microplastics are a severe threat to the entire food web of Vembanad.

Marine life being affected by plastics and microplastics is well documented, but for rivers, the information is limited, synthetic fibres and abrasive micro-beads from cosmetics are abundant in STPs.

Microplastic serves as a novel substrate that selects and transports distinct bacterial assemblages in urban rivers. Rates of microplastic deposition, consumption by stream biota, and the metabolic capacity of microplastic biofilms in rivers are unknown.

Microplastics have already been found in birds and fish and whales. Researchers have tracked microplastics to remote locations, and identified these tiny particles in drinking water, beer, table salt, and seafood. So it should have come as no surprise that microplastic has been discovered in humans stool. To be specific tiny plastic particles and fibres have been found in the stool of eight Europeans who provided samples as part of a pilot study. But the implications in this particular case remain unclear.

Chemical Water Pollution Due to Everyday Detergents

Laundry detergents contain 35-75% phosphates. Phosphates can inhibit the biodegradation of organic substances. They cause eutrophication, leading water bodies to choke with algae and deprive the water of the available oxygen, hence killing aquatic organisms. Detergents could be carcinogenic. Many ingredients in detergents are not biodegradable. Detergents may also contain heavy metals- cadmium, arsenic, lead- and pesticides. Detergents are petroleum based chemicals, sometimes containing nonylphenolethoxylates (NPEs), which are toxic to aquatic life, bio accumulative, and have been linked to reproductive and developmental issues. Detergents change the chemical composition of water, - temperature, electrical conductivity and acidity. Detergents also cause water to become turbid, blocking out light and clogging the respiratory systems of fish. Pathogens from toxic, eutrophied water bodies can make animals and humans fall ill.

The most visible form of detergent pollution is copious volumes of foam. It forms a thick and dense layer over the surface, extending several hundred meters in the river water. Shockingly, even simply washing clothes without detergents is also harmful for the environment. This is due to synthetic clothing- nylon, polyester, and rayon, and blends of these. The lint from these clothing add substantially to the micro-plastic pollution. Scientists found that each synthetic garment releases up to 1,900 micro-plastic fiber bits every time it is washed. Current filtration devices can't capture these particles. The simplest solutions would be to wear natural fibres coloured with natural dyes and use eco-friendly detergents (like soap nut or laundry soap).

1.5 Loss of Biodiversity

The effect of pollution on wildlife is substantial. Scientists are able to use the presence or absence of certain species as indicators of pollution or ecological health. Human activity has brought the rate of species extinction from a background rate of 2-5 species a year to 150-200 species per day! Over 1

million seabirds and 100,000 sea mammals are killed by pollution every year. These occurrences take place far from us, and therefore they go unnoticed by the general public. Plastic pollution harming terrestrial animals and harming mangroves are two very visible forms of wildlife loss due to solid waste.

Mangrove Forests at Risk

Mangrove forests are precious for the ecosystem. They are specialist plants that can survive the extremes of tidal life- changing water levels, changing salinity and heavy siltation. They are the nurseries for fish fingerlings, shrimps, bird heronries, etc and the security cover for coastal areas. Sadly, these blue forests are chocking on solid waste. Marine debris causes animal deaths, suppresses habitat, blocks up tidal channels, thus preventing tidal flushing and therefore increases salinity levels. Salinity stress causes mangrove mortality and affects mangrove productivity and carbon sequestration potential. Accumulation of toxic metals in the silt brought in by rivers. As a consequence, sensitive species die off while resilient species proliferate. This results in loss of mangrove diversity.

Animal Deaths due to Plastic

Threat to stray animals

Rumenotomy of a single cow brings out 53 kgs of plastic waste from within its body, accumulated over 6-10 years.

(Watch Film: The Plastic Cow: Duration 33 min. https://youtu.be/SifRIYqHfcY)

Threat to Wild Animals in Urban Areas

Not only stray animals, but also wild animals in ex-situ conservation- zoos and parks are under threat. Despite a long barricade built to avoid people's contact with the animals at Deer Park in Hauz Khas, people can be seen throwing food items in plastic wrappings to the deer. In a recent incident, officials snatched the camera of an environmentalist when he photographed cheetals or spotted deer eating polythene thrown in the enclosure along with food. This was reported in the Hindustan times in 2016.

Fig 1.5 Deer at Deer Park eating plastic

The Nehru Zoological Park, Hyderabad has put a stringent ban on the entry of plastics into the park, with stringent checking at the gate, a refundable deposit of money against the entry of plastic bottles (no more than 2 bottles per head), since 2014. This was due to the death of a number of zoo inmates due to ingestion of plastics. In spite of this, on 25th July 2018 a baboon was caught on camera munching on a blue plastic cover. A PIL was launched and a division bench of the High Court decided to hear a PIL taken up *on suo moto* basis for which the secretary to ministry of forest and environment, curator of Nehru Zoological Park, Hyderabad, State Chief Secretary, Principal Secretary to Municipal Administration and Urban Development, Chief Conservator of Forest, Member Secretary of Telangana State Pollution Control Board and GHMC Commissioner were named as the respondents by the high court. This incident showcases the careless attitude of visitors and their apathy towards waste management.

Threat to animals in the wilderness: One would assume that wild animals are safe in their natural habitats. But this is also not true. In December 2015, the death by plastic of a sambar deer in Sabarimala raised an alarm. The post mortem report revealed that the deer had consumed 4.7kg of plastic waste. Deer are eating plastic and drinking sewage at one of Mumbai's biggest animal sanctuary,

the Sanjay Gandhi National Park (SGNP). Chital foraging in heaps of rubbish is becoming an increasingly common sight. The skittish spotted deer can also be seen quenching their thirst from an open sewer tank near the forest staff quarters in the Krishnagiri range. (Reported in May, 2016). Visitors throw plastic wrappers of food items that attract deer for their salt content. Encroachers offer chapati to the deer, making them come back for leftovers thrown into the bushes in plastic bags.

Fig 1.6 A Mute Swan Resorts to Using Plastics as Nesting Material

Several species of wild herbivores including gaur, sambar, spotted deer, nilgai and even elephants, have died a silent but agonizing death due to blockage of the stomach/intestine resulting from the consumption of plastic litter. "The prime responsibility of the forest guards is to protect the forest and not to regulate tourism activity. A dedicated team should be appointed by the forest department to ensure that all ecologically damaging items such as plastic, match boxes, knives and aluminium foil are confiscated at the entrance of National Parks." said Anish Andheria, President of the Wildlife Conservation Trust (WCT). It is commonplace to find waste wires, bits of string and plastics in birds' nests. Animals in the ocean are even more vulnerable to floating garbage. New-born turtles have died by the hundreds by ingesting plastic debris. The same has been the case of whales. Effort is on to clean up the Great Pacific Garbage patch.

Plastic Boat in Thattekad Bird Sanctuary

This news article showcases once again how *in situ* conservation efforts are being sabotaged by tourists who are welcomed to learn and enjoy the recreational services provided by natural habitats.

A boat was made by a youth group associated with the Thattekkad-based Nature and Wildlife Team by collecting 1,460 1-litre water bottles littered around the famed bird sanctuary and its neighbourhood.Sathish, a member of the team, designed the boat using reed as the frame of the boat. They collected the bottles in two days' time mainly from Thattekkad and Urulanthanni, approximately 10 km away from the bird sanctuary.

The plastic boat is an innovative method in dealing with the menace of plastic waste. Efforts are being made by concerned citizens and volunteers all over the world to address the plastic menace. Sadly,they are far outnumbered by those who do not care for the environment or do not realize the role it plays in our well-being.

Solution to the littering of dangerous plastics

The Government of India is beginning to take stringent action against those who litter and violate the Solid Waste Management Rules 2016.

In Kolkata, citizens may have to shell out a maximum fine of Rs 1 lakh for littering in public places, as the West Bengal Assembly passed a Bill to enhance the penalty for offenders. The penalty has been

raised through an amendment to section 338 of the Kolkata Municipal Corporation (second amendment) Act which was passed in the Assembly. The move comes after CM expressed her displeasure after finding out the newly inaugurated Dakshineswar skywalk was stained with betel juice.
(Source: PTI, Kolkata, 23 Nov 2018)

Likewise, the NGT imposed a Rs.10,000 fine for littering in New Delhi . “Any person, hotel, resident, slaughter house, vegetable market, etc that does not comply with the directions and throws waste over any drain or public place shall be liable to pay environmental compensation at the rate of Rs. 10, 000 per default:’ the NGT said. All major sources of Municipal Solid waste generation should be directed to provide segregated waste and handover the same to the corporation in accordance to the rules. The Bench further added, “As per Polluter Pays Principle, each person will be liable to pay for causing pollution. It is the duty of a citizen to ensure that waste is handled properly. The entire burden cannot be shifted on the state and authorities.” (Source: TNN, Dec 20, 2016). The same is being replicated in many other cities across India.

PUNE MUNICIPAL CORPORATION

SHIVAJINAGAR,
PUNE- 411 005, MAHARASHTRA

Public Notice

(Spot Fine Under SWM Rules- 2016)

All citizens are hereby informed that Ministry Environment, Forest and Climate chang Government of India, has notified and enacted So Waste Management Rules, 2016 vide Notificati No. S.O. 1357(e) dated 08.04.2016. These rules a effectively being implemented in the city. accordance with Government Resolution N SMA- 2017/C.R.256(1)/ UD- 34 Urban Developme Department, Government of Maharashtra dated 7 September 2018. ULBs are authorized to levy sp fine in all cases be it citizens/ Organizations whe provisions of Solid Waste Management are Violate

Accordingly, the penalties mentioned below will b levied on all those violating the said SWM Rules 201

Fine Details

Sr. No.	Action	Amount of fine in Rs.
1	Littering on Roads	180/-
2	Spitting at Public Spaces	150/-
3	Open Urination	200/-
4	Open Defecation	500/-

This is brought to the notice of all citizens organizations. Cooperation of all is solicited

Sd/-
Sourabh Rao
Commissioner
Pune Municipal Corporation

Advt. No.
Date: 09/11/2018
Place : Pune

Seal

Fig 1.7 : Public Notice- fine levied for littering

In June 2018, Union Minister for Environment, Forest, and Climate Change, has requested the Principals of various schools across the country in written, to declare their schools/institutions free from plastic pollution. A proper ban on plastic items in the school includes plastic bags, plastic water bottles, plastic plates, plastic cups, plastic water jugs, plastic trays, folders, and pen stands, etc. The Ministry will certify schools as “Green School” if they become plastic free and contribute to broadcast the detrimental effects of plastic. Schools are expected to select a pond, water body, beach or eco-sensitive area in or around their campus and make them plastic free. There must be an undertaking of some cleanliness drives on prescribed holidays between April to May every year.
Senior officers of the Ministry, regional offices of MoEF&CC, and district administration will monitor this programme. Union Minister for MoEF&CC will also issue certificates as a token of appreciation to all the participating schools and colleges.

Extinction of Species

It is important to understand what happens when a species goes extinct. Extinction could be local or global. It is not just the death of an individual. It means that all the individuals of all the populations of a species are eliminated from the planet forever. ‘Human extinction’ would mean not a single human being is present on the entire planet. Extinction of a mango tree would mean not a single mango tree is present on the planet. Species whose names ordinary citizens do not know, leave alone the ecological services they provide, are dying out by the thousands every due to human activity alone.

Each species is part of a food chain- it has a niche, which means it eats certain other species and is food for specific creatures. Often in Nature each species has a role to play, much of which is not fully understood. For instance, we are taught that caterpillars of butterflies eat leaves. This is not entirely true. Some caterpillars are carnivores and feed on small mealy bugs that attack leaf buds. So, they are good for agriculture. Butterflies are also very closely associated with their own host plants, where they

lay their eggs. Caterpillars of butterflies and moths are food for several birds that depend on their large numbers to feed their young in the monsoon. Now, if a farmer or gardener sees caterpillars and applies pesticide, unknowingly, he is destroying an entire food chain. If he applies herbicide, he is eliminating the vulnerable herbs. And all the insects, birds and microbes linked with it. Once a native species is eliminated, Nature has a way to fill up the niche. But often, invasive, exotic (foreign) species take over the gap, leading to further breakdown of the food web. Our native species lose the battle and get extinct right before our eyes, without our knowledge. There is much about nature for us to learn. Even if scientists do find out hidden facts about ecosystems, it does not become common knowledge. As urbanization grows, our generation is losing touch with nature. As the gap keeps rising, we will have no support from the environment to help us clean up our mess. Without human interference, the rate of extinction is a mere 1 to 5 species per year. Today, world over an estimated 120-200 species are going extinct every day, which is a whopping 40,000 to 70,000 species per year. And it is our fault.

(Watch film: Year Zero the year when wild animals are gone. Duration 3 min https://www.youtube.com/watch?v=6OYE8_TsteA)

Cost of Species' Services

"The cost of losing India's vultures has been estimated at $34bn", largely because of the public health costs associated with their demise, including increased rabies infections.

The annual pest-control value provided by insectivorous birds in a coffee plantation has been estimated as $310 per hectare while the annual per hectare value added from birds controlling pests in timber-producing forests has been put at $1,500. Great tits predating caterpillars in a Dutch orchard were found to improve the apple harvest by 50%.

How much the degradation of nature is costing the global economy, a study by Trucost estimates that is already about $6.6tn per year (11% of world GDP) and on present trends will reach $28tn by 2050.

In contrast, a study from a group of leading conservationists suggests that to meet global goals that would avert a mass extinction of species would cost around $76bn per year – or 0.12% of annual world GDP."

Summary

Poor Solid Waste Management spells doom for many creatures. It has direct, quantifiable impact on global warming. It can destroy groundwater without our knowledge or capacity to recover. Plastics have reached deep into the food chain, to be now found within human bodies. We are finding new ways to control pollution due to solid waste, everyday. The important thing is to pick up the pace in implementing these actions to slow down the pollution, if not put an end to it completely. It is often necessary to conduct an Environmental Impact Assessment to identify environmentally deleterious effects of MSW and suggest alternatives.

Self-Assessment Test

1. Discuss on Improper waste management
2. Discuss with students how mismanagement of solid waste leads to air pollution.
3. Knowing that microplastics are ubiquitous, how can you prevent plastics from entering your food?
4. What are the best ways to deal with farm waste?
5. Explain the different components of solid waste that cause air pollution.

6. Explain how wildlife is harmed by solid waste.

Further Reading

1. EIA for Integrated SWM, Berhampur, Odisha. http://www.ouidf.in/pdf/3EIA-Report-of-SWM%20Project-Berhampur.pdf
2. EIA for Bandhwari Village, Gurgaon http://www.environmentclearance.nic.in/writereaddata/EIA/16072018VXN2TDA7FinalEIAGurgaon.pdf
3. Puskar, 2018, http://greencleanguide.com/environment-ministry-forms-19-teams-to-undertake-cleaning-of-beaches-river-fronts-and-lakes-in-nine-coastal-states/

Video Films

1. Human Activities that threaten biodiversity. Animated, Duration 13 min. https://www.youtube.com/watch?v=2RC3Hsk90t8
2. Recycling tyres: road to success - business planet, duration: 4 min, https://www.youtube.com/watch?v=6kD9YJ9iSfc
3. Deonar Fire, 3 min https://www.youtube.com/watch?v=2yeKYfhjviM)
4. The Plastic Cow: Duration 33 min. https://youtu.be/SifRIYqHfcY
5. Are You Eating Plastic for Dinner?
6. https://www.youtube.com/watch?v=FjT8GG0ETQg
7. Microplastics in your bottled water?
8. https://www.downtoearth.org.in/video/environment/microplastics-in-your-bottled-water--59962
9. Living plastic-free is harder than you think
10. https://www.youtube.com/watch?v=enaPjyMf2JY

Chapter 2
Human Cost to Non-Management of Waste

Objectives

- To know how solid waste directly affects the lives of the waste-pickers
- To understand the impact of waste related diseases
- To learn techniques to quantify health of a population, DALY and QALY.

Structure

2.1 Human Development Costs
2.2 Measuring the burden of disease- DALY and QALY
2.3 Occupational and Environmental Health Hazards for Waste pickers
2.4 Vulnerability of citizens
2.5 The value of Education in risk elimination

To Do Activities

- Discuss Ban ki Moon's quote. Engage students to understand the cost of human development. Facilitate a discussion on how education is linked with healthcare. Explain why spending on preventive healthcare and education benefits human development.
- Show film- Satyamev Jayate. Facilitate an open discussion about the students' opinion on the film.
- Do a case study analysis and discussion. Assign topics to group and ask them present accordingly.
- Classroom teaching – Vulnerability of citizens. Make students collect news articles from local newspapers regarding health issues due to improper waste management.
- Organise seminar for students to explain their findings and analysis.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.
- Visit the nearest primary health care centre. Prepare a questionnaire.
- Collect information about health issues due to waste mismanagement. How many cases are directly related to pollution or waste? Interview families of patients, find out how many days does the bread winner miss due to illness in their family? Find out socio-economic background of the families interviewed.
- Analyse your data to find the link between poor health, loss of work/ loss of pay due to illness, connection between education, health and financial status of the family. Do you find any patients affected by solid waste related diseases without being directly involved in its management?

Saving our planet, lifting people out of poverty, advancing economic growth… these are one and the same fight. We must connect the dots between climate change, water scarcity, energy shortages, global health, food security and women's empowerment. Solutions to one problem must be solutions for all.

– Ban Ki-moon, Former UN Secretary General

2.1 Human Development Costs

There has been a general concern for disparity across rural and urban areas particularly pertaining to human development. This is despite the persistent policies of investing more in rural health

infrastructure and an orientation of health policies which remain rural focused in India. It is pertinent to explore the issue that why this outcome of adverse indicators of human development for rural areas has emerged as a prominent outcome of planned effort and to suggest remedy for this disparity. The objective of this paper is to analyse this disparity in terms of human development and health outcomes across major Indian states with a view to suggest suitable policy modifications to overcome the disparity between rural and urban areas in regard to these aspects. Unlike other studies our focus is to link the health and human development aspects using information from household level surveys. Instead of analyzing state level differentials alone the study contributes in understanding the causes of this disparity between rural and urban areas both in poorer and richer states of India and suggests policy imperatives to overcome this outcome.

UNDP, the sponsor of Human Development Index methodology since 1990, reported India's HDI to be 0.554 for 2012, an 18% increase over its 2008 HDI. United Nations Declared India's HDI is 0.586 in 2014, a 5.77% increase over 2012. As for the year 2016, HDI for India stood at 0.624.

Human Development and Budgetary Financing: Poor versus Rich States

A broad view of the human development indices (HDI) across major Indian states is presented in Figure 2.1. This is indicated by HDI bars. These generally are depicting a lower index value for low income states like Orissa, Bihar, Chhattisgarh and Madhya Pradesh (MP) as the states which rank lowest and with the sequence moving to better off states ranking higher in HDI with Kerala, Punjab, Himachal Pradesh (HP), and Maharashtra among the top five states. However, there has been a concern about

rising inequalities and uneven distribution of the benefits of growth and explicitly capturing quantification of the potential loss due to inequality with respect to access to education and, health and recently a study by United Nations Development Programme (UNDP) provides another index, called Inequality-adjusted Human Development Index (IHDI) which is based on methodology proposed in the 2010 Human Development Report. To facilitate a comparison between usual HDI indices and newly presented IHDI we have also presented both of these in Figure 1

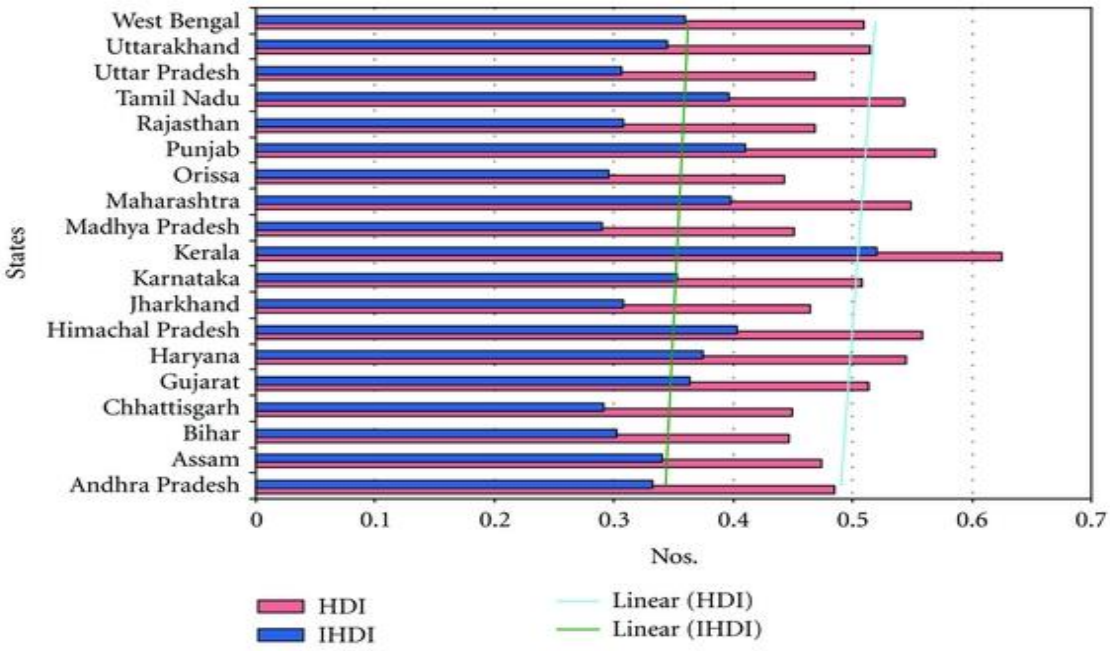


Fig 2.1 HDI and IHDI for major Indian States (2011)

Source: Estimates from Suryanarayana et al.

Bearing in mind the distinct differential in HDI across rich and poor states, researchers compared the financing situation among these groups of states.

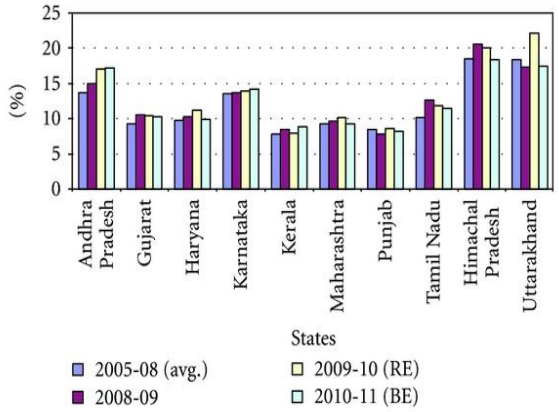


Fig 2.2 Average income and rich states (social sector exp./GSDP) (%) (2005–11)

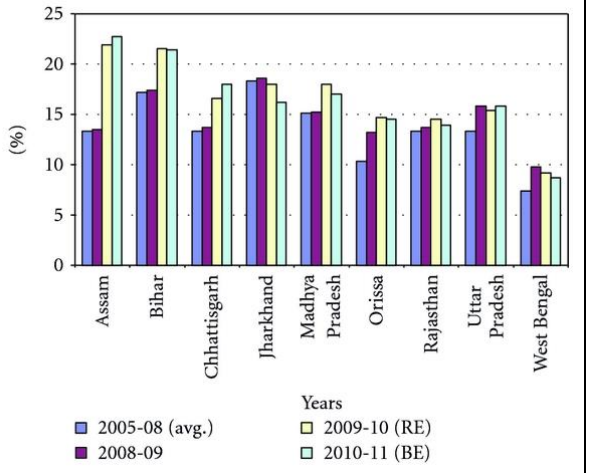


Fig 2.3 Poor States (Social Sector Exp/GSDP) (%) (2005–11). Source: RBI, 2011;

	GSDP = Gross State Domestic Product

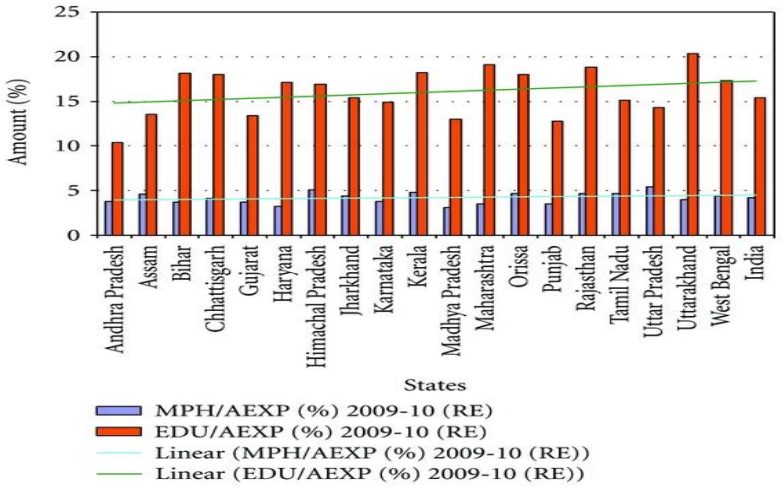


Fig 2.4 Budgetary Expenditure on health and education for Major Indian cities (2009-10), Source RBI 2011.

This is reinforced by the budgetary expenditure on health and education presented for major Indian states for 2009-10 Fig 2.4 and the growth rate of these expenditures for the rich and poor states separately for the financial years from 2000–2011. The regression results indicated that **both poverty and rural-urban belonging influence health demand**. Education modifies the pattern of demand as well as pattern of diseases.

Despite efforts to increase public spending after 2005-06 including the adoption of NRHM, the expenditure increased only marginally to 1.2 percent of GDP in 2009-2010. In fact, the High Level Expert Group on Universal Health Coverage for India has further recommended that public spending on health should increase to 2.5 to 3 percent in the medium term.

2.2 Measuring the burden of disease- DALY and QALY

The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It was developed in the 1990s as a way of comparing the overall health and life expectancy of different countries.

The DALY is becoming increasingly common in the field of public health and health impact assessment (HIA). It "extends the concept of potential years of life lost due to premature death... to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability.

Calculation

DALYs are calculated by combining measures of life expectancy as well as the adjusted quality of life during a burdensome disease or disability for a population. DALYs are related to the quality-adjusted life year(QALY) measure; however QALYs only measure the benefit with and without medical intervention and therefore do not measure the total burden. Also, QALYs tend to be an individual measure, and not a societal measure.

Traditionally, health liabilities were expressed using one measure, the years of life lost (YLL) due to dying early. A medical condition that did not result in dying younger than expected was not counted. The years lost due to disability (YLD) component measures the burden of living with a disease or disability.

DALYs are calculated by taking the sum of these two components:

DALY = YLL + YLD

The DALY relies on an acceptance that the most appropriate measure of the effects of chronic illness is time, both time lost due to premature death and time spent disabled by disease. One DALY, therefore, is equal to one year of healthy life lost.

Age weighting: A crucial distinction among DALY studies has been the use of "age-weighting", in which the value of each year of life depends on age; however, the World Health Organization has abandoned age weighting and time discounting in DALYs since 2010.

There are two components to this differential accounting of time:

1. Age weighting
2. Time discounting

Age-weighting is based on the theory of human capital. Commonly, years lived as a young adult are valued more highly than years spent as a young child or older adult, as these are years of peak productivity. Age-weighting receives considerable criticism for valuing young adults at the expense of children and the old. This age-weighting system means that somebody disabled at 30 years of age, for ten years, would be measured as having a higher loss of DALYs (a greater burden of disease), than somebody disabled by the same disease or injury at the age of 70 for ten years.

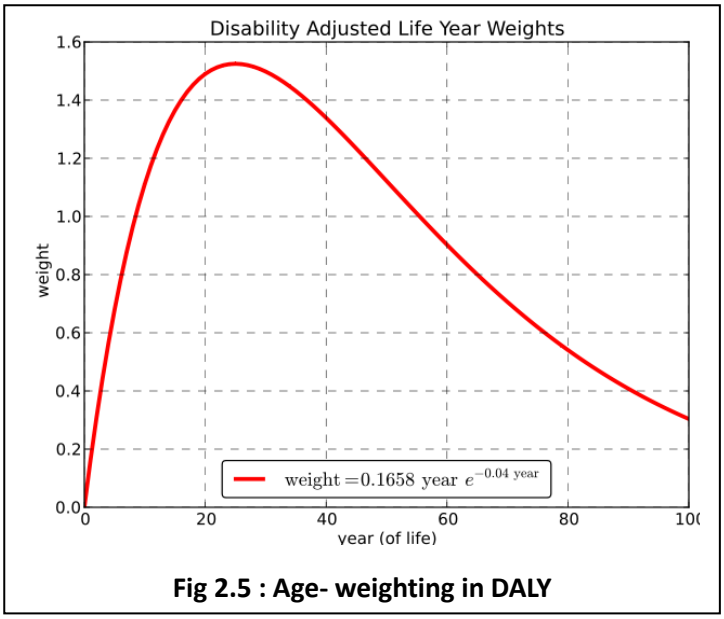


Fig 2.5 : Age- weighting in DALY

Some studies use DALYs calculated to place greater value on a year lived as a young adult. This formula produces average values around age 10 and age 55, a peak around age 25, and lowest values among very young children and very old people.

This age-weighting function applies only to the calculation of DALYs lost due to disability. Years lost to premature death are determined from the age at death and life expectancy.

Time Discounting describes preferences in time as used in economic model. The effects of the interplay between life expectancy and years lost, discounting, and social weighting are complex, depending on the severity and duration of illness.

For example, the parameters used in the GBD 1990 study(Global Burden of Disease) generally give greater weight to deaths at any year prior to age 39 than afterward, with the death of a newborn weighted at 33 DALYs and the death of someone aged 5–20 weighted at approximately 36 DALYs.

As a result of numerous discussions in the year 2010, the World Health Organization had abandoned the ideas of age weighting and time discounting. They had also substituted the idea of prevalence for incidence (when a condition started) because this is what surveys measure.

Limitations of the DALY

- Global estimate of severity – Cannot account for subpopulation differences.
- Cannot account for co morbidities.
- Age weighting – Is it ethical or appropriate?
- Societal 'value' of disease changes –Societal value may be influenced by other.

Dhapa Landfill, Kolkata

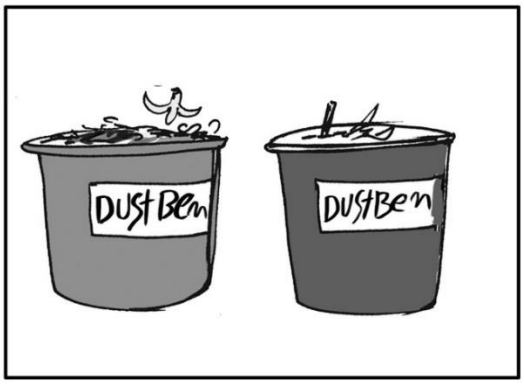
Taking forward the case of the Dhapa Landfill in Kolkata, let us look at the community of slum dwellers who eke a living out of the dumpsite face several health issues.

Living and working on the landfill comes with serious health hazards that successive state and central governments continue to ignore. Inextinguishable fires burn all day and night, which pollute the air. They are so ubiquitous that the workers no longer complain about the fumes, and municipal authorities don't bother to put them out.

The garbage dump is dangerous. The ground can fall beneath your feet anytime. Even huge government trucks turn over at times, especially in the monsoon when the garbage is wet. Many trucks have been overturned on the mountain of garbage. People have died there.

"It's difficult to breathe sometimes," says Durga Mundun, who lives on top of the landfill. "We get ill a lot. There's a lot of pollution and it smells very bad. Even though we live here and we're used to it, it bothers us a lot. People get sick, they get diarrhoea, they get tuberculosis." "Most people die by the age of 50. Sometimes they live till 60 and then they go up to God. I'm already 30, I'll probably die soon too."

The landfill site at Dhapa was set up when Kolkata, then Calcutta, was the colonial capital of the British Raj in India. A garbage train used to run along the main roads of the city collecting waste from all the big residential buildings and offices of the British administration. Since then, Kolkata's population has grown, and so has the amount of waste it produces. The landfill has grown into an entire landscape of garbage, which stretches for miles on the eastern fringes of the city. Kolkata municipal council has tried to find a new dumping site in the city, with hopes to reclaim what could become prime real estate at Dhapa, but their proposals have been rejected by civic bodies because of objections from local residents.



[1]Human life is precious, especially the life of the breadwinner. Our living and working conditions as well as our lifestyle and genetic makeup determine our health and longevity.
The burden of diseases and mortality for each person is a personal tragedy. To some extant a doctor or nutritionist can guide us to live a better life. But, quantifying the burden of disease from mortality and morbidity for an entire population surviving in certain living conditions can throw light on important issuewhich can be then managed better at different levels.

Measuring burden of disease: the concept of QALYs and DALYs
Two metrics abbreviated as QALY and DALY, can aid such assessments.

- Quality-Adjusted Life Year (QALY): QALY measures years lived in perfect health
- Disability-Adjusted Life Year (DALY): DALY measures years in perfect health lost.

Together, they are the most frequently cited metrics for risk-benefit assessment. They guide is the decision making process, where the intervention are most likely to be successful or most economical are to be selected.
QALYs and DALYs are tools, providing a single measure of mortality and morbidity, used internationally for assessing health care interventions and treatments. Their application in the realm of Public Health enables policy makers to make informed decisions, and countries to choose vital, cost-effective health solutions.[1]

Disability-Adjusted Life Year (DALY)
DALY is an alternative tool which emerged in the early 90s, as a means of quantifying the burden of disease. DALY is used to measure the health of a population, country, region etc. not just one person.
DALYs sum years of life lost (YLL) due to premature mortality and years lived in disability/disease (YLD).

YLL are calculated as the number of deaths at each age multiplied by the standard life expectancy for each age.
YLD represent the number of disease/disability cases in a period multiplied by the average duration of disease/disability and weighted by a disease/disability factor.

The concept is that in a particular year, in a particular community with a known population, a certain number of people contract diseases or have accidents. The number of years it takes for them to recover and lead fully functional lives is calculated. This is YLD.

In the same year, a few individuals died. Each person could have lived a long life. The ideal life expectancy of the population is known. If the age of the person who dies is subtracted from the life expectancy, we know the number of years lost (YLL). If calculated for every sick and dead person in the

[1] *Watch Film: Duration 1 hour: Satyamev Jayate Season 2 | Episode 3 | Don't Waste Your Garbage | Full episode (English Subtitles) https://www.youtube.com/watch?v=lS0_FCBzI_w*

community, the final figure will tell us how many years of productive life were lost in the population. Calculating DALY is complicated. For instance, the same sickness of cholera that keeps a child out of school, an adult out of office and an old person in bed for the same number of days is not considered equal.

A scale used to measure health state is inverted to a 'severity scale', whereby '0' equates perfect health and '1' equates death. Schizophrenia has a 0.53 weighting and a broken leg has a 0.37 weighting in the latest WHO weightings. Weight factors are age-adjusted to reflect social preference towards life years of a young adult (over an older adult or young child). Furthermore, they are discounted with time, thus favouring immediate over future health benefits.

Years of life lost due to death: YLL measure the incident stream of lost years

YLL= N x L

Where,
N = number of deaths
L = standard life expectancy at age of death in years

Years lived with disability:YLD measure the incident stream of lost years

YLD=I x DW x L

where:
I = number of incident cases
DW = disability weight
L = average duration of the case until remission or death (years)

Prevalence YLD: Introduced by GBD 2010, IHME 2012, it calculates YLD on prevalence rather than incidence as per the updated life expectancy standard.

YLD= P x DW

where:
P = number of prevalent cases
DW = disability weight

Disability adjusted life years:

DALY= YLL + YLD

Because of life due to deaths, an incidence perspective has also been taken for the calculation of YLD in the original Global Burden of Disease Study for year 1990 and in subsequent WHO updates for years 2000 to 2004.

To estimate YLD for a particular cause in a particular time period, the number of incident cases in that period is multiplied by the average duration of the disease and a weight factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (dead).

The original Global Burden of Disease Study and WHO updates for years 2000-2004 also applied several social value weights in the calculation of DALYs for diseases and injuries. Apart from the disability weights, these also included time discounting and age weights.

In short, DALY tries to measure how the productivity of a population is lost due to premature deaths and poor health.
It is important to understand the differences between QALYs and DALYs, they are not interchangeable. The two measures can produce different results dependent on age at onset and duration of disease, and whether age and disability are weighted.

Quality-Adjusted Life Year (QALY)

The QALY was invented in the 1970's and has become an internationally recognised standard tool since the mid-1990s. A QALY is the arithmetic product of life expectancy combined with a measure of the quality of life-years remaining. The QALY is a measure of the value of health outcomes. It assumes that health is a function of length of life and quality of life, and combines these values into a single index number.

One QALY equates to one year in perfect health.If an individual's health is below 1, QALYs are accrued at a rate of less than 1 per year. To be dead is associated with 0 QALYs. In some circumstances it is possible to accrue negative QALYs to reflect health states deemed "worse than dead"!

To determine QALYs, one multiplies the utility value associated with a given state of health by the years lived in that state. A year of life lived in perfect health is worth 1 QALY (1 year of life × 1 Utility value). A year of life lived in a state of less than perfect health is worth less than 1 QALY; for example, 1 year of life lived in a situation with utility 0.5 (e.g. bedridden, 1 year × 0.5 Utility) is assigned 0.5 QALYs. Similarly, half a year lived in perfect health is equivalent to 0.5 QALYs (0.5 years × 1 Utility).

QALYs can be used to

- ✓ inform personal decisions,
- ✓ evaluate programs,
- ✓ set priorities for future programs,
- ✓ to assess the value for money of medical interventions.

The "weight" (utility) values between 0 and 1 are usually determined by methods such as those proposed in the Journal of Health Economics:

- Time-trade-off (TTO): Respondents are asked to choose between remaining in a state of ill health for a period of time, or being restored to perfect health but having a shorter life expectancy.
- Standard gamble (SG): Respondents are asked to choose between remaining in a state of ill health for a period of time, or choosing a medical intervention which has a chance of either restoring them to perfect health, or killing them.
- Visual analogue scale (VAS): Respondents are asked to rate a state of ill health on a scale from 0 to 100, with 0 representing being dead and 100 representing perfect health. This method has the advantage of being the easiest to ask, but is the most subjective.

Another way is through questionnaires. QALY is calculated as follows:

Years of Life x Utility Value = #QALYs

This means

- If a person lives in perfect health for one year, that person will have 1 QALY.
  (1 Year of Life × 1 Utility Value = 1 QALY)

- If a person lives in perfect health but only for half a year, that person will have 0.5 QALYs.
  (0.5 Years of Life x 1 Utility Value = 0.5 QALYs)

- Conversely, if a person lives for 1 year in a situation with 0.5 utility (half of perfect health), that person will also have 0.5 QALYs.(1 Year of Life x 0.5 Utility Value = 0.5 QALYs)

Data on medical costs are often combined with QALYs in cost-utility analysis to estimate the cost-per-QALY associated with a health care intervention. This parameter can be used to develop a cost-effectiveness analysis of any treatment.

If an intervention provided perfect health for one additional year, it would produce one QALY.

Likewise, an intervention providing an extra two years of life at a health status of 0.5 would equal one QALY. This effect is related to cost; cost per QALY. For example, if a new treatment gave an additional 0.5 QALYs and the cost of the new treatment per patient is 5,000 then cost per QALY would be a 10,000 (5,000/0.5).

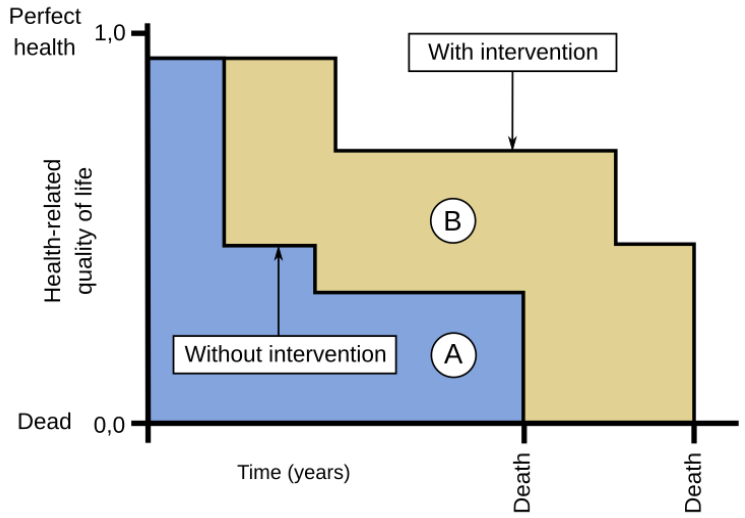


Fig 2.6 Demonstration of QALY for individual A, who did not get intervention and individual B, who did (Source: Wikipedia)

This incremental cost-effectiveness ratio (ICER) can then be used to allocate healthcare resources. The QALY model requires utility independent, risk neutral, and constant proportional trade-off behaviour. Because of these theoretical assumptions, the meaning and usefulness of the QALY is debated.

Limitations of DALYs and QALYs

QALYs and the DALYs can be applied to a wide range of diseases and interventions in different population settings. However both have limitations.

1. Neither measure fully captures the wider effects that stem from interventions: emotional and mental health, impact on careers and family, or non-health effects such as economic and social consequences (e.g. loss of work).
2. QALYs can lack sensitivity and may be difficult to apply to chronic disease and preventative treatment.
3. The derivation of 'health state utilities', i.e. defining weighting factors for specific health states, is subjective and controversial. Disease-specific measures may be used, but must be interpreted with caution.
4. Standard life expectancy figures may overestimate DALYs saved when actual (local) life expectancy is shorter.
5. Social preference weighting and discounting of DALYs present certain ethical issues: are young adults and non-disabled more productive and valuable to society? Does the value of health decrease over time?

Nonetheless, when we avert one DALY, it means that we prevented the loss of one year of productive, healthy life – a year of life that, without our intervention, would have been lost to illness or death.

DALY is very significant for waste management. A number of people working directly with solid waste and sewage fall ill or lose lives.

2.3 Occupational and Environmental Health Hazards for Waste pickers

There are an estimated 15 to 40 lakh Indians working as ragpickers in this country, many of whom are destitute migrants from poor states. Ragpickers sustain themselves by collecting, sorting and segregating waste and then trading it. In doing so, they help clean up a significant proportion of the 62 million tonnes of waste generated annually in India.

Rag-picking is a totally informal sector that complements the work of civic bodies. Therefore it is hard to quantify how much waste is collected by them. But there are rough indicators: Only 75-80% of the waste generated in India is collected by municipal bodies. And more than 90% of India does not have a proper waste disposal system.

While studies in developed countries focus on the different routes of environmental contamination from solid wastes (such as dioxins) studies in the under-developed countries focus on economics of waste management. Overall, little interest is shown in their health.

The health needs of this underprivileged workforce stay unfulfilled. The most common diseases among rag pickers are:

- Substance abuse: Tobacco-chewing and consumption.
- Dog bite and rat bite
- Redness of eyes,
- Headache,
- Backache,
- Accidental injuries are very common among Rag-pickers.
- Mild depression and mild anxiety

.

Other health issues they often face include:

- cuts,
- worm infection,
- skin diseases,
- sunstroke,
- respiratory diseases – influenza, pneumonia, tuberculosis
- burns- from burning waste and other accidents

Apart from poverty, humiliation, harassment, and sexual abuse on the streets, police harassment is a common complaint.

The occupational health hazards faced by waste pickers can be under three broad headings:

1. **Direct health hazards** posed by the nature of solid waste: include faecal-oral contamination (from animal and human excreta), cuts from needles and sharp objects, burns and skin disorders. Worm (helminth) infections are very high (43%compared to 17% in non waste-pickers). In India 26% child waste pickers suffer from worms. Cuts due to lack of gloves and exposure to sharps is very common. Risk of being hit by cars, heavy machinery, refuse trucks is high. In Bengaluru, truck accidents are reportedly the main cause of death at dumpsites.
2. **Direct environmental hazards of solid wastes and their collection:** Risk of cuts, burns, traffic accidents, dumpsite collapse, contamination of air, water and soil by solid waste materials. Half of the wastepickers in Kolkata have reported dog bites, 16% rodent bites. Although no cases of rabies were reported, but waste picker children are the most vulnerable to being bitten. Flies are a nuisance; so are mosquitoes and cockroaches. Blocked drains, stagnant water, solid waste dump

yards containing water filled buckets, pots, etc are all associated with vector borne diseases- dengue, malaria, filariasis, etc. The risk of landslides at un-capped dumpsites is a major risk. Ambient carbon monoxide levels at Smokey Mountain were found to be twenty-five times higher than the Philippines national standard. Child waste pickers in this country have impaired lung function and very high blood lead levels (higher than at the workers of a neighbouring battery manufacturing unit). This could well be true for India.

3. **Indirect environmental hazards** of solid wastes and their collection: Contamination of air, water, soil around the dumpsite. Weather conditions can further impact the health of waste workers- sunstroke, flooding, further contamination of water and land; drop in price of paper and cardboard due to rains. Both collection and cost of paper reduce. Harassment by police and sexual harassment are rampant, though unreported. These can lead to injuries, fights and sometimes deaths.

There is very limited environmental monitoring at dumpsites.

Occupational Hazard for Children

The IQ level of rag-pickers' children in the 7-13 age group shows a decline. They perform worst in verbal ability, problem solving, ability to absorb new information and ability to plan ahead. It appears that the dull nature of the work itself and the lack of intellectual stimulation coupled with physical factors such as malnutrition and lead poisoning might play a role in low IQ levels. Young children also have less experience and lack judgement of hazards.

However, they have a high social intelligence, in the form of their ability to understand their social environment (threat of violence and responsibility to bring home food and money). These children are least likely to attend school and therefore take up waste-picking full-time and have limited expectations of their future as compared to non-waste picker children.

Waste picker children also have stunted growth- both height and weight, and lower immunity as compared to non-waste pickers. By starting young, these children build up long cumulative exposures to different contaminants over their childhood and adolescence which will most likely continue to have an impact on their health as adults.

Water supply and sanitation is lacking in slums of waste- pickers. Waste pickers also become lax towards personal hygiene as a result of constantly being surrounded by dirt. Lack of privacy and washing facilities contributes to this.

Waste pickers were also found to have high prevalence of respiratory infections, lead and mercury poisoning, tetanus and, in a small number of cases, HIV infection and hepatitis B. Beyond its impact upon physical health, the work is seen as being much stigmatized and this has an impact on self-esteem, employment chances (outside waste picking) and even marriage prospects.

Many women and children are involved in this work. In India, waste picker children and women are 'tied' to a waste buyer who loaned them money and material, thereby making them vulnerable to exploitation. The profits of this informal sector are usually made by the wholesale buyers of recyclable materials and those involved in their recycling. For those involved in the initial collection of materials, either from waste on the roadside, from bins or at dumpsites. The financial incentives are small and the risks to health are often high. The occupation is seen as a survival strategy by many observers. The reason for engaging in this work is due to not having other skills and easy or daily income. Despite performing an important environmentally beneficial job, waste pickers are rewarded with very low

incomes and virtual social exclusion. Action is needed to separate hazardous waste and protect those engaged in it.

2.4 Vulnerability of Citizens

Social vulnerability refers to the inability of people, organizations, and societies to withstand adverse impacts from multiple stressors to which they are exposed. These impacts are due in part to characteristics inherent in social interactions, institutions, and systems of cultural values.

They include rapid population growth, poverty and hunger, poor health, low levels of education, gender inequality, fragile and hazardous location, and lack of access to resources and services, including knowledge and technological means, disintegration of social patterns (social vulnerability). *Vulnerability* also concerns the wider environmental and *social* conditions- this means that it is generally the poor who tend to *suffer* worst from disasters.

Vulnerability and Capacity Assessment (**VCA)** uses various participatory tools to gauge people's exposure to natural hazards and their capacity to resist these natural hazards. It is an integral part of disaster preparedness and contributes to the creation of community-based disaster preparedness programmes at the rural and urban grass-roots level.

The aims of VCA are to:

- assess risks and hazards facing communities and the capacities they have for dealing with them;
- involve communities, local authorities and humanitarian and development organizations in the assessment from the outset;
- draw up action plans to prepare for and respond to the identified risks;
- identify risk-reduction activities to prevent or lessen the effects of expected hazards, risks and vulnerabilities.

VCA is complementary to national and sub-national risk, hazard, vulnerability and capacity mapping exercises that identify communities most at risk. A VCA is undertaken in communities to diagnose the specific areas of risk and vulnerability and to determine what action can be taken to address them. To complete the circle, what a VCA unearths at the local level can provide a valuable indication of national and sub-national vulnerabilities and capacities.

The International Federation's experience over the last ten years has enabled it to refine and improve VCA to make it better focused and more effective in achieving its purpose. It has also shown how VCA can be linked to and reinforce other Red Cross Red Crescent programmes and activities. Moreover, as VCA is a participatory process, National Societies can develop realistic and relevant activities that are better suited to local needs and priorities.

As one National Society member said after undertaking a VCA:

"Before, we used to work for people, but now we work with them."

The general public is usually unaware of what becomes of their waste after it is picked up at their doorstep. However, the situation can get out of control, in case of a large accident or disaster.

Waste Management after Kerala Flood

Kerala Flood of 2018, was the worst ever since 1924. After a long deluge that began 1st June 2018, the relentless rains of Aug 15th to 18th 2018 brought the state into crisis, with dams brimming over and water tables high. The sluice gates of all 39 dams in Kerala had to be opened. Idukki dam (the third highest in India) was opened for the first time in 26 years. The water that flowed out carried heavy silt and flooded houses 6 km on either side of the river. The army was deployed to conduct aerial rescue operations. With citizen support, there were several flood relief camps opened where water, food, clothing, bedding,

medicines, diapers etc were supplied. Once the flood waters receded, people returned to homes reeking of sewage (due to the flushing of dam silt) and destroyed property. This posed a huge solid waste management crisis. The highlight of the aftermath was that 35,717 metric tonnes of waste has been collected in Kerala after the floods. Areas of Alappuzha, Ernakulum, Thrissur are struggling with the problem of accumulated waste.

Fig 2.7 : Aftermath of Kerala Flood , 2018

Swachhta Mission took up the task of clearing post-flood waste on a war footing. From wet mattresses and personal belongings, to electronic goods, vehicles and mounds of waste piled up at doorsteps. Temporary waste dumps were created. Carcasses of over 8000 cattle, and 3500 other pets were burned. More than 200 carcasses brought in 48 trucks were disposed by burning in HMT colony, Kalamassery. 10,000 tonnes of biodegradable waste (mostly from civil supplies distribution units) was buried using 8 earth movers. This was done on priority to prevent communicable diseases.

A total of 2,618 truckloads of chemical waste, nearly 1,110 tonnes, from flood-hit areas have been transported to Brahmapuram. Brahmapuram Waste Plant is a run-down old waste treatment facility, spread over 110 acres along the banks for Chitrapuzha and Kadambrayar rivers. It is located about 10 km from Cochin Infopark. In 2007, it was chose as a waste treatment facility for Cochin under orders from the High Court. The 200 families living around it protested. But they were asked to sacrifice for the 25 Lakh population of Cochin. Of the 200 families, only 70 remained. They had to flee from home due to the unbearable stench of rotten garbage to take refuge in a nearby school as truckloads of garbage started arriving at Brahmapuram. The once agrarian village became a ghost town. As per reports, Kochi city generates around 380 tonnes of waste a day, of which 150 tonnes are biodegradable and 100 tonnes comprise plastic waste.

Fig 2.8: Dumpyard at Brahmapuram

In 2010, the Corporation set fire to the burgeoning plastic waste. The fire raged for 7 days. An independent agency appointed by the state government in 2015 also reported that around five lakh tonnes of waste -both biodegradable and non-degradable- are simply buried at the plant. The Brahmapuram Waste Plant is now segregating and disposing the clothes waste from the flood, while continuing to function with business as usual without PCB permissions. Recent news reports suggest that Brahmapuram Plant is a tinderbox, waiting to ignite due to the massive amounts of plastics dumped there.

The case study highlights the importance of quick and scientific waste disposal at the time of crisis. It also explains the importance of proper management of waste dumpyards.
As with the case of Cochin, several cities in India are struggling with ground water pollution, diseases and the public nuisance of bad odour.
There is a possibility of heavy pollution due to a one-time incident involving an oil spill or a hazardous waste. One such event was the Bhopal gas tragedy, explained in the following case study.

Cleanup after Bhopal Gas Tragedy

The Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh, India. It was considered as of 2010 to be the world's worst industrial disaster.
The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release. A government affidavit in 2006 stated that the leak caused 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries. Others estimate that 8,000 died within two weeks, and another 8,000 or more have since died from gas-related diseases.
The Bhopal Gas tragedy of 1984 has gone down in the annals of India's history as the most devastating man-made disaster. Methyl isocyanate (MIC) was leaked from the Union Carbide factory which produced many pesticides and intermediaries. Thousands died and thousands more suffered. There was a long court battle after which Union Carbide gave compensation to the Government of India.
The remaining MIC in the storage tank was used up to produce the pesticide 'Sevin'. 15 years later, it was decided to **detoxify, decommission and dismantle** the production units for which a detailed technical and tender document has been prepared by IICT. The plants are now in a highly corroded condition and many equipment and pipelines are missing. The wide range of pesticides and intermediaries from the factory seeped into the grounds of the site and neighbourhood including Methyl Isocyanate, Mono methylamine, Phosgene, Hydrochloric Acid, Carbaryl (Sevin), Chloroform, Alpha-Naphthol, Carbon monoxide and Chlorine.
This is the **legacy of pollution** of the site with metals and organic contaminants both inside and outside the plant. The soil within the factory walls is contaminated, in some places very seriously, while some of the remaining buildings still house stockpiles of unwanted chemicals. Local people, including children, regularly enter the site, risking exposure to raw chemicals and those contaminating the soils. Some local residents even graze their cattle there, opening up the possibility of indirect exposure to contaminants that can be passed on via milk to humans.
In situ detoxification methods have been proposed for the equipment and piping including hot air purging, steam purging, alkali wash, dilute acid wash, water wash, and alkali soak. Tenders have been invited for undertaking the remediation measures. The project is underway.

The Bhopal Gas Tragedy brought about the Public Liability Insurance Act. The intent of this Act is to make every industry owner pay an insurance against any accident involving pollution that may cause wide-scale damage to human and environmental health. In the event of an accidental spill, the insurance money will be used to compensate people as well as help restore the environment.

1.5 Value of Education/ Awareness

Contrary to the popular adage, 'ignorance is not bliss'. Whether poor or rich, citizens who are aware of potential danger can try their best to bring themselves out of a dangerous situation, if they know of its potential hazards.

The importance of spreading awareness of the hazards of environmental pollution to the community, or lay persons cannot be stressed enough. Newspapers and electronic media play an important role in this. So does one- to – one community awareness or education.

Often, the victims of pollution are late in waking up to the stresses/ hazards of pollution. They have an inkling of doubt that the waste disposal activities happening around them are not good for their health, but may not be fully aware of the extent of danger. To quote an example, in the case of illegal disposal of waste oil on agricultural lands (3.6, Case study on CBA of waste), the farmers felt that it was dangerous and they went often to the police station to complain, but got no help. The police did not identify illegal dumping of waste as a law and order situation. It was only on approaching the Pollution Control Board that the problem was correctly addressed.

When the community is made aware of the right way to manage their wastes, the chance of them taking the onus of waste management-at-source rises. They also make informed choices towards eco-friendly methods and proactively choose morally responsible ways of dealing with their wastes.

Applying stringent laws usually gives miscreants opportunities to find loopholes to continue their mal-practices. Laws and regulations only work when the citizens make an informed choice to follow them, realizing that the laws have been created with their well-being in mind. For example, we read (in Course 3, 5.4) about Sikkim's ban on all pesticides and herbicides. It could not have occurred without every farmer being educated about the human, environmental and economic costs incurred due to pesticide use. It also could not have been possible without educating the farmers and the local communities about the benefits of using organic compost, and educating them about the right way to eliminate pests. This education along with government incentives, penalties has helped Sikkim become the first certified fully organic state in the country and the health of the children and wildlife and tourism has also improved.

Summary

The vast population of waste pickers and the sanitation workers in India are most vulnerable to risk due to their occupation and socio-economic status. DALY and QALY are calculation techniques that can be used to quantify the health status and suggest interventions to improve their lives. Waste and hazards can cause extensive damage to citizens and their property. Supreme Court has enacted the Public Liability Insurance Act to protect citizens from loss due to hazardous substances. It is important that to mitigate any risks, a proper risk assessment be done.

Self-Assessment Test

1. How would DALY and QALY be used for improving the lives of rag-pickers?
2. How are the children of rag-pickers different from what you were as a child?
3. What are the steps in Risk Assessment?
4. Why public liability is insurance required?

Further Reading

Indian Institute of Chemical Technology, Feb 2010, Technical And Tender Document For Detoxification, Decommissioning And Dismantling Of Union Carbide Plant (Union Carbide India Limited, BHOPAL
http://www.indiaenvironmentportal.org.in/files/UCILreport.pdf

Video Film

Satyamev Jayate Season 2 | Episode 3 | Don't Waste Your Garbage | Full episode (English Subtitles)
https://www.youtube.com/watch?v=lS0_FCBzI_w
The DALY Show, Disability-Adjusted Life Year (DALY) https://www.youtube.com/watch?v=Exce4gy7aOk
Waste pickers facing hazardous conditions in Bangalore
https://www.youtube.com/watch?v=dCuhSx8gJaY
Waste Pickers' - Life & Livelihood
https://www.youtube.com/watch?v=aLda8O2ySMc
India's ragpickers - the harsh reality
https://www.youtube.com/watch?v=K9l0K8Of7aU

Chapter 3
Economic Cost of Improper Waste Management

Objectives

- To know how consumerism has driven the economy
- To find out the consequences of resource crunch due to consumerism
- To use Life Cycle Analysis as a tool
- To assess the cost of taking shortcuts

Structure

3.1 Waste – to be Contained at Source
3.2 Waste Production on the Rise
3.3 Consumerism
3.4 Efficiency of Resource Use- Production and Consumption
3.5 Life Cycle Assessment
3.6 Cost- Benefit Analyses

"You destroy the environment, you destroy jobs. People don't seem to get this."
– Dennis Weaver, American Actor and Environmentalist

To Do Activities

- Question why students are being made to participate in cleanup jobs. Lead the discussion to the continuous waste generation and improper waste disposal.
- Discuss about the honey trap of advertising and the history of consumerism. Also speak about the growing rich-poor divide and living on credit.
- Show news clipping on online shopping waste.
- Explain resource crunch and the need for resource use efficiency. Explain fig 3.1
- Taking the simple example of a shopping bag (box item) , explain resource use efficiency.
- Make students do a fieldwork cum practical exercise on LCA .
- Recap of Chapter, open discussion on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.
- Read through the LCA reference reports. Prepare an LCA report for any product of your choice. This can be done in teams.

3.1 Waste – to be Contained at Source

If pollution or waste is not contained at source, it gets an opportunity to escape and spread in the environment, bringing in its wake health problems and dangers to the ecosystem. The economic cost of cleanup is extremely high, many fold higher than managing the waste at source. The following case study shows the level of involvement required to restore cleanliness. It is a continuous battle of wills between the polluter and the preserver- one dirties, the other pays for cleaning up. The ultimate cost is borne by the taxpayer, both in terms of wealth and health.

MOEF&CC Ministry Forms 19 Teams to Undertake Cleaning of Beaches, River Fronts and Lakes in Nine Coastal States

In order to begin with the cleaning of various beaches, lakes, and riverfronts, 19 teams have been formed by the Ministry of Environment, Forest, and Climate Change.

This buildup to the World Environment Day has pledged to clean up around 24 beaches in 9 coastal states and also riverfronts in 24 recognized polluted stretches in 19 states. In addition, a special drive of cleanliness was carried out at Yamuna riverfront in Delhi, and some certain water bodies and lakes have also been identified for cleaning.

The 19 teams undertaking the initiative will include State Pollution Control Boards, senior officers of MoEF &CC, state nodal agencies in-charge of eco-clubs of schools, college of fisheries located along the coastal stretches, the district administration, and other educational/research institutions. They will also involve college students, school children, and local communities in this cleaning operation. The Ministry will also engage Eco-club schools that are getting support from MoEF & CC under the National Green Corps programme.

A sum of **₹10 lakh has been assigned for each stretch** of lake, beach, and riverfront. The campaign will also include cleaning up of important archaeological sites. The clean-up operation started on May 15 and is to be closed on June 5. During this entire period, multitudinous activities will be organized like quiz competition, awareness rallies, debated, and various cultural programmes.

3.2 Waste Production is on the Rise

India's waste crisis is set to spiral–450 million tonnes by 2050. The Environment Minister has stated that in another couple of decades India will generate nearly thrice the waste it currently does–"165 million tonnes by 2030 and 450 million tonnes by 2050".

Only 22-28% of the waste now collected is processed or treated. The problem is particularly acute in cities. Per capita waste generation rate in Indian cities ranges between 200 and 870 grams a day and is rising. Between 2001 and 2011, growing urban population and increase in per capita waste generation has resulted in a 50% increase in the rubbish in Indian cities. The government traced this to changing consumption patterns and consumer behaviour.

Recovering Resources from Cellphones- how easy is it?

Low handset prices and affordable entry-level smartphones for low income users implies that more equipment will be discarded. Paywall forecasts that e-goods in India are poised to touch $400 billion.

As each cell phone is replaced for a newer model, it is usually trashed. Once trashed, it adds to the landfill's toxic waste. The battery in the cellphone may catch fire in the landfill, or add to the leachate. If recycled by a reputable organization, the phone may get refurbished and sold to

the secondary markets in Asia or South America. If the phone is badly damaged, it is shredded and melted into a shredder. Palladium, gold and a few other precious metals are recovered from the molten liquid, while the rest is allowed to burn, releasing mercury and other vapours.
As per US-EPA, by recycling one million cell phones, 16,000 kg of copper, 350 kg of silver, 34kg of gold and 15 kg of palladium can be recovered.
Most cellphones meet a worse end. They are shipped to scrap yards in India, China, Thailand, Pakistan, etc. Many micro-entrepreneurs have been 'cooking' circuit boards to extract metals from within. These workers get exposed to nickel, cadmium, mercury and other toxic fumes. The environmental cost and human cost of e-waste recycling is very high.
It is interesting to know that 11% of the total gold mined each year is used to manufacture circuit boards. However, to extract it back from a typical cellphone is expensive.
India has E-Waste Management Rules since 2016 and 66 % of the countries in the world have e-waste laws, but the unorganized e-waste sector poses a recycling issue, as they collect 95% of the phones. Due to illiteracy and lack of awareness, they do not know the dangers involved in recycling phones.
There is a need to provide training to recyclers on the safety, health, dismantling and recycling operations. Moreover, there is a need for manufacturers to create a phone that is easy to recycle, and with reusability in mind. In addition, the modular components should be 'fair trade' or replaceable, allowing the handset to last longer. This is cradle-to cradle, circular economy. But this may happen only when resources become so scarce that recovering materials from old phones is more economical than using fresh raw materials.

3.3 Consumerism

Honey trap of Advertising

Modern societies are much influenced by the visions shown to them on media. This moulds the way people imagine others see them and judge them. This leads them to ape the 'perfect' looking world of media and in the process they become tremendously self-conscious. The desire to 'fit-in' with their idea of an acceptable image leads to a consumer culture. Post-modern world is moving away from their national and cultural identity to embrace a global identity.

This could be considered good, if only it was driven by the ethics. Advertisements on billboards, in newspapers and television, social media etc repetitively encourage us with their vibrant colours and attractive jingles, appealing to our emotions. One word or phrase repeatedly heard conjures up an image that gets fixated in our minds. This constant fixation is leading to an uncertainty regarding our own will. Advertising is more than just a display of a product or service, but a trick to create a need, desire, and demand for that product/ service. Advertisements give a false promise that buying a particular product will buy you happiness and peace of mind. Freedom of choice based on values and rights, and opinions has been replaced by fear of not fitting in with the latest trends in clothing and gadgets. 'Throwaway culture' has become a norm in India now. Material goods have become indicators of status and social stratification. The global economy has instilled a culture of 'buy- use- discard and buy some more'.

After all, this is a demand-driven economy. The more we buy, the more the production will increase. If surplus is produced (at the cost of resources which could have been used more judiciously and sustainably), more effort is being put to create a false demand for the product.

History of Consumerism

Though humans are consumers in the ecological sense, they became 'consumeristic' only in the century gone by. In the early 20th century, a temporary abundance of cheap, concentrated, storable and portable energy in the form of fossil fuels enabled a dramatic rise in the rate and scope of resource extraction. Chain saws, powered mining equipment, tractors, powered fishing boats, etc coupled with electrically powered assembly lines and the use of petrochemicals and cheap fossil fuel allowed the manufacturing of a vast array of commercial products.

This led to a serious economic problem known as **overproduction,** which later contributed to the Great Depression of 1929-30, starting in America and taking over the entire industrialized world. This crisis gave birth to the massive and rapid expansion of the advertising industry during the 20th century as an "aggressive device of corporate survival." During the 1930s, the US-based National Association of Manufacturers enlisted a team of advertisers, marketers and psychologists to formulate a strategy to counter government efforts to plan and manage the economy. They created an ad campaign equating consumerism with the "The American Way."

Living on Credit

With the advent of automobiles, the ordinary citizens felt unable to pay for the vehicle and the 'Credit' companies began. With credit, households could consume now and pay later. Consumers took on more debt, the financial industry mushroomed and manufacturers sold more products. The American Government swiftly lent support as sales tax and income tax revenues grew. Gross Domestic Product (GDP) became the nation's primary measure of economic success.

By the time India gained Independence, GDP had become a universal measure of a nation's progress.

To keep consumerism alive, products had to be made less durable. Things needed to be worn out very soon, to be replaced at an ever-increasing rate.

Problems associated with Consumerism

1. Consumerism, according to the critics, warps human values.
2. Societies evolved to constitute a "leisure class" that engaged in conspicuous consumption.
3. Mass production became a way to universalize leisure. Therefore, owners engaged workers in an endless pursuit of status symbols, while continuously exploiting them.
4. The rich-poor divide continued to grow.
5. Status symbols deflected the attention of the society from this important problem of unequal distribution of wealth.

Two other major issues that were observed by environmental scientists, but ignored by the industrialists were:

A. Consumerism is physically impossible to maintain due to resource limits. Even at a fraction of one percent per year growth in consumption, all of earth's resources eventually would be used up.
B. The consumer economy also produces an unending variety of wastes, of which water, air and soil can absorb only so much before planetary life-support systems begin unraveling.

Solution to Consumerism

The solution was arrived at as early as 1954, when physicist Harrison Brown envisioned devastating social and environmental consequences from the relentless growth of human population and resource consumption. The solution was for each of us to rein in our consumptive habits. Buy nothing! Reuse! Recycle! Share! However, consumerism spiraled on unheeding, and effectively became the mainstay of Economy, contributing up to 70% of GDP.

In the present day, the predicted end of resources is foreseeable. The impact has commenced. Fossil fuels are limited, environmental sink limits leading to climate change, ocean acidification and other pollution dilemmas are well within sight. While there may be short-term ways of pushing back against these limits (unconventional oil and gas, geo-engineering, quantitative easing), it is not totally avoidable.

Waste Generation by Online Shopping

There are no estimates about it, but e-commerce is adding substantially to our garbage. Amazon, e-bay, Flipkart, Alibaba, are a few e-commerce sites that offer big discounts and provide the goods at your doorstep. Their easy return policy, wide range of products and convenience of credit card discounts have made them a favourite with shoppers. Flipkart alone does 8 million shipments per month; India's e-commerce business is expected to be worth $73 million by 2020. Traditional brick-and-mortar shops are lamenting the loss of business. And in the background, people hardly notice the packaging waste accumulating at their doorstep- plastic, paper, blister wrap, air packets, tape and cardboard cartons.

Though these are mostly recyclable, the problems associated with them are:

1. As they are individually wrapped for express packaging, they are multi-layered and more in volume.
2. We do not have proper recycling systems in place for this waste.
3. Cardboard is produced from wood pulp, which translates to cutting of trees and dwindling of tree cover. As it is, India is trying hard to meet is tree cover from 21.5% to the world average of 33%.

Add to this the home delivery of food service which is expanding in all metro cities, such as Swiggy, Uber Eats and Zomato. Each quick and easy delivery comes with its plastic covers, tin foils, plastic cutlery, etc. Since Indians are not trained in proper waste segregation at source, the food waste and plastics/paper are disposed together, making them unfit for both recycling and composting.

Film: CNBC News https://www.nbcnews.com/nightly-news/video/why-online-shopping-boxes-are-to-blame-for-cities-growing-garbage-dump-costs-970745411861?v=railb&

3.4 Efficiency of Resource Use- Production and Consumption

The Earth's resources are objects of nature which are extracted by man from nature and taken as useful input to man-controlled processes, mostly economic processes. Natural resources can be categorized in many ways- fossil fuels, minerals, metals, nuclear energy, water resources, land resources (biomass and occupation), abiotic renewable energy (including hydropower, wind, tidal, wave and geothermal energy) and atmospheric resources. Apart from these natural resources, industrial resources and waste-as-resources may also be considered.

To use these resources efficiently is a rising challenge due to shrinking resources and the need to maintain sustainability. The transition toward resource efficient production and consumption patterns is currently one of the main challenges in engineering, environmental science and especially in governmental policies. This transition has led to a proliferation of meanings related to the resource efficiency concept, resulting in a wide variety of indicators.

Internationally much effort is being put to increase resource efficiency:-

1. The Resource Panel of the United Nations Environment Programme, conducts scientific assessments to prepare policies to achieve a more sustainable use of resources.
2. Japan is promoting resource efficiency since the 1990s through policies focusing on resource productivity and waste management, both of which are the basis of a sound material-cycle
3. Japanese society promotes the “3R (reduce, reuse, recycle)” principle and the cascading use of resources.
4. US policies are focusing on energy efficiency through the ‘Energy Star’ program, a voluntary labeling scheme to reduce greenhouse gas emissions.
5. “Resource Efficient Europe”, Flagship Initiative that faces challenges related to efficient use of natural resources, to avoid scarcities and achieve environmental targets like reducing climate change and preserving ecological assets, and also as an opportunity for economic competitiveness. Natural resources are given high priority in the EU industrial policy for resource security. In order to prioritize the policy actions and avoid supply shortages, **a first list of materials** (Critical Raw Materials, CRM) facing the highest supply risk to the whole EU economy has been published in 2010 and is updated every three years (EC, 2010b, EC, 2014).

As can be observed from these examples, each region is working out a different strategy, making it difficult to quantify resource efficiency. But it becomes hard to quantify and compare their works. Hence, indicators have been developed for systems at different levels of economic activity: from the micro-scale of specific processes and products to the meso- and macro-scale of sectors and countries.

Category	Example	Scale/Method
Energy Efficiency	Ethanol-producing system	Micro Scale
	Energy efficiency of the Norwegian society	Macro-scale
Products and process Analysis	Gate-to-gate perspective	Micro Scale
	Full life cycle perspective	Macro-scale
Resource efficiency	National or regional perspective	Macro-scale
	Global perspective, imported products	Global Scale

Source	Inland water consumption	Extracted from nature
	Electronics equipment	Recycling waste
Resource Consumption	Gross Domestic Product (GDP) over domestic material consumption (DMC)	used by Resource Efficient Europe
	GDP over the Environmentally Weighted Material Consumption (EMC)	established by Van der Voet et al.

Table 3.1 Examples of different scales of resource and energy efficiency

Efficiency of Resource Use - Production and Consumption

Resources and energy are being utilized all across the world. Efforts are on at various levels to improve resource efficiency. Two metrics are being used to characterize efficiency:

- Efficiency at level 1: originates from thermodynamics-assisted engineering It is defined as the ratio between the useful outputs (or benefits) and the inventoried flows

$$\text{Efficiency at level 1} = \frac{\text{benefits}}{\text{inventoried flows}}$$

- Efficiency at level 2 is derived from the original eco-efficiency concept. Eco-efficiency is defined as the ratio between the intended effects (or benefits) and environmental impacts, assessed through specific impact assessment models

$$\text{Efficiency at level 2} = \frac{\text{benefits}}{\text{environmental impacts}}$$

For Level 1 efficiency, the inventoried flows can be natural resources, industrial resources, waste-as-resources or emissions. Natural resources extracted from natural environment enter the industrial system. They are transformed into industrial resources e.g. energy carriers, semi-finished products, chemical building blocks, etc and get used in primary, secondary and tertiary economic sectors. The output of the production system consists of products and services that are supplied to the consumption

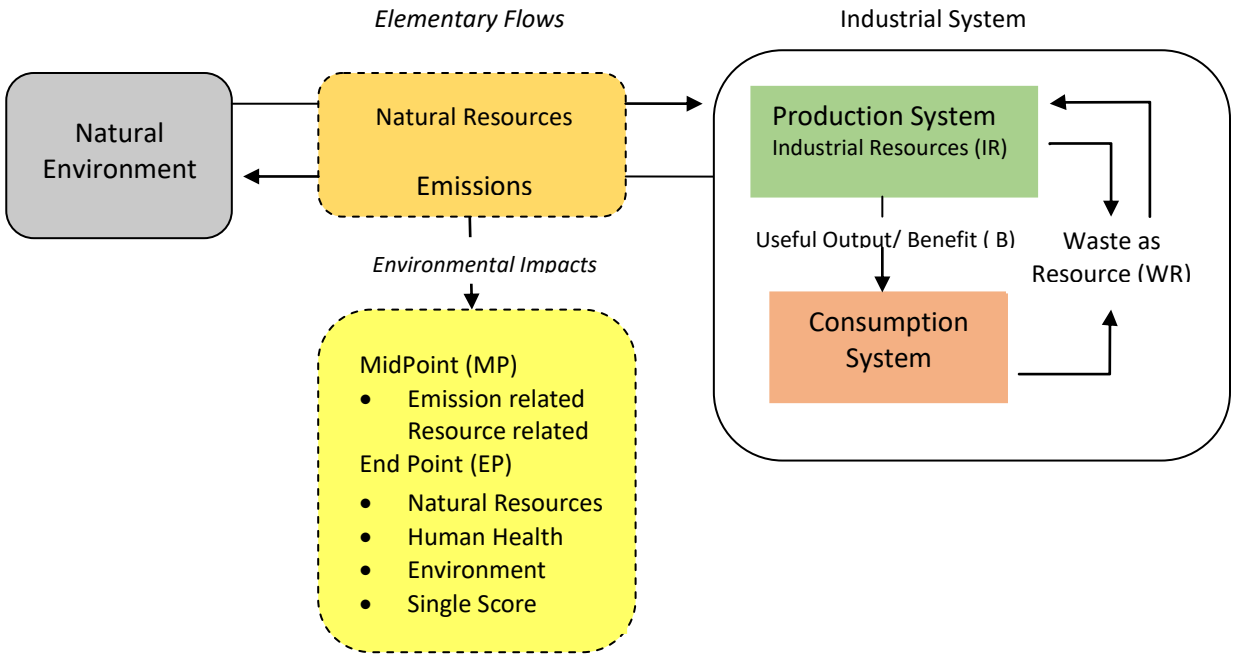


Fig 3.1 Elementary Flows to Calculate Efficiency

(Source: Sofie Huysman, *et al*, Feb 2015, Toward a systematized framework for resource efficiency indicators)

system. These products and services are the useful outputs or benefits (B) of the production system. Both the production and consumption system generate emissions and waste materials. Emissions are released to the environment. Waste can be transferred to the waste treatment sector, from where it may be utilized as waste-as-resources (WR) and supplied to the production system. If not, they are disposed without any recovery. In case of waste-as-resources, environmental impacts can also be used to quantify the benefits.

The concept of 'waste-as-resources' is based on two paradigms:
(a) waste prevention implies the reduction of the use of resources
(b) the recovery of waste and the use of recovered materials implies the reduction of the use of natural resources.

Flows and benefits can be expressed in biophysical metrics (e.g. mass, volume, energy or occupation) or in monetary metrics (e.g. euros, dollars).

Level 2 efficiencies are usually expressed by comparing the environmental benefits related to the amount of avoided or reused/recycled/recovered waste, to the environmental impacts of the considered system. These benefits are generally 'credited' to the considered product as avoided impacts otherwise produced by other production systems.

A commonly used methodology that converts the inventoried flows that are directly exchanged with the environment, i.e. natural resources and emissions, to environmental impacts is Life Cycle Assessment (LCA) (ISO, 2006). LCA can help us identify the areas in the process where the effort, be it resource, energy or money is being spent on over-processing. This will be discussed later in the course.

The Right Way to Use Shopping Bags

Cotton bags are not always greener: using organic cotton has a greater environmental impact than non-organic due to higher production costs. Our assumptions about what is environmentally friendly don't always stand up to scrutiny.

So what are the best replacements for single-use plastic bags? There is no direct answer. Composition, printing, transport, etc complicate the answer. A Danish LCA Study conducted in 2018 reveals that it is not important which shopping bag you carry, but how many times you reuse it before discarding. So if you reuse a plastic bag (say, as a bin liner), you need to reuse the same bag for many days for it to be eco-friendly.

Type of Bag	Times to reuse before discard (Danish Recommendation)	Times to reuse before discard (UK Recommendation- only for Climate change mitigation)
polypropylene bags **(green reusable bags at supermarkets)**	37 times	At least 3 times
Low density polypropylene		3 times
High density polypropylene		4 times
Non-woven poypropylene		11 times
paper bags	43 times	3 times

cotton bags	7,100 times.	131 times

A USA study of 2014 found that reusable LDPE and polypropylene bags do have a lower environmental impact than the usual plastic bags found in supermarkets – but only if they are reused enough times. This study found that about 40% of shoppers forgot to bring their reusable bags and therefore end up using the plastic bags. This adds to the environmental burden of shopping.

Here are the things to remember:

1. Whatever bag type you use, use it as many times as possible
2. Choose bags made from recyclable materials
3. Avoid bags that have printing or decorations – these alone can add significantly to the environmental burden of the bag
4. Never allow a bag to become litter – recycle, reuse and repurpose your bags.

To evaluate the environmental impact of these flows, characterization factors are applied to convert the flows to common units within environmental impact categories (e.g. acidification, eutrophication, etc.). In flow-to-impact modelling, the impacts are studied at mid-point and end-point. At the midpoint, the impact categories include aspects such as eutrophication, eco-toxicity, abiotic resource depletion, emissions and climate change. Endpoint impact categories usually aggregate midpoint impact categories into three areas of protection: human health, natural environment, and natural resources. At single score endpoint impact level all areas of protection are covered by one single indicator.

Environmental impacts are quantified by characterization factors. For example, the abiotic depletion potential is expressed in kg antimony equivalent per year for minerals mining to express their contribution to depletion. From a waste management point of view, increasing the fraction of waste as resource is the most suitable way of increasing resource use efficiency. This makes it simpler to compare two totally different efforts in different regions of the world towards achieving the same goal of resource efficiency.

3.5 Life Cycle Assessment (LCA)

Life cycle assessment and cost benefit analysis are popular **decision support tools** to determine the best waste management options with a scientific basis. They compare waste management systems before policies and targets are set or investments made.
For example, LCA or CBA can help a municipality to choose between landfill, incinerator and composting plant. Local authorities can decide whether to spend public funds on improving recycling centres or to launch a waste prevention/ segregation campaign. It can even answer whether it is most beneficial to recycle plastic, glass, aluminium, or paper. Always two or more alternative options are chosen for comparison. Sometimes both LCA and CBA are used to confirm results.

Life-cycle assessment (**LCA)** is also known as life-cycle analysis, ecobalance, and cradle-to-grave analysis. Life-Cycle Analysis evaluates all the known environmental impacts of a product or sevice throughout its lifetime- from material extraction (cradle) to final disposal (grave). This includes the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.

Energy consumption, auxiliary materials, emission outputs, waste generated and recoverable material or energy are all inventoried. Inputs and outputs in the inventory are grouped and categorised into potential impact categories- toxicity, climate change, or resource consumption, etc. As per scientific knowledge, their environmental impacts are predicted. Each different input or output is further grouped and weighted against each other to arrive at a single score called an "ecological footprint". Placing weightage is the most crucial part of LCA. It is a subjective decision, for instance stating that toxicity is more, or less, important than climate change.

There are two main types of LCA:

- Attributional LCA
- Social LCA

Attributional LCA: seek to establish, or attribute, the burdens associated with the production and use of a product, service or process, at a point in time (typically the recent past).
LCAs are oriented to the future, seeking to identify the environmental consequences of a decision or **a** proposed change in a system under study, taking into account the market and economic implications of a decision.
Social LCA: Social LCA suggests a different approach to life cycle thinking intended to assess social implications or potential impacts. Social LCA is an approach that is complementary to environmental/ attributional LCA.
ISO 14040, an international standard has been developed to ensure that the LCA is of a certain quality and transparency regarding the assumptions.
The 4 phases of LCA are

1. Goal and definition of scope: Technical details of the functional unit,
2. Lifecycle Inventory analysis (LCI) - Setting system boundaries
3. Impact assessment- allocating environmental load.
4. Interpretation of the first three points

The functional unit in the production system provides a reference to the inputs and outputs to be analysed and alternatives suggested. System boundaries demarcate the processes into units, for easy analysis. These boundaries are difficult to allot, as environmental load maybe shared by many processes. So, system expansion, substitution and partition are the methods applied. Impact categories include human toxicity, smog, global warming, eutrophication, etc.

The variants of LCA are:

1. Cradle-to grave: They assess from resource extraction to disposal. e.g. paper
2. Cradle to Gate: This is a partial LCA, only till the product leaves the product leaves the factory gate. This analyses the impacts in the production process only and suggests ways to improve efficiency in manufacturing/ production.
3. Gate to gate: This is another partial LCA. It looks at only value added processes. Gate-to-gate modules may later be linked in their appropriate production chain to form a complete cradle-to-gate evaluation.
4. Cradle to Cradle: When the end-of-life disposal step for the product is a recycling process, the LCA is cradle to cradle. It is used to minimize the environmental impact of products by employing sustainable production, operation, and disposal practices and aims to incorporate social responsibility into product development. New, identical products (e.g., asphalt pavement from discarded asphalt pavement, glass bottles from collected glass bottles), or different products (e.g., glass wool insulation from collected glass bottles) emerge from the recycling process.

LCA can be helpful for:

- Decision support connected to product research and development;
- Defining product and process design principles;
- Business strategy support;
- Environmental education;
- Environmental product declaration and labelling;
- Integrated policies for waste management;
- Studies on the quantifying and reduction of environmental pollution

3.6 Cost – Benefit Analysis (CBA)

This analyses the cost of a project, programme or policy. It also takes into account the benefits to the society, and environment. If the net benefit is higher, then the project gets an approval. It is important to note that every cost and every benefit is measured in monetary terms, making it easier to compare and decide. Besides the inputs in the LCA, the CBA includes investments, manpower, employment, safety and health. Based on these, a net present value of each option is arrived at 9 considering both past, and future events as well). No international standards are present for CBA. The Danish Topic Centre for Waste and Resources has recommended special attention to be paid to the decision on system boundary. CBA and LCA are decision support tools, not decision making tools.

Limitations of LCA/ CBA

1. Sometimes only the land within national or regional barriers is considered. The effect across the border may be kept out of the equation.
2. Information on the alternative (non-existent) is required.
3. Not all information can be added to the assessments.

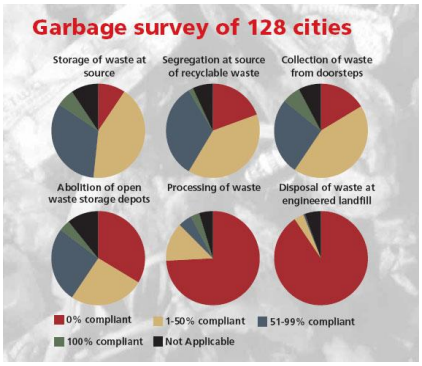
Cost and Benefit of Waste Management

CITIES	WASTE QUANTITY
	tonnes per day (tpd)
Delhi	5,922
Greater Mumbai	5,320
Chennai	3,036
Kolkata	2,653
Hyderabad	2,187
Bangalore	1,669
Ahmedabad	1,302

Source: Central Pollution Control Board, Delhi

Urban India produces 1,20,000 tonnes of municipal solid waste each day. Businesses want to burn this garbage to produce electricity, using government subsidies. Environmentalists say this is not viable, given Indian conditions--they also fear toxic emissions from incineration.

With no proper planning for waste management at the dumpsite, and every increasing tones of waste appearing on site every single day, cities are fighting a losing battle. Cities of Surat and Cochin are particularly struggling with their waste disposal. Cochin Municipality has been slapped with a fine of Rs 1 crore for n



The case of waste oil from two factories in Tamilnadu, changing hands and being dumped on to an unsuspecting farmer's leased land in Tumkur at midnight, is a misdeed whose investigation revealed that for an industrial unit to clean up its dirty oil costs about Rs.11,000 per barrel, but illegal dumping makes it possible to bring down the cost to a mere 3,100 per barrel. Meanwhile, the emptied barrels fetch the illegal scrap trader up to 17,500 per

truckload. In Tumkur the waste oil came from at least 340 km away in Cuddalore and 850 km in Raigad. The affected farmers in Tumkur, are bearing the brunt, with their borewells pumping out sludgy black water laced with lead and aluminium. Laboratory tests suggest that it could take over 10 years to clean up the pollution.

The state pollution control boards are confounded and unable to tackle the innumerable cases of illegal waste trafficking across state borders within the country. We do have stringent laws, but these are blatantly flouted, while law enforcement remains lacking in most parts of India to tackle the situation.

Summary

Waste production is increasing due to consumerism. Consumerism was aggressively promoted by the Americans after the great depression of 1930s. It encourages a use-and-throw culture, which consumed more resources and produces more waste. Advertisement, media exposure, purchase on credit, ease of shopping and peer pressure have broken down traditional societal values. Online shopping and cheap mobiles are adding to the global waste issue. With dwindling resources, it is time to focus on efficiency in resource use in production as well as consumption. Efficiency is measured by the benefits derived at the cost of resource flow as well as environmental impacts. Life Cycle Assessment and Cost-Benefit analysis are tools to find the most efficient resource use in production and waste management.

Self- Assessment Test

1. What are the driving forces of consumerism? How can consumerism be controlled?
2. Explain LCA and CBA with your own example.
3. How can we simplify the recycling of cellphones?
4. Is online shopping good or bad? Debate in class. How can online shopping be made more responsible?
5. Discuss on the burden of waste disposal and the CBA of waste management.

Videos

1. How Does Advertising Reflect Consumerism?
   https://www.youtube.com/watch?v=LvKdMrY9nrw
2. Takeout creates a lot of trash. It doesn't have to
   https://www.youtube.com/watch?v=5qx2WFpNTPs
3. https://crossingborders.dk/global-events/recycling-stagnates-waste-on-the-rise
4. The Story of Electronics - animated video
   https://www.youtube.com/watch?v=sW_7i6T_H78
5. The Story of Bottled Water
   https://www.youtube.com/watch?v=Se12y9hSOM0
6. LCA - The life cycle of a t-shirt - Angel Chang
   https://www.youtube.com/watch?v=BiSYoeqb_VY

Reference Book:

1. Life Cycle Assessment of Supermarket Carrier Bags- 2006, Environment Agency, Feb 2011
2. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291023/scho0711buan-e-e.pdf

3. Life Cycle Assessment of Grocery Bags, Environmental Project, Ministry of Environment and Food, Denmark, Feb 2018, https://www2.mst.dk/Udgiv/publications/2018/02/978-87-93614-73-4.pdf
4. Alejandro Villanueva, Karen B. Kristensen and Nanja Heda, Copenhagen Resource Institute,2006: A quick Guide to LCA and CBA in Waste management https://cri.dk/sites/cri.dk/files/dokumenter/artikler/filea951.pdf
5. In depth, Down to Earth, https://www.downtoearth.org.in https://www.downtoearth.org.in/coverage/waste/costs-and-benefits-of-india-s-waste-disposal-options-5623

Chapter 4
Issues of Sustainability

Objectives

- To know the main aspects which hinder sustainable growth
- To gauge risk assessment and product stewardship
- To explore methods to use resources efficiently

Structure

4.1 Major Threats to Sustainability
4.2 Environmental Impact Assessment
4.3 Risk Assessment for Solid Waste
4.4 Resource Efficiency
4.5 Product Stewardship

To Do Activities

- Read through a risk assessment report of a company.
- Do a practical on risk assessment of a project in your area, or of a chemical.
- Conduct practical exercise. The practical need not be completed in one day. It can be done as a weeklong assignment.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.
- Choose a live project in your locality. Try to conduct a risk assessment for the same.
- Explore and understand different eco labels in India and make a list of companies/ products with eco-label certifications in India.
- Select any product made of natural resource (eg. rubber tyres, fruit based confectioneries, etc) . Ask them to study its manufacturing process. How can they make the process resource efficient? Make them prepare a slide show and present before the class.

4.1 Major Threats to Sustainability

Sustainability is the process of maintaining change in a balanced fashion, in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable Development has been explained in Chapter 5 of Course 3.

This diagram indicates the relationship between the “three pillars of sustainability”, in which both Economy and Society are constrained by environmental limits.

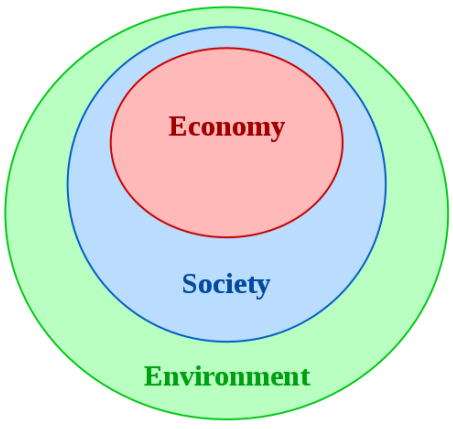


Fig 4.1 Three Pillars of Sustainability

Economic Development

Decoupling Environmental Degradation and Economic Growth

The term decoupling is in the context of economic production and environmental quality. Economic growth and Environmental degradation are indirectly proportional to the community growth and resulting environment decline. An economy that is able to sustain GDP growth without having a negative impact on the environment is said to be decoupled.

Nature as an Economic Externality - The economic importance of nature is indicated by the use of the expression 'ecosystem services' to highlight the market relevance of an increasingly scarce natural world that can no longer be regarded as both unlimited and free. Since ecosystem services are usually treated as economic externalities, they are un-priced and therefore overused and degraded, a situation sometimes referred to as the **Tragedy of the Commons**.

Economic opportunity - Treating the environment as an externality may generate short-term profit at the expense of sustainability. Growth that depletes ecosystem services is sometimes termed "uneconomic growth" as it leads to a decline in quality of life. Minimizing such growth can provide opportunities for local businesses.

For example, industrial waste can be treated as an "economic resource in the wrong place". The benefits of waste reduction include savings from disposal costs, fewer environmental penalties, and reduced liability insurance. This may lead to increased market share due to an improved public image. Energy efficiency can also increase profits by reducing costs.

Social Development

Peace, Security Social Justice – Social disruptions like war, crime and corruption divert resources away from human need to the great extent. It damages the future plans of the society and becomes threat for human well being and environment. This has resulted in the depletion of natural Resources.

Poverty – Poverty is a major cause and effect of global environment problems and results in degradation. The major hurdle to achieve sustainability is elevation of poverty. So there should be a better deal in the improvement of environment quality with respect to the growth of population.

Human Relationship with Nature – According to Murray Bookchin, the idea that humans must dominate nature is common in hierarchical societies. The relationship between capitalism and market, if unchecked, has the capacity to reduce the planet to the mere resource to be exploited. Nature is treated as a commodity.

Human Settlements - One approach to sustainable living, exemplified by small-scale urban transition towns and rural eco villages, seeks to create self-reliant communities based on principles of simple living, which maximize self-sufficiency particularly in food production. Other approaches loosely based around New Urbanism, work for successfully reducing environmental impacts by altering the built environment to create and preserve sustainable cities which support sustainable transport and zero emission housing.

Environment Protection

Healthy ecosystems provide vital goods and services to humans and other organisms. To keep the ecosystem in a quality manner it is important to manage environment in standard condition.

Environment management is the process of managing the environmental segments i.e Air, Water and Land.

4.2 Environment Impact Assessment

Environmental impact assessment (EIA) is an effective method which evaluates the effects of different sectors and activities of a project on environmental components and finally according to results of this assessment offers solutions to reduce negative effects.

EIA is covered in detail in the next chapter.
The steps in an EIA are as follows:

1. Screen
2. Scope
3. Assess: Assessment is based on Precautionary Principle as well as Polluter Pays Principle.
4. Report: A non technical report is prepared and presented before the public.
5. Decision making
6. Review: The activities of the industry are monitored and checked for compliance
7. Enforce- An environmental audit is performed for enforcement.

EIA is generally carried out before the project. In case of waste management, often it is on a site already being used for dumping wastes. The main objective of EIA projects in MSW landfills is to understand the current situation of landfill and, given the current situation, appropriate enforcement strategies should be presented to improve the quality of the environment and reduce pollution caused by landfilling. Problems of unsanitary disposal sites and environmental risks by landfills, specifically hospital and industrial wastes, and traditional methods substituted for of environmentally sound and sustainable methods are addressed in an EIA.

Rapid Impact Assessment Matrix (RIAM) is a tool to analyse alternatives suggested by the EIA. Advantages of RIAM:

- minimizes the elements of subjectivity
- introduces transparency and objectivity.
- Using the RIAM, EIA has been carried out on different municipal solid waste disposal options.
- able to integrate all of the components and various parameters,
- it is an ideal mechanism that guarantees clear and rapid assessment of the environmental impacts of a project
- the process of operation is documented simultaneously which causes saving the amount of required time.
- RIAM makes it easy for the user to assess procedures; because an expert will have a matrix in which each of its cells has very useful information that offers magnitude and significance of effects, and finally, the user is able to reach a conclusion.

If the EIA process is successful, it identifies alternatives and mitigation measures to reduce the environmental impact of a proposed project.

4.3 Risk Assessment for Solid Waste

Risk is defined as a probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through prompt action.

Risk assessment (RA) is defined as the characterization of the potential harmful effects on human health due to exposure. It is a systematic collection of information about potential risks and evaluating them for necessary action. Risk assessment may address any of environmental issues but it primarily focuses on health and safety of humans, animals and plants. For example, abandoned landfill sites after closure are often later developed for public use as parks, or other development projects. Many noxious gases like methane and mercaptan continue to be generated long after the landfills are closed. In all such cases a risk assessment should form an integral part of EIA process for any development project on such sites.
Risk estimate of harmful or adverse effect on health (due to chemical releases) is often expressed as the ratio of predicted concentration to no-effect (or safe) concentration.

Purpose of Risk Assessment
Risk assessment is a thorough look at the workplace to identify those things, situations and processes, that may cause harm, particularly to people. After identification is made, the likelihood and severity of the risk are analyzed and evaluated. When this determination is made, the management can decide what measures should be in place to effectively eliminate or control the harm from happening.

Risk assessments are sometimes used to evaluate specific design features of solid waste disposal facilities such as liners for a disposal site. While risk assessment is a requirement and in the main stream of the safety management of radioactive disposal facilities, it is really just beginning to make its move into the world of solid waste management.

There is an important difference between Risk Assessment and Risk Analysis. Risk analysis is often a subcomponent of the larger risk assessment process. The broader risk assessment process typically includes:

- Identification of the issues that contribute to risk,
- Analyzing their significance
- Identifying options for dealing with the risk issue,
- Determining which option is likely to be the best fit
- Communicating results and recommendations to decision-makers.

As can be seen, “analysis” is about evaluating significance and/ or enabling the comparison of options.
Unfortunately, much of Risk Management today is assessment without meaningful (or accurate) analysis. The result is poorly informed prioritization and cost-ineffective decisions. The bottom line is that the purpose of any risk analysis is to provide a decision-maker with the best possible information about loss exposure and their options for dealing with it.

Steps in Risk Assessment
Risk assessment is the overall process of hazard identification, risk analysis, and risk evaluation.
Risk Assessment is a four-step method as given below:

- Identification of hazards (sources and receptors)
- Hazard Assessment
- Risk Analysis
- Risk Management
- Review and Monitor the Assessment

Step 1 Identification of Hazards

This is a systematic examination of various project components and activities to determine source of impact and the potential receptor. The likely acute, chronic or fatal effects on receptors are identified. Hazard identification can be carried out by suing checklists or through field surveys.

Chemicals of potential concern are identified using various indicators e.g. toxicity, persistence, and mobility. A toxicity score may be developed for each chemical by multiplying the maximum concentration with its carcinogenic potency factor. In the case of non-carcinogenic chemicals, the toxicity score is obtained on dividing the maximum concentration by a reference dose.

Process of Hazard Findings

Overall, the goal is to find and record possible hazards that may be present in the workplace. The team should include both people familiar with the work area, as well as people who are not - this way you have both the experienced and fresh eye to conduct the inspection. The inspectors should have a critical eye for detail. The person or team should be competent to carry out the assessment and have good knowledge about the hazard being assessed, any situations that might likely occur, and protective measures appropriate to that hazard or risk. To be sure that all hazards are found:

- Look at all aspects of the work.
- Include non-routine activities such as maintenance, repair, or cleaning.
- Look at accident / incident / near-miss records.
- Include people who work off site either at home, on other job sites, drivers, tele-workers, with clients, etc.
- Look at the way the work is organized or done (include experience of people doing the work, systems being used, etc).
- Look at foreseeable unusual conditions (for example: possible impact on hazard control procedures that may be unavailable in an emergency situation, power outage, etc.).
- Determine whether a product, machine or equipment can be intentionally or unintentionally changed (e.g., a safety guard that could be removed).
- Review all of the phases of the lifecycle.
- Examine risks to visitors or the public.

Factors that contribute to the level of risk such as:

- The work environment (layout, condition, etc.)
- The systems of work being used.
- The range of foreseeable conditions.
- The way the source may cause harm (e.g., inhalation, ingestion, etc.).
- How often and how much a person will be exposed.
- The interaction, capability, skill, experience of workers who do the work.

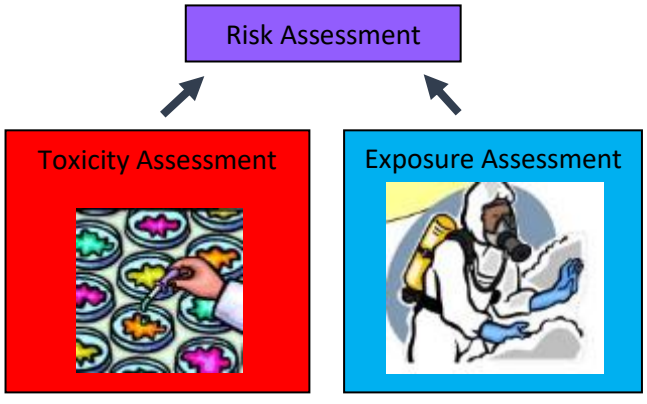


Fig 4.2: Risk Assessment of Toxicity

Step 2 Hazard Assessment

Hazard identification is the process of finding, listing, and characterizing hazards. It includes determination of the probability of accidental releases; quantification of release rates and calculation of dose and duration of exposure.

Accidental events may be due to human error, equipment failure during transportation, or due to a catastrophe.

Bioaccumulation and synergistic effects of chemicals are also estimated in the hazard assessment. Dose response relationship has been extensively studied for this purpose. This helps in identification of carcinogenic chemicals when risk depends on total cumulative dose and not simply on duration of single dose. Chemicals which have no adverse effect on human health below a threshold or reference dose (R_fD) are categorized as non-carcinogens.

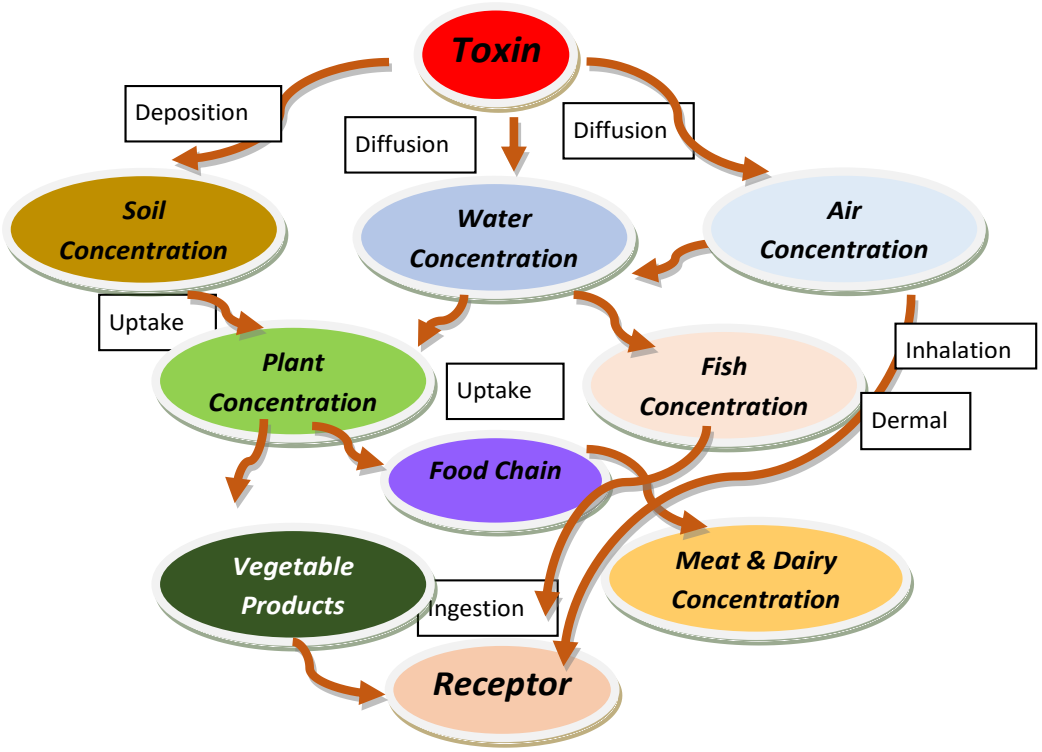


Fig 4.3: Pathways to consider for Hazard Assessment

Step 3 Risk Analysis

Risk analysis is a process for comprehending the nature of hazards and determining the level of risk. Risk analysis provides a basis for risk evaluation and decisions about risk control.

Risk analysis = Risk Estimation + Risk Evaluation

Risk estimation is an additional input for decision making along with other indicators e.g. the cost of project. Information can include current and historical data, theoretical analysis, informed opinions, and the concerns of stakeholders.

Risk evaluation is the process of comparing an estimated risk against given risk criteria to determine the significance of the risk. Risk evaluation indicates whether a risk is acceptable or not. Guidelines/standards are set relative to the medium to which receptor is exposed.

Risk Rating

Rating or prioritizing hazards is one way to help determine which risk is the most serious and thus which to control first. Priority is usually established by taking into account the employee exposure and the potential for incident, injury or illness. By assigning a priority to the risks, you are creating a ranking or an action list.

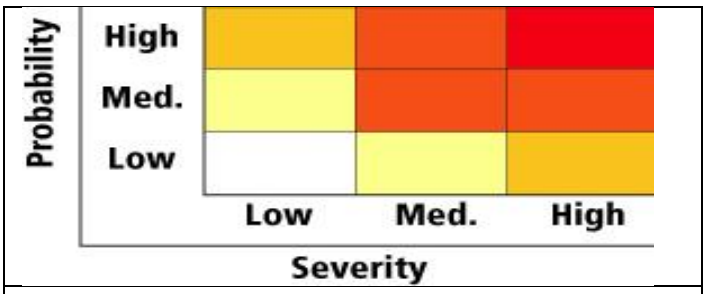


Fig 4.4: Risk Matrix

Severity ratings in this example represent:

- High: major fracture, poisoning, significant loss of blood, serious head injury, or fatal disease
- Medium: sprain, strain, localized burn, dermatitis, asthma, injury requiring days off work
- Low: an injury that requires first aid only; short-term pain, irritation, or dizziness

Probability ratings in this example represent:

- High: likely to be experienced once or twice a year by an individual
- Medium: may be experienced once every five years by an individual
- Low: may occur once during a working lifetime

	Consequences				Increasing Likelihood				
Severity	People	Assets	Environment	Reputation	A Never heard of it in the industry	B Heard in the industry	C Has occurred, once or twice	D Has occurred at 5 locations or more than once	E Has occurred more than once at each location
0	No Injury or health effect	No damage	No effect	No impact					
1	Slight Injury or health effect	Slight Damage	Slight effect	Slight impact					
2	Minor Injury or health effect	Minor damage	Minor effect	Minor impact					
3	Major Injury or health effect	Moderate damage	Moderate effect	Moderate impact					
4	Permanent Disability/ up to 3 fatalitites	Major damage	Major effect	Major impact					
5	More than 3 fatalitites	Massive damage	Massive effect	Massive impact					

Fig 4.5 Risk Assessment Matrix

Step 4 Risk Management

Risk control includes actions implementing risk evaluation decisions. Risk control can involve monitoring, re-evaluation, and compliance with decisions. After a risk has been identified and estimated the next step is to develop a strategy for its management. All aspects of risks potential have to be examined to devise a suitable management plan. Precise details will obviously depend on the nature and magnitude of the risk estimated.

The total risk assessed must be compared with the acceptable risk to devise any risk management plan. The risk management strategies are developed by decreasing the chances of exposure or by decreasing the concentration of the exposure-usually both. Human exposure may be limited by isolation or by providing physical barriers or protective clothing e.g. masks or shields.

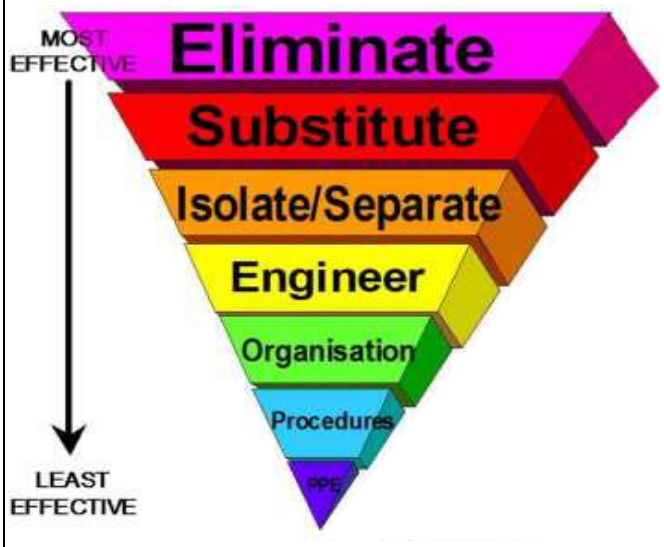
Methods of Hazard control : Hazard control methods are often grouped into the following categories:

- Elimination (including substitution).
- Engineering controls.
- Administrative controls.
- Personal protective equipment.

Strategies should be developed to reduce the quantity of hazardous waste generated and if possible, to change the character of hazardous wastes generated e.g by changing the technology, substituting alternative raw materials with less hazard potential.

The basic steps in risk management are the following:

- Determine if other alternatives/options are available, which carry lesser risk of exposure
- Estimate the cost of avoiding and or reducing the risk to acceptable limits.



1. Eliminate the hazard
2. Substitute a process/ method to lower risk
3. Isolate/ Separate hazard from target
4. Engineered safeguards:
   - Prevention of unwanted event
   - Recovery to mitigate consequences
5. Organisational control- training, competency, communication
6. Procedural Control
   - Operating procedures, work instructions, permits
   - Maintenance regimes
   - Emergency response procedures
7. Personal Protective Equipment (PPE) to protect the worker

Fig: 4.6 Risk Controls

Step 5 Review and Monitor the Assessment

Keeping records of your assessment and any control actions taken is very important. You may be required to store assessments for a specific number of years. Check for local requirements in your jurisdiction. The level of documentation or record keeping will depend on:

- Level of risk involved.

- Legislated requirements.
- Requirements of any management systems that may be in place.

It is good practice to review the assessment on a regular basis to make sure the control methods are effective.

Importance of Risk Assessment

Risk assessments are very important as they form an integral part of an occupational health and safety management plan. They help to:

- Create awareness of hazards and risk.
- Identify who may be at risk (e.g., employees, cleaners, visitors, contractors, the public, etc.).
- Determine whether a control program is required for a particular hazard.
- Determine if existing control measures are adequate or if more should be done.
- Prevent injuries or illnesses, especially when done at the design or planning stage.
- Prioritize hazards and control measures.

The aim of the risk assessment process is to evaluate hazards, then remove that hazard or minimize the level of its risk by adding control measures, as necessary. By doing so, you have created a safer and healthier workplace. Risk Assessment Matrix is to be used as a standard to identify controls that reduce risk to ALARP. This Matrix for Risk Management is shown below:

There may be many reasons a risk assessment is needed, including

- Before new processes or activities are introduced.
- Before changes are introduced to existing processes or activities, including when products, machinery, tools, equipment change or new information concerning harm becomes available.
- When hazards are identified.

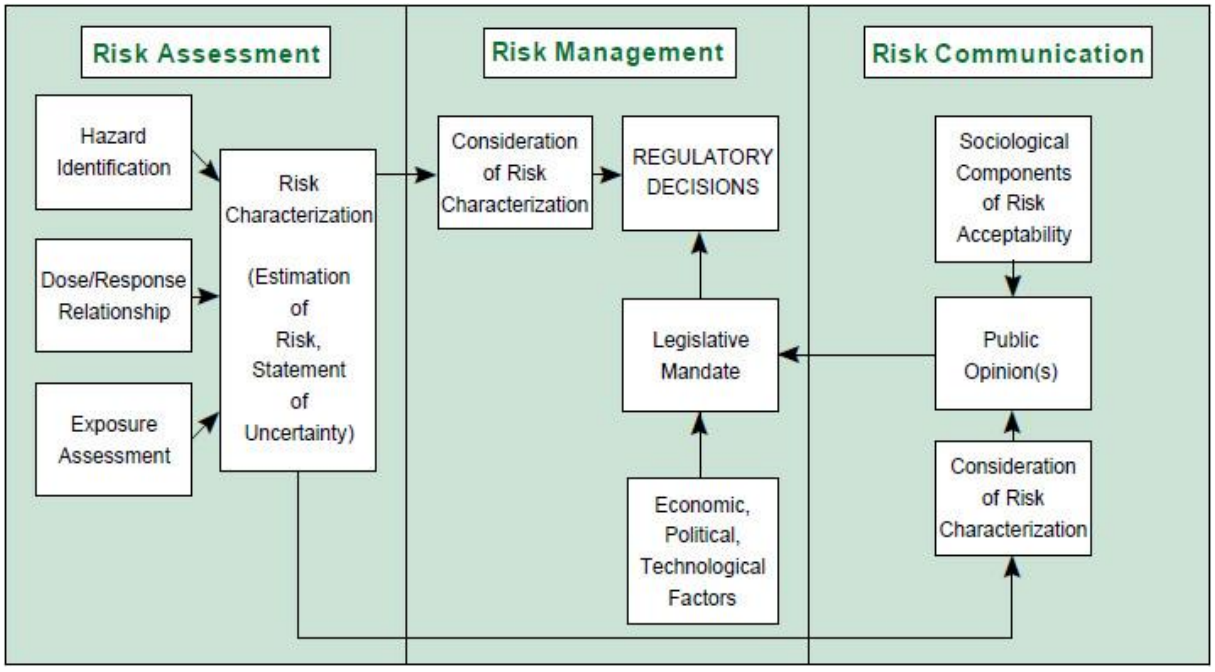


Fig 4.7: Trinity of Risk Issues

Source: Food Technology Magazine, May 1997. 51[5]:85-92.

Application of Risk Assessment

Risk assessment is required for solid waste (municipal waste), e-waste and hazardous waste, among others. As of now here are no requirements for operators of landfills or other waste disposal sites to perform risk assessments. The primary purpose of the risk assessment of solid wastes has been to provide a technical basis for setting standards.

Reuse, recycling and treatment of hazardous waste should be examined before it is finally disposed off on a secured landfill. It is also essential that various guidelines and statutory provisions be laid down by government, CPCB or other authorities are implemented strictly. Ideally, all hazardous emissions or wastes should be captured in a cradle to grave management system.

Risk assessment is also done for public health, information security, mega projects (large scale projects like airports, highways, tunnels and bridges, power plants, dams, oil and gas extraction, aerospace projects, etc), Software and Information Technology, shipping, outdoor and wilderness activities, underwater diving etc. Two other important areas of Risk Assessment are:

- Environmental Risk Assessment (ERA): This assesses the effect of stressors such as chemicals on the local environment. The undesired event for which assessment takes place is the detrimental effect on organisms, population or ecosystem. A ratio PEC/ PNEC is calculated where PEC stands for the Predicted Environmental concentration while PNEC stands for Predicted no-effect concentration. This ratio is used for regulation purposes and to communicate effectively to the management and the public.

- Biodiversity Risk Assessments . This RA evaluates the risks to biological diversity, especially species extinction and ecosystem collapse. The units of assessment are therefore species, sub-species or population, and habitat, ecosystem, etc. The risk is human interventions (threats and pressures). The global standard of biodiversity risk assessment includes the Red List of threatened species and IUCN Red List of Ecosystems. These assessments are used as indicators to measure progress towards sustainable development goals.

Risk from Burning Tyres

Tyres contain 25 % extender oils derived from benzene, 25% styrene, a derivative of benzene, and 25% 1,3 butadiene – both benzene and 1,3 butadiene are suspected human carcinogens. (A carcinogen is any substance, radionuclide or radiation that is an agent directly involved in causing cancer).

Foetuses, nursing babies, elderly, asthmatics, and immune suppressed individuals are all much more vulnerable to the pollutants released burning tyres. Even a nursing woman can transfer the pollutions she inhales to a baby through the fat in her breast milk. During breast-feeding, infants are exposed to higher concentrations of organic pollutants than at any subsequent time in their lives. Minuscule particles released during the burning can settle deep in the lungs. These are the risks associated with inhaling the smoke released from burning of tyres as an alternative cheap fuel.

4.4 Resource Efficiency (RE)

The purpose of RE is to govern and intensify the resource utilization. Such resource use brings about multiple benefits in the dimensions of economic, social and environmental. Sustainable Development is a key factor to sustain in future at Global Level. Many countries across the world are implementing new methods.

Typically, resources are materials, energy, services, staff, knowledge, or other assets that are transformed to produce benefit and in the process may be consumed or made unavailable. The concept of resource is

applied in Economics, Biology, Ecology, Computer Science, Management, and Human Resource. Any item can become a resource with time and developing technology.

Benefits of resource utilization may include

- ✓ increased wealth,
- ✓ proper functioning of a system,
- ✓ enhanced well-being.

Resources have three main characteristics:

- utility,
- limited availability,
- potential for depletion or consumption.

Resources have been variously categorized as biotic vs. abiotic renewable versus non-renewable, and potential versus actual, with more elaborate classifications. In our community, resources require Resource Allocation as well as Resource Management.

For this course, Resource Efficiency is primarily concerned with Natural Resources:

- Abiotic resources comprise non-living things such as land, water, air, minerals such as iron, aluminium, uranium, copper and gold.
- Biotic resources are obtained from the biosphere, such as forests animals, birds, fish, other marine organisms, agriculture, etc.

Objective of Resource Efficiency: The main objective of Resource Efficiency to emphasize resource productivity in the country which helps in Sustainable Development. Utilisation of resources in an efficient manner would improves the economy in a productive direction. Efficiency of resource use is the ability to derive maximum output per unit of resource. Therefore, it is the key to effectively addressing the challenges of achieving food security. Raising productivity in agriculture will certainly lead to availability of food and reduce the real price of food.

RE can be improved in specific areas in a business and guide subsequent actions.

- ✓ Waste assessment.
- ✓ Improve purchasing.
- ✓ Improve storage.
- ✓ Conserve energy.
- ✓ Conserve water.
- ✓ Preserve waterways.
- ✓ Reduce waste.
- ✓ Reduce risk.

Highlights of the RE Strategy:

The Resource Efficiency Strategy includes the core-action plan for the period 2017-2018 and medium term action plan for 2017 – 2020 with the following key elements:

- Institutional development including setting up an inter-departmental committee and Task force of experts,
- Capacity development at various levels for strengthening of capacities and sharing of best practices,
- Development of an indicator monitoring framework for baseline analysis
- Launch of Short term course on RE under the MHRD GIAN Programme
- Promotional and regulatory tools in selected sectors (automotive and construction) such as Eco-labeling for Secondary Raw Material (SRM) products, recycling standards, R&D and Technology Development, Sustainable Public Procurement, development of Industrial clusters and waste-

exchange platform, information sharing & awareness generation along with development of sectoral action plans.

It is expected that the strategy will pave the way forward in taking the agenda towards resource security and minimizing environment impact by setting up a framework. The strategy implementation would also identify need for setting up a Bureau for Resource Efficiency (BRE) which creates a prominence and enabling platform for this topic like the Bureau of Energy Efficiency (BEE) in India.

4.5 Product stewardship

"Product stewardship occurs when all those involved in the lifecycle of a product take responsibility to reduce the risk of adverse environmental, health and safety impacts to gain the most value from a product",- Georjean Adams, President EHS Strategies, INC.

Stewardship is an **ethic** that embodies the responsible planning and management of resources. It involves the conducting, supervising, or managing of something entrusted to one's care, such as a business or a natural resource, with utmost care and responsibility.

Product stewardship is the act of minimizing the health, safety, environmental, and social impacts of a product and its packaging throughout all lifecycle stages, while also maximizing economic benefits.
The importance of product stewardship is to ensure that those design, manufacture, sell and use consumer products are for reducing the negative impacts to the economy, public health, environment, and workers safety.

Examples of Product Stewardship Implementation:

- ⇨ To reuse of fly ash and slag wastes in cement industry
- ⇨ Discarded paper to reuse in the paper industry
- ⇨ Spent cooking oil can also be converted to Bio-Diesel for operating vehicles
- ⇨ Co processing of plastic and old tyres used in the cement industry for the purpose of Incinerator.

Fig 4.8: Product Stewardship

This concept of reuse is the producer's responsibility. It motivates environmentally beneficial products and ensures the products are suitable throughout the life.

Waste Management Systems vs. Product Stewardship

Waste Management method puts the responsibility of the product with the manufacturer till its sale. Then the resource is the responsibility of the consumer till he disposes it. After the resource turns to waste, the responsibility is handed over to the local government, for which the citizens pay through tax and also as waste handling fee to the local waste collectors.
Since the producer does not face the challenge of waste management, their main concern is greater production, for greater sales and larger profits. This must change.

Product Stewardship suggests that the Producer continues to remain responsible and bears the expense of recycling and scientific disposal of waste. Instead of the Government, an appointed Stewardship organization does the waste management on behalf of the producer. The recycled material re-enters the production line as raw material. In India, PROs are the stewardship organisations dealing with selected

streams of waste for the Producer. We have discussed this as part of Extended Producer Resoponsibility (EPR)and Producer Responsibility Organisations (PRO) in Course 3, section 4.6.

Product Stewardship defines 12 management practices:

1. Leadership
2. Accountability & Performance
3. Resources
4. Information on Health, Safety and Environment
5. Product Risk Characterization
6. Risk Management Systems
7. Product and Process Design Improvement
8. Employee Education and Product Use Feedback
9. Contract Manufacturer
10. Suppliers
11. Distributors
12. Customers and other Direct Product receivers.

Eco Labels

"Ecolabeling" is a voluntary method of environmental performance certification and labeling that is practised around the world. An ecolabel identifies products or services proven environmentally preferable overall, within a specific product or service category.

In contrast to "green" symbols, or claim statements developed by manufacturers and service providers, the most credible labels are awarded by an impartial third party for specific products or services that have been independently determined to meet transparent environmental leadership criteria, based on life-cycle considerations.

In India, the Confederation of Indian Industries (CII) runs the GreenPro Programme to assist manufacturers with green label certifications.

There are 31 ecolabels available in India, including:

- ✓ Best Aquaculture Practices: which protects biodiversity and worker rights
- ✓ Better Environmental Sustainability Targets (BEST), 1001: A certification for lead battery manufacturers who meet minimum emission standards and practice sound recycling.
- ✓ Carbon Neutral Certification: For businesses that offset their Scope 1 &2 carbon footprints.
- ✓ Ecomark-India (since 1991): A government operated seal of environmentally preferred consumer products that follow cradle to grave approach.
- ✓ Forest Stewardship Council (FSC): It tracks socially beneficial, environmentally appropriate material through its production process- processing, transformation, manufacturing and distribution.
- ✓ Global Organic Textile Standards (GOTS): It has comprehensive rules for ecological and socially responsible textile production. It ensures organic status of textile right from the harvest of the raw material, to the dyes used, till labeling.
- ✓ India Organic- National Programme for Organic Production (NPOP): A certification body to promote organic farming.

Case Study: India Looks to South Korea for Waste Management Ideas

India has much to learn from South Korea on Waste Management Policies. India generates over 1,50,000 tonnes of municipal solid waste (MSW) per day, with Mumbai being the world's fifth most wasteful city. Yet, only 83% of waste is collected and less than 30% is treated. According to the World Bank, India's daily waste generation will reach 3,77,000 tonnes by 2025. The consequences of India's megacities producing tonnes of waste are tangible and troubling.

India's waste predicament presents numerous social and environmental challenges - urban waste has significant effects on our health. There are thousands of informal ragpickers who sustain their livelihoods by collecting, sorting, and trading waste. They save almost 14% of the municipal budget annually, but suffer in health and social well-being. Waste burning is a major contributor to the air pollution crisis, for instance at the Ghazipur landfill site in Delhi. As India's own economy grows faster and further, the country will face an insurmountable waste crisis, unless the government puts a high priority on waste management.

South Korea on the other hand, has one of the world's most sophisticated waste management systems, and has been hugely successful in decoupling the link between economic growth and waste generation. A country of 51 million people, generating around 53,000 tonnes of MSW per day,it has a daily per capita MSW generation that is two to five times larger than that of India. Despite rapid industrialization over the past half century, it is the only Organisation for Economic Co-operation and Development country that has reduced MSW by 40% while its nominal GDP (gross domestic product) has seen a five-fold increase.

Until the 1980s, Korea focused on improving efficiency of waste management through incineration and landfills- like most other developing countries. This was considered relatively easier than public campaigns to "Reduce and Recycle". However, by the late 1980s, in the face of accelerating waste generation, South Korea implemented **a volume-based waste fee system**—a paradigm shift focused on controlling waste generation and achieving maximum rates of recycling while raising additional resources to finance waste management.

It has since seen a drastic reduction in MSW generation: from 30.6 million MT in 1990 to 19.3 million MT in 2016. **Korea is now the country with the second-highest recycling rate in the world (60%) after Germany.** It is one of the few countries to separate and recycle food waste. Meanwhile, landfill and incineration rates have decreased dramatically from 94% in 1990 to 38% in 2016.

Landfill recovery projects such as the Nanjido recovery project carried out by the Seoul metropolitan government in 1999, have successfully transformed hazardous waste sites into sustainable ecological attractions. Today, the Nanjido site welcomes 10 million visitors a year, and saves about $6,00,000 a year by providing landfill gas to be used as boiler fuel. Other municipalities are following suit: the world's largest landfill, Sudokwon landfill in Incheon, is currently being converted into "Dream Park", a leisure and environmental education centre.

A complementary policy focus has been to harness energy from WTE plants. South Korea released "Measures for Waste Resource and Biomass Energy" in 2008, which provided budgetary and technical support to local governments to expand WTE facilities. The world's first landfill-powered hydrogen plant

was built in South Korea in 2011, and currently over 60% of new and renewable energy is produced from waste—a contrast to India where wind and solar constitute major renewable energy sources.

A comprehensive yet creative policy mix for effective waste management in South Korea was made possible only through political will and strong public demand for cleaner, healthier living environments.

Summary

Sustainability requires economic development to be part of society and the environment. Sustainable development goals suggest a 'decoupling' of environmental degradation from economic development. Environment Impact Assessment is the first step for any enterprise to understand where its actions harm the environment and society and rectify them before progressing, or contemplate a mid-course correction. Rapid Impact Assessment Matrix as a tool has been explained in this chapter. Risk assessment and its components are explained for hazard prevention. Product stewardship occurs when the producer takes full responsibility for their product- from cradle to grave. Waste management puts the burden on the government to deal with waste, while stewardship engages in durable products and pays to recycle its used products to minimize resource consumption. An external certification called eco-labeling is a credible third party certification, which consumers can trust while making informed choices.

Self-Assessment Test

1. Explain on sustainability and sustainable development goals.
2. What are the steps in Risk Assessment?
3. Explain the importance of Product Stewardship in Sustainability.
4. How is the risk assessment matrix put to use?
5. How are resource efficiency and sustainability linked?
6. Explain the trinity of risk issues. How do they contribute to sustainability?
7. Discuss on natural resources and resource efficiency

Further Reading

- Core Competencies for the Product Stewardship Professional (free download), The Product Stewardship Society https://www.productstewards.org/Pages/default.aspx

Chapter 5
Environmental Impact Assessment

Objectives

- To understand the method of conducting EIA, SEA and EMP
- To know tools for ensuring sustainability and environmental protection

Structure

5.1 Fundamentals of EIA
5.2 Steps in EIA
5.3 Strategic Environmental Assessment
5.4 EIA in India
5.5 Environmental Management Plan (EMP)
5.6 Applications of EIA specific to this course

To Do Activities

- Show videos on EIA.
- Explain steps of EIA using flow chart fig 5.1
- Read and analyse the Human project case study. Explain to students how EIA in India differs from the West.
- Facilitate discussion on EIA in India using Case Study of Jindal Thermal Plant
- Classroom teaching EMP, and how it is conducted on the project site.
- Conduct practical exercise- Prepare EMP.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.
- Using news reports from your city, select a project that is suited for an EIA. Conduct a mock EIA. Present an Environmental Management Plan. Work in groups and make the EIA as realistic as possible.
- Study the Jindal Power case. What is your opinion on it? Should the project be allowed? What mitigation plans would you suggest? What are the discrepancies in the EIA report? Discuss in class.

5.1 Fundamentals of EIA

Environmental Impact Assessment is an activity designed to identify and predict the impacts(s) of a proposed project, operational procedure, policy, or legislative procedures on the environment, health and well being. Further, EIA must interpret the information and communicate it to the public.

EIA can take 30 days. For ecologically sensitive areas, it takes 90 days.

EIA is a major tool for minimizing the adverse impact of rapid industrialization on environment and for reversing those trends which may lead to climate change in long run. The EIA document itself is a technical device that identifies, predicts, and analyzes impacts on the physical environment, as well as social, cultural, and health impacts.

EIA is compulsory for 29 categories of activities including mining, electroplating, thermal power, etc and those with investment more than 50 crores as per EPA, 1996. MSW disposal site is one of the projects that cause severe negative effects on the environment, if the EIA is not done on it.

Purpose of EIA

- To facilitate decision making
- To aid in development with minimum harm
- To promote sustainable development

The purpose is not just to get environmental clearances. The main purpose of EIA is to be a management tool for planning. The important outcome that comes out of an EIA is an environmental Management Plan (EMP). It is the responsibility of authorities to ensure that every project should cause minimal environmental damage while bringing in maximum economic benefit.

Usually an EIA is carried out before the project begins but in case of waste management, often it is on a site already being used for dumping wastes. The main objective of EIA projects in MSW landfills is to improve the quality of the environment and reduce pollution through appropriate enforcement strategies. Problems of unsanitary disposal sites and environmental risks by landfills, specifically hospital and industrial wastes, and traditional methods should be replaced by environmentally sound and sustainable methods are addressed in an EIA.

History of evolution of EIA

EIA got mandatory status for the first time in the USA through the national Environmental Protection Act of 1969.United Nations Environmental Programme (UNEP) laid out the guidelines on EIA nad encouraged developing countries to take it up in 1980, supporting them in EIA related research and proposal development. Good practices in EIA was developed by Organization for Economic Cooperation and Development (OECD) in 1992.

In India EIA first began in 1976-77 for the River-Valley project. By 2006, it became statutory for 30 different activities. EIA 2006 is the latest supersession followed in India. Its preamble recommends that EAI is required for construction of new projects, or expansion/ modernization of existing projects listed in the schedule. So projects across India need an EIA based environmental clearance to proceed.

5.2 Steps in EIA Method

Step 1:EIA first identifies the project characteristics and baseline environmental characteristics. This ensures that all potential impacts are identified and studied.

Step 2: Method is chosen. The method should comply to regulations. The full range of impacts- social, economic and physical should be covered. The method should distinguish between large, small, long-term, short-term, reversible and irreversible impacts. By doing this, the EIA can make a distinction between significant and insignificant impacts. Besides direct impacts, the EIA must also identify secondary, indirect and cumulative impacts.

The methods of EIA can be

a. Adhoc
b. Overlay
c. Checklists
d. Matrices
e. Networks (cause- condition-effect)

Adhoc methods suggest broad areas of possible impact and their general nature. The ad-hoc methods are useful for very large systems. Sometimes they are used as pre-EIA exercises. Brainstorming, panels, expert opinion and checklist are the main ad-hoc methods.

Map Overlay, a.k.a. McHarg method uses a set of maps of the project area- physical, social, ecological and aesthetic. The maps are overlaid to produce a composite characterization of the regional environment. Impacts are identified by noting the impacted environmental characteristics within the project boundary. The disadvantage of map overlay is that it cannot quantify the possible impacts. Nor can it weigh them. It requires much technical expertise, software and money. Overlay method is therefore best for short-listing the alternative where decisions need to be taken mainly on physical characteristics.

The checklist method employs a structured list of environmental factors that are potentially affected. The checklist could include water, soil, atmosphere, flora, fauna, resources, recreation and culture.

Environmental Factor	Changes and rate of change
Soil	Soil Quality- structure, depth, fertility, degree of acidification or salination, etc
	Soil stability Area of arable (fertile) land affected
Air	Air quality
	Climatic elements
Water	Water quality
	Volume of water
	Seasonality
	Surface area of lakes
	Extent of Irrigation
Biota (Flora and fauna)	Abundance or scarcity of species, or genetic resources
	Extent of forest cover, cropland, vegetation, grasslands, ecosystems
	Biodiversity- species diversity
	Extent of provision for migratory species or nesting grounds
	Extent of pests, diseases, abundance/ scarcity of invasive species

Table 5.1 : Environmental Factors considered for EIA (This is not an exhaustive list).

The matrices method is an expanded form of the checklist method, with much more information. Matrices can be categorized into 3 groups:

1. Matrices that consider the magnitude and importance of the relationships.
2. Extended component interaction matrix- developed for second and higher order impacts using matrix multiplication
3. 3D matrix representing cause-effect matrix, cause-impact matrix and effect-impact matrix. Causes are the activities of the proposed project. Impacts are

Network method is also called the Impact Tree Analysis. This method works on the premise that environmental sub-systems are interconnected and any impact on one of the subsystems will affect several other subsystems leading to secondary, tertiary and higher order impacts.
A list of all project activities and actions are noted and then cause-condition-effect networks are generated. This allows the EIA to identify impacts by selecting and tracing out the events as they might

be expected to occur. This is a very detailed mapping and requires much skill to make an informed decision.

Step 3: Impact Prediction. This gives the preliminary assessment and broad review of the project effect. It predicts the extent of changes due to project. It scientifically characterizes impacts, causes and effects. The prediction draws on physical, biological, socio-economical and anthropological data and techniques. To create impact predictions, various tools are used such as mathematical models, photomontages, physical models, socio-cultural models, economic models, experiments and expert judgment. The uncertainty on the prediction technique must be reported as margin of error, or probability.

Step 4: Mitigation. From the impact prediction, it is first decided that do the changes really matter? If yes, then what should be done about it? Several measures can be suggested to mitigate each probable impact- to prevent, reduce, compensate or remedy each impact.
Some mitigation measures often suggested are:

a. Change the project site, route, process, raw material, operating method, disposal route, location, timing or engineering design.
b. Introduce pollution control, waste management, monitoring, phased implementation, landscaping, personnel training, special social services or public education.
c. Offer restoration of damaged resources, financial assistance to affected persons, concessions on other issues, offsite programmes to enhance other aspects of the environment or quality of life for the community.

Step 5: Public Participation. All stakeholders, i.e. those affected by the proposed project are invited to participate in the discussion. The reports should be passed on to the stakeholders. A consultation is held where a genuine effort is made to communicate the relevant information and their advice is sought. If relevant, then their response is acted upon. The consultation is limited to the project. There may be pressure from political agencies, sponsors or local governance. Despite the pressure, the consultation should be kept impartial.
The consultation meeting invites all stake holders, including:
Individual citizens, social and cultural groups, local authorities, citizen groups, NGOs, experts within the community, scientific organizations, expert government agencies, expert professional groups, university departments, and the general community.

Step 6: EIA monitoring and auditing. This is the last step.
To ensure that the suggestions in the EIA have been followed and the mitigation measures recommended are useful, the project needs to be monitored. The monitoring plan specifies the measuring technique for each indicator, the frequency, location, responsibilities and methods of reporting, data storage and so forth.

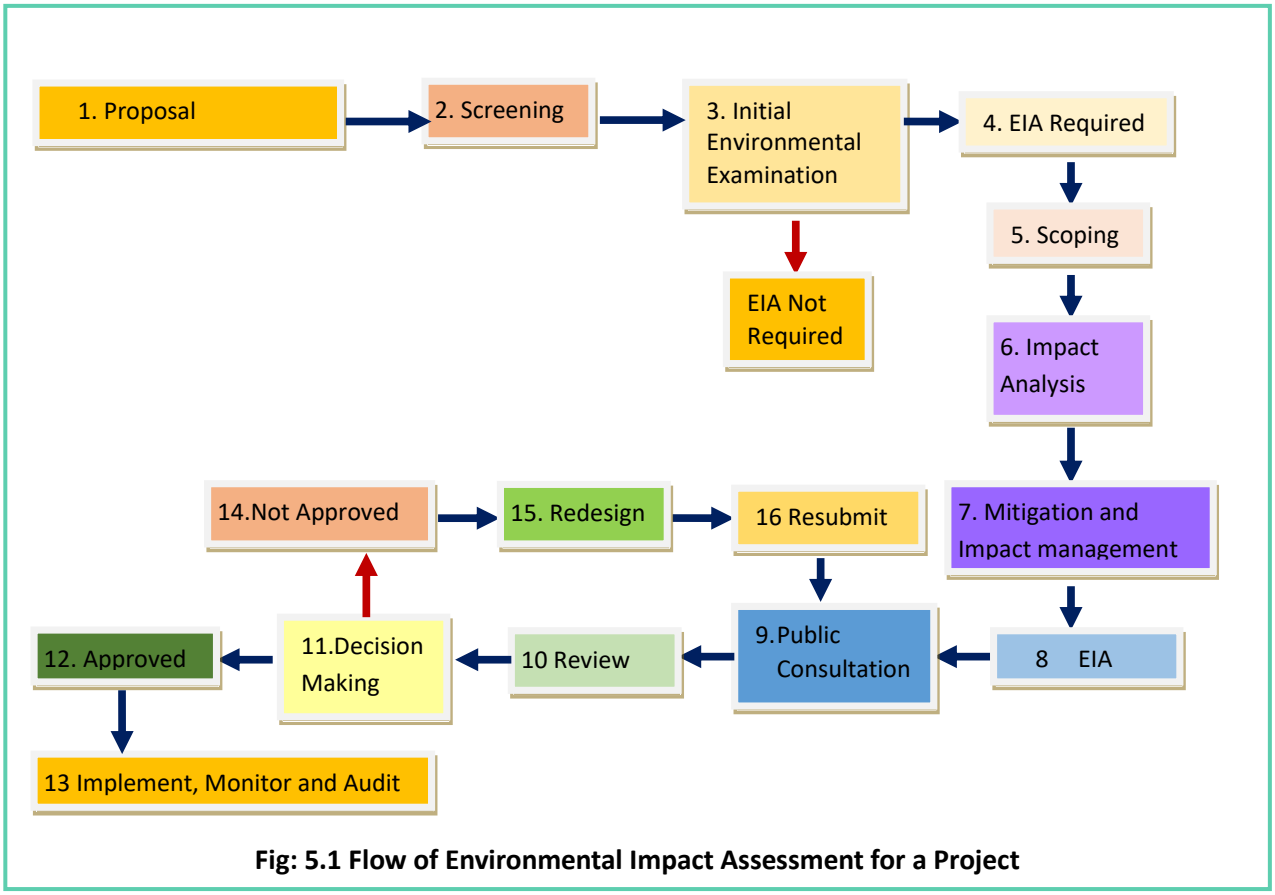


Fig: 5.1 Flow of Environmental Impact Assessment for a Project

Environment Management and Auditing systems may also be applied to monitor the project. Auditing ensures that the monitoring results are compared with the criteria/ standards of acceptability. Later a value judgment is made to decide whether further action is needed or not.

The EIA methodology is explained in detail in the following educational videos.
(Watch Educational Video: EIA Part 1: https://www.youtube.com/watch?v=nrv1zBMAEL8
EIA Part 2: https://www.youtube.com/watch?v=Q_sYi3-eBJg
EIA Part 3 :https://www.youtube.com/watch?v=Hi9EZEey8R4)

Case Study EIA analysis of Jindal thermal power plant

IN 2019-10, Jindal Steel and Power Ltd. (JSPL) planned to set up a thermal power plant in village Dongamahua, located in Raigarh district of Chattisgarh. Centre for Science and Environment, New Delhi took up a Rapid Environment Impact Assessment on behalf of the local community and two activists from EktaParishad and Jan Chetna.

The EIA was conducted by Min Mec Consultancy Pvt Ltd, New Delhi. The study area for the EIA includes a core zone occupied by the project and a buffer zone within a 10-km radius of the project site.

About the project

JSPL is operating the Gare IV/1 open cast coal mine, along with a crushing, screening, and washing plant, in Raigarh. This mine and washery is located in Nagarmuda, Janjgir, Tapranga, Dongamahua and Dhaurabhata villages. JSPL is now proposing to set up a 2x150 MW thermal power plant in Dongamahua, which will use the middling and coal fines generated during coal washing at Gare IV/1 as raw material. The company runs a steel plant in Raigarh, and proposes to transmit the power generated by this thermal power plant to its steel plant through its own dedicated transmission network.

Salient features of the project

The site is approximately 50 kms away from Raigarh, and 30 kms off the Raigarh-Ambikapur state highway. The Kelo *Nadi* flows at a distance of around 3.5 km from the proposed site. There are many seasonal *nullahs,* and tributaries of the Kelo, which ultimately merge into the Kelo river. Agriculture is a main occupation in the buffer zone. 57 per cent of the area is agricultural land, either irrigated or rainfed. Wheat, paddy, millet and maize are the main crops grown. There are 94 inhabited revenue villages within a 10-km radius, with a population of 85,000.

The area is rich in coal, many coalmines are either operating, or are proposed. Also, industries based on coal have come up. Raigarh district is also an emerging hub for the sponge iron industry in Chhattisgarh, with many plants already operational and many more in the pipeline.The 4x250 MW OP Jindal Super Thermal Power Plant is under construction 7 km away from the project site. Within a 0-7 km radius of the project site, apart from the Gare IV/1 open cast coal mine, one underground coalmine is operational 3 km away from the proposed site, and another five coalmines are proposed.

The project requires 2.47million tonnes of coal per annum (at the rate of 312 tonnes/hour for 330 days). Middling and coal fines will be transported to the plant site via road, or conveyor belts. The project will also require some light diesel oil (LDO).

The project requires 7.46 million cubic meters of water (MCM), sourced from groundwater collected in the mine sump, and from borewells. The entire water requirement will be met from groundwater. According to the EIA report, the water requirement will be reduced from 7.46 MCM to 6.84 MCM through recirculation and reuse of water *(page 2-7)*.

The project requires 56 acres of land (approximately 22.7 hectares). The area has a flat topography. According to the EIA report, the land acquired for the project is either agricultural or wasteland *(page 2-1)*. No diversion of forestland has been mentioned. However, according to the same report, 25 per cent of the area (83 hectares out of a total of 325 hectares) in Dongamahua village is forested *(Annexure-XI)*.
Also, the EIA report mentions that 26.5 per cent of the area within the EIA's study area is forestland *(Annexure-XI)*. 77 per cent of the forest land in the study area is under reserve or protected forests. The Tolge, Silot, Burapahar, Jamkhani and Barkachar reserve forests and the Gare and Devgaon protected forests are located within a 10-km radius of the project site.
Environmental impact of the project and the analysis of the EIA report:
1. Impact of water consumption by the project
Thermal power projects are water intensive. Impact on local water resources should be studied in good detail. There were many discrepancies in the report regarding water use.
In one place, the EIA report suggests that proposed project will consume 7.46 MCM of water, which will reduce to 6.84 MCM through recirculation and reuse. All of this will be groundwater. There are some discrepancies in the EIA while calculating the water consumption. IT first calculate as per 300 working days, Later with 330 working daysin the same report the water consumption would increase by0.235 MCM for the mines, and another 0.165 for the washeries.

However, there is also some discrepancy in the data provided in the EIA report, and data recorded by the company elsewhere. According to the letter dated December 6, 2005 (No.J-11015/204/2005.IA.II (M)), and written by the Ministry of Environment and Forests (MoEF) to Jindal Steel and Power Ltd. (this is the letter where the MoEF grants environmental clearance for the expansion of the capacity of the Gare IV/I mines from 2 million tonnes per day to 6 million tonnes per day), "the total water requirement of the project is 2325.27 m^3/day, out of which 244.75 m^3/day is drinking water requirement which will be met from ground water and remaining 2080.52 m^3/day for other mining operations will be met from mine water (sump)."

Therefore, the actual water consumption by the mines is not 0.214 MCM, but *0.687 MCM*. Also, the EIA report claims that the water requirement in the washeries would increase to 1,400 m^3/day in the future, from the current 500 m^3/day *(page 4-6)*. This means an additional consumption of 900 m^3/day. Therefore, the water requirement which will be met from borewells will be ***3.23 MCM*****,** and not 2.45 MCM. Even if the water availability and water consumption from the proposed Gare IV/2&3 mines is taken into consideration, the water consumption required would be **1.38 MCM**. This is the *minimum* water requirement of the proposed thermal power plant, which will be met from borewells.

Also, the EIA report has calculated the average seepage of groundwater into the mine sump as 11,200 m^3/day (page 4-6). Elsewhere, the report claims that groundwater seepage from Gare IV/2&3 (proposed, and *not operational* mines) would be 4872 m^3/day. However, there is no information on **how** these figures were calculated. Only a rapid EIA has been done, with data collection for one season.

The EIA has tried to assess the impact of the project's operations on local water resources by doing a simple water balance. According to the EIA report, the total groundwater recharge is 46 MCM, while the current groundwater utilisation is just 5.1 MCM *(pages 3-19, 3-20)*. However, while assessing the impact on local groundwater resources, the EIA has *not* taken into account the cumulative impact of water consumption by various industrial and non-industrial sources. Apart from the huge 4x250 MW OP Jindal Super Thermal Power Plant (which is completely dependent on groundwater), the other industrial users in the region have *not* been accounted for in the EIA.

The EIA report has calculated the annual monsoon recharge by using the water table fluctuation method. However, the EIA has *not* made any estimation of possible recharge through other sources – *for instance recharge through water spread areas, recharge through irrigated areas and recharge through mine discharge*.

While calculating groundwater utilisation, the EIA report has only considered domestic and irrigation water consumption. However, other important uses- *consumption by cattle, forest areas, groundwater pumped out as mines discharge, and groundwater losses – were ignored*.

the Central Mine Planning and Design Institute Ltd. (CMPDI) stidued this for an EIA of the Nataraj Underground Project in the Talcher coalfields, Mahanadi Coalfields Ltd.

Breaching of groundwater by mining activity has the potential to substantially alter the local groundwater regime. Gare IV/1 mine: average seepage of groundwater is 11,200 m^3/day *(page 4-6)*. The other mines in the area (either operational or proposed) will also probably similarly alter the local groundwater regime. Gare IV/2&3: water seepage 4,872 m^3/day. Breaching of the groundwater table is likely to be the rule rather than the exception. The cumulative impact of large-scale and widespread breaching of the groundwater table could have serious adverse impacts on the local water regime, vastly reducing water availability and increasing stress. This has not been given any consideration in the EIA report.

Without a comprehensive water balance for the entire area, it will not be possible to predict the impact on local groundwater resources. The Kelo river, is already heavily stressed. It has consequently been the focus of many protests against industrialisation in Raigarh. The poor water flow in the river has meant

that various users, including industry, are now becoming increasingly dependent on groundwater. Therefore, protecting the groundwater from being excessively exploited is imperative.

Jindal Power Ltd. asked for permission to dig 40 tubewells for its Super Thermal Power Plant. The Groundwater Survey Department recommended *against*giving this permission – stating the possible adverse impacts on the local groundwater regime (ref: letter dated 15/04/2006). In yet another communication, the Water Resources Department of Raigarh, as well as the Groundwater Survey Department in Bilaspur have calculated the groundwater availability in the area as just 0.9 MCM. *If this is the case, the area is completely incapable of handling the water requirement of the proposed plant (the minimum water requirement for the project is 1.38 MCM, and that too after the proposed Gare IV/2&3 mines are opened).*

2. Impact of the project on local air quality

Thermal power projects are hugely air polluting. Assessing the impact of air pollutants is therefore very important in the EIA for a thermal power plant. Suspended particulates, sulphur dioxide (SO_2), oxides of nitrogen (NO_x), carbon dioxide (CO_2) and emissions of mercury have to be estimated, and their impact assessed.

Particulate emissions: The EIA for the proposed project has estimated the particulate emissions as 64.5 kg/hr, which works out to 511 tonnes of particulate emissions per annum *(page 4-3)*. However, according to the EIA report, this estimation is based on an assumption that the concentration of outlet gases will be *at most* 50 mg/Nm^3 *(page 4-3)*. This is theoretically possible, but vast experiences show that even with Electro Static Precipitators (ESPs) attached, particulate emission levels < 50 mg/Nm^3 are *often* not achieved. Therefore, it is quite likely that the particulate emissions will be much higher.

SO_2 and NO_x emissions: The EIA has estimated the SO_2 emissions as approximately 3120 kg/hr. This estimation has been crosschecked and verified by CSE, by using information provided on coal consumption, and sulphur content in coal (between 0.4-0.6%, on an average 0.5% as per *page 2-5*). However, while the EIA mentions that light diesel oil will be used as a secondary fuel, there is no mention of how much oil would be consumed. Oil has a high sulphur content (1.8%, as per *page 2-6*), and therefore, data on the quantity of oil consumed would make the estimation of SO_2 emissions much more robust. The EIA report has not paid attention to the control of SO_2 emissions – no mitigation measures have been suggested. Studies show that SO_2 emissions even at low concentrations of 5-20 mg/Nm^3 can be detrimental to some kinds of plants – for instance chickoo, litchi, cashew, mangoes etc. They can cause decreased yields, chlorophyll loss and greater leaf fall. The impact of SO_2 emissions is even higher under humid and high wind conditions.

Similarly the EIA report has estimated the NO_x emissions as approximately 4,000 tonnes per annum. NO_xemissions can be detrimental at low concentrations of 3-20 ppm. The report has not suggested any mitigative measures.

Mercury emissions: Mercury emissions from the power plant have been completely overlooked by the EIA. There is no mention whatsoever – no estimation, no impact analysis, no mitigation. However, this should not be ignored, as thermal power plants account for 70 per cent of the country's mercury emissions. Considering average mercury content of 0.25 ppm, mercury emissions from the proposed plant account for 618 kg/annum.

Carbon dioxide emissions: The EIA has also completely ignored CO_2 emissions from the proposed plant. This is not acceptable, as the thermal power sector contributes 11 per cent of total CO_2 emissions, 65 per cent of the industrial greenhouse gas emissions. The proposed plant will release 9.47 lakh tonnes of carbon dioxide per annum (calculated at the rate of 997 gms of CO_2/kWh of power generated).

Fugitive emissions: Regulations governing air pollution concentrate on point source emissions – however, emissions from non-point sources, i.e emissions during raw material storage, transportation and handling are equally important to monitor and control. In fact, often, fugitive emissions are more harmful than particulate emissions.

Increase in traffic load: According to the EIA report, entire transportation of the coal will be done by roads hence, potential of fugitive dust will be the greatest threat. Further, EIA report also states that flyash from the thermal power will be used for filling the dug out area. But EIA is silent on the impact of flyash on environment due to transportation.

The EIA report for the proposed project has not made any estimation of fugitive emissions. According to the EIA report, approximately 2.47 million tonnes of middling and coal fines will be used every year. Assuming that just 0.1 per cent of this raw material escapes in the atmosphere in the form of dust, this will mean approximately 2,500 tonnes of dust per annum. If 0.5 per cent is lost as fugitive dust, this figure jumps to over 12,500 tonnes of dust per annum.

Apart from coal, fly ash is also a source of fugitive emissions. An estimated 1.37 million tonnes of ash (fly ash and bottom ash) will be generated every year *(page 4-7)*, and all of this will be highly susceptible to fugitive emissions.

The EIA report has neither made estimations, nor analysed the impact of fugitive emissions. The only way of controlling these emissions is through proper infrastructure and proper management. The EIA has mentioned 'water spraying' as a means of controlling emissions, but in reality, effective control of fugitive emissions requires *closed storage areas, closed transportation systems, mechanical material handling systems, and wherever possible conversion of non-point source emissions to point source emissions through creation of vacuum or suction*.

The EIA report has not elaborated on many of these points. While dealing with control of fugitive emissions, the emphasis is on water spraying. The report does mention that raw material will be transported from the mines to the plant through roads *or* covered conveyor belts, and that there will be '*effective* dust suppression/collection systems at the transfer points', though no details have been provided *(page 5-3)*.

However, there is *no* mention of other infrastructure/mechanisms that should be installed to reduce fugitive emissions (like covered material storage yards, covered material loading/unloading points with attached suction devices etc.). These issues are particularly important with respect to the storage and handling of fly ash. If ash is stored in the open, or handled manually, the potential of fugitive emissions is very high given the *extremely fine* nature of ash particles. The EIA report does not adequately address how fly ash will be handled so as to reduce fugitive emissions.

Monitoring impact of air pollution: The EIA has been conducted during the summer season. However, for proper evaluation of air pollution impacts, monitoring and data collection should be done during winter *also*. Therefore, given the sensitive nature of the project site, and the location of other polluting industries in the vicinity (thermal power plants, mines, sponge iron plants etc.), *a rapid EIA with one-season data collection is insufficient*.

According to the EIA report, the most prevalent wind directions near the project site are northeast and southwest *(page 3-13)*. Therefore, for proper air pollution impact analysis, monitoring should be done in the downwind direction – i.e monitoring stations should be located southwest and northeast of the proposed site. Therefore, monitoring stations should ideally be located at the mine colony, and at the villages of Libra, Jhinkubahal, Jharna, Tapranga, Bajlor, and Janjgir. The EIA has *not* done monitoring at all these locations. Overall, the data collected on air quality is not sufficient to adequately analyse the impact of air pollution.

3. Local biodiversity

The region surrounding the proposed site is rich in biodiversity. More than a fourth of the area in the buffer zone is forested. According to the EIA report, even the core zone is home to mammals like foxes and *bandars* (Bandar is included in Schedule I of the Wildlife Protection Act 1972). The buffer zone consists of many protected species including the spotted deer, the rheasus macaque, the bear, and the leopard.

The region surrounding the proposed plant is also rich in *mahua* plantations, which is of very high economic value to the local community *(page 3-30)*. There are allegations (recorded in a case submitted to the National Appellate Authority, which is reviewing the environmental clearance given to the 2nd stage of JSPL's existing steel plant) that emissions from JSPL's existing steel plant in Raigarh have caused a reduction in the yields of *mahua* crop in the surrounding areas. It is therefore important to conduct a thorough study of the exact impact of *various* pollutants on *mahua* as well as other vegetation in the forests in the region. No such analysis is available in the EIA report.

However, the biggest weakness of the EIA in terms of evaluating the impact of the project on local biodiversity is that *no attempt* has been made to do a *cumulative impact analysis* of the various industrial activities. The ecologically-rich study area is now facing the brunt of not just this proposed project, but also of other large projects in the area – including the 4x250 MW Super Thermal Power Plant.

4. Solid waste management

The proposed plant will generate fly ash and bottom ash – a total of 1.37 million tonnes of solid wastes will be generated. The EIA report has not dealt extensively with how fugitive emissions from fly ash storage and handling will be controlled. Regarding waste utilisation, according to the EIA report, 'in the initial years of operations, efforts will be made to ensure maximum utilisation of fly ash in dry form for commercial use such as brick making, manufacturing of pozzolona cement …Unutilised fly ash shall be converted to high concentration slurry and shall be transported to abandoned portion of coal mines' *(pages 5-8, 5-9)*. However, the project has not incorporated reuse of fly ash as part of its operations – i.e, *there is no mention of whether a brick making facility will be set up, or whether users of fly ash (like cement manufacturers etc.) have been identified and long-term contacts signed to ensure use of the fly ash generated*.

Experience shows that unless proper mechanisms are set in place, fly ash will not be used even if it *can*be used – just 10 per cent of the fly ash generated in the country is reused, even though India has a huge cement manufacturing capacity. Therefore, just implying that fly ash may be used does not mean that it will actually be used.

Conclusion

JSPL's proposed thermal power plant is not a small-scale project. There are two main impact areas of the project – impact on local groundwater regime, and impact on forests and local biodiversity. The project is coming up in a forested area. It is the *site* of the project that will play the largest role in deciding its overall environmental impact. The region is eco-sensitive for many reasons – the forests form the base of peoples' livelihood in this predominantly tribal area (*mahua* in particular is central to the local economy), the forests are also home to many protected species and moreover forests play an extremely important role in groundwater recharging.

The ecology in the area is facing the impacts of many industrial projects – including the 4x250 MW Super Thermal Power Plant, many coal mines, and many sponge iron plants. Therefore, in considering the environmental impact of this proposed project, the larger picture has to be kept in mind. The impact on the local ecology – whether on the forests or on the local groundwater regime - will be cumulative. The biggest weakness of the EIA report is that it has not been able to capture the overall, cumulative impact of the project.

5.3 Strategic Environmental Assessment (SEA)

At times, a more complex form of EIA has to be applied, known as SEA. This is defined as the formalised, systematic and comprehensive process for evaluating the environmental impacts of a policy, a plan or a programme. The alternatives for the impacts of these programmes/ policies are prepared into a written report on the findings of the evaluation and then the report is used for publicly accountable decision

making. These strategic Assessments strengthen Project EIAs, help to achieve sustainability goals and address large scale effects and cumulative effects beyond the project limit.

CASE STUDY FROM CONVENTION ON BIODIVERSITY

Title: Strategic environmental assessment of proposed Human River Irrigation Project, Maharashtra State, India.

Description India is predominantly an agrarian country faced with a relentless growth in its population that continues to impose increasing demands for enhancement of crop productivity on marginalized and impoverished land area under agriculture. The critical need for providing irrigation inputs for improving agriculture productivity has led to the commissioning of several minor and major irrigation projects of varying capacities in the country. As a result of past initiatives of harnessing water for irrigation, the area under irrigation in India has trebled in the last 40 years and stands at 70 million ha. By the year 2010, the country is aiming to bring an additional area of 113 million ha under irrigation. This envisages the construction of over 1000 dams on various rivers in different states of the country (MoWR, 2000). The state of Maharashtra has been severely constrained in improving its agricultural production due to vagaries of monsoon and recurrent drought. In pursuit of the state policy to enhance agriculture production by providing irrigation facilities, the Government of Maharashtra proposed several schemes to harness its huge water resources for the improved inputs of irrigation. The Human (pronounced as 'hooman') Irrigation Project over the untamed Human River was prioritized to benefit Chandrapur District of the State.

The project envisages construction of a composite dam of 3172 m length with a maximum height of 27 m for creation of a storage reservoir with a Full Reservoir Level (FRL) fixed at 217.70 m and an estimated irrigation potential of 46118 ha. The Reservoir would consist of two head regulators on both flanks of the dam – the Left Bank Canal (LBC) and the Right Bank Canal (RBL). The project is expected to benefit 130,000 individuals of 160 villages in the command area of the Chandrapur District, provide 34.2 m3 of drinking water to Chandrapur Township and enhance agriculture production of the District from 45128 metric tons to 336665 metric tons.

Following the administrative and technical approvals granted to the project by the Maharashtra Govt. and Central Water Commission in early 1990s, Vidharba Irrigation Development Corporation (VIDC) prepared the technical proposal for seeking clearance for diversion of the forest for the project under the provisions of the Forest (Conservation) Act, 1980 and the Environmental Impact Assessment (EIA) report for seeking environmental clearance under the provisions of EIA Notification (GOI, 1994). The review of the EIA report and other documentation prior to accordance of environmental and forestry clearances and observations made by MoE&F team based on site visit highlighted crucial gaps in biodiversity related information and the obvious deficiencies in mitigation planning. This constrained the decision making and created the necessity for undertaking SEA to review earlier evaluation. Further impetus for the review of the earlier EIA of the project was given by several conservation organizations in the country that questioned the comprehensiveness and the credibility of the EIA studies that had failed to incorporate the evaluation of the project induced habitat degradation and more specifically the disruption of the migratory route of the tigers moving between Tadoba – Andhari Tiger Reserve (TATR) and the Reserved Forests across the Human River. The SEA was adopted as a tool to undertake 'EIA inspired' assessment to supplement the deficient information and make value additions in critical information for aiding improved conservation planning and decision making. The Wildlife Institute of India, an independent professional body (www.wii.gov.in) was assigned the responsibility of overseeing the earlier EIA and conducting the strategic level assessment.

Table 5.2: Difference between EIA and SEA

EIA	SEA
Occurs at the end of decision–making cycle	Occurs towards the early stages of decision making
Reactive approach to developmental activities.	Proactive approach to developmental activities.
Identifies specific impacts on the environment.	Identifies environmental implications and issues of sustainable development.
Considers limited number of alternatives.	Considers broad range of potential alternatives.
It has a limited view of cumulative effects	Gives early warnings of cumulative effects.
Emphasises on minimizing impact and mitigation.	Emphasises on meeting of environmental objectives and maintaining natural systems.
Narrow perspective, very detailed.	Broad perspective, lower level of details. Provides vision to the overall framework.
Well defined process, clear beginning and end.	Multi-stage process, overlapping components, policy level. Continuing and iterative.
Focuses on standard agenda, treats the symptoms of deterioration.	Focuses on sustainability agenda. Approaches the source of environmental deterioration.

5.4 EIA in India

As was mentioned before, EIA was enacted in India by making an amendment in the Environmental Protection Act, 1986. If we compare how EIA is conducted in India with the practices abroad, we observe the following:

1. In India we see a limited involvement the public and the government agencies during the initial phase. However, in developed countries such as Canada, there is active participation from competent authorities, government agencies and affected people right from the beginning. Their process is therefore far more robust and addresses every issue fairly.
2. We have no provision to cover landscapes and visual impacts in our EIA regulations, while developed countries have a more holistic approach, including social and health issues.
3. We give proper consideration to alternatives in our EIA, same as developed nations.
4. Screening is done as per a defined list. Threshold values on the size of the project are used by Central and State Government to decide whether to clear the project. In Japan the screening decision is made by an authorized agency, while in Canada it is the same as India- federal authorities make the decision.
5. The onus of scoping the project lay with the consultant or proponent previously. But now the new notification puts the onus of scoping on the expert committee, based on the information provided by the proponent. In Europe, USA and Canada, the involvement of the public and their concerns get addressed in the scoping exercise. Funding organizations such as World Bank, ADB and ERDB also have provisions wherein they can call for consultations with the affected people and NGOs during the scoping exercise.
6. Consultation with public is optional and left to the discretion of the expert committee.
7. Unlike India and the developing world, developed countries print their reports in the local language. This makes the report more accessible to the public. In some cases in India the executive summary alone is translated into the local language.
8. We have a multidisciplinary approach, at par with the West. Experts from different areas are brought in.
9. EIA is prepared by the expert consultants. So, often the criterion for selecting the consultant depends on their consultation fee, more than any other factor.

10. While developed countries follow a 2-tier EIA review and emphasize on adequacy and effectiveness of EIA through proper monitoring and analysis, in India, EIA review is not good enough. The review agency seldom has an inter-disciplinary capacity or NGO involvement, which is a breach of the EIA notification.
11. The field of EIA is still developing in India, with much scope for growth.

5.5 Environmental Management Plan (EMP)

In the real sense, if a project requires EIA, that itself means that the project has potential to damage the environment. This is usually confirmed by the EIA. But, if every project is prevented from happening due to environmental or socio-cultural reasons, development may grind to a halt. Therefore, at the end of an EIA, an environmental Management Plan is sought. The EMP aims to nullify the risks associated with the project, while still allowing the project to go through. Therefore, EMP is an essential step. It may be said that the EIA is done so as to arrive at an EMP.

An EMP document clearly defines the objectives, which are:

- to identify mitigation measures to bring down the negative impact to insignificant levels,
- to create management structures that address complaints of stakeholders,
- to establish monitoring and audit methods,
- to ensure that construction and operation of the said project is done within the principles of Integrated Environment Management,
- to explain specific actions necessary for mitigating environmental impact in great detail,
- to specify the time period (where necessary) to implement the EMP,
- to proposed mechanisms for monitoring compliance with EMP and reporting on them,
- to ensure that the safety measures recommended in the EMP are complied by the project under EIA.

The EMP document also specifies roles of the:

- Project Manager (who is responsible for implementation of the EMP) along with
- Health, Safety and Environment (HSE) Officer, who monitors compliance and
- Engineering, Procurement and Construction (EPC) contractors.
- Operations and Maintenance (O&M) company is responsible for the implementation of the EMP during the operation and decommissioning phases of the project. Decommissioning requires a new team after several years of construction and operation. Their job will be to ensure proper rehabilitation of the land and the associated environment.

The Project Manager must know the findings and conclusions of the EIA and the conditions under which the EIA licence has been issued. He must be familiar with the recommendations and mitigation measures in the EMP and must get them implemented. He must monitor site activities for compliance every day. Confine the constructions to within the area specified by EMP, take corrective actions in case of any transgressions and conduct frequent internal audits.

The HSE Officer liaises with the developer, contractor, landowner and the authorities. He too must be aware of the findings and conclusions of the EIA and the conditions under which the EIA licence has been issued. He must be familiar with the recommendations and mitigation measures in the EMP and must get them implemented. He must audit the site for weekly or monthly as per the EMP regulations.

A regular report of non- compliance as well as satisfactory compliance must be prepared. Corrective action in case of any incidence of non-compliance with EMP should be suggested by the HSE Officer.
The EPC Contractor must ensure compliance with the EMP at all times. An environmental register should be maintained for recording all kinds of incidents on the site, such as health and safety incidents, public complaints, non-compliance incidents and those involving the storage of hazardous materials on site.

The Contractor HSE officer is appointed by the EPC contractor as his on-site representative to monitor daily activities.

Landowners and neighbouring communities usually think of the construction period as an interference with their daily activity. Therefore often complaints are made. So the Contractor must ensure that there is no transgression into the neighbourhood property and that the neighbouring community is safe at all times.

An independent auditor comes in every 6 months to conduct an environmental audit during the construction phase, or as per EMP. His audit report is submitted to the Project HSE Officer. Sometimes special sub-consultants may be engaged by him.

The responsibilities of the concerned officers are as follows:
The Contractor's HSE Office is responsible for the compliance of EMP during construction phase. Project HSE Officer is responsible for monitoring, keeping weekly and fortnightly reports. Inspection technique will include the review of Contractor HSE Officer's records. Overall, the client will bear the ultimate responsibility for the environment management.

Training and awareness programmes should be held for all construction workers. Environmental training includes 'clean-site' protocol, health and safety on site, sensitization on potentially hazardous equipment and materials, location of borrow pits, and prevention of soil erosion, compaction as well as contamination. The importance of maintaining water resources, proper sanitation and public areas for food preparation, etc must be specifically explained.

An emergency response plan and contingency plan must be prepared and intimated to the labour as well as the neighbourhood.

Landowners and community around the project site must be informed of the project start date and phases of construction. The EPC contractor should keep in mind the phases of weather while planning the phases, especially wet weather. A proper communications protocol must be set up and maintained throughout the construction period.

Protocol for dust control, fire prevention, rehabilitation of exposed soil surface, night-time noise levels, day time noise levels, labour noises and loitering must be followed properly. Neighbouring community must be advised on how to suppress noises reaching them. If the noise is expected to be particularly unbearable, they should be informed the schedule of the noise making activity in advance.

For the protection of biodiversity in and around the construction site, existing indigenous vegetation should be retained where possible. A follow-up survey must be done before site clearing to demarcate the vegetation to be retained. Materials should not be delivered much before requirement, as additional storage space cleared may harm the vegetation. Permits may be taken for clearing any protected species.

Wherever possible, vegetation should be left undisturbed. Gathering and using firewood on site is strictly prohibited.

Rubble and construction debris must be placed in a receptacle for regular removal.
Despite all precautions, accidents do happen on the construction site. For these certain remedial action are to be followed.

- Contaminated soil must either be excavated ortreated onsite, depending on the extent and nature of the spill.
- Spills on an impervious surface should be cleaned up with absorbent material, which should them be disposed safely as per protocol.
- Wherever required, oil absorbent sheets must be placed below machinery to collect drips and leaks.

EMP requirements for the construction phase include site preparation, establishment of the construction camps and materials yards. Here, proper waste bins toilet facilities, with chemical toilets right from the beginning should be supplied by the contractor. Under no circumstances should unsanitary activities take place.
Construction traffic, alternative routes, controlled access to materials delivery vehicles, clear signages regarding routes, minimal obstruction to traffic are some aspects to be adhered to.
Work safety, welfare schemes, protective gear, site safety and minimal contact of labour with locals is advised.

5.6 Applications of EIA

EIA and EMP is an interesting and promising field for Post graduates as Health, Environment and Safety Officers. EIAs are commissioned by the project proponent and the consultant is duty-bound to clear the project. The key then is to prepare a strong EMP and ensure that it is stringently followed.
EIA and EMP are robust techniques for environment protection. Even when EIA is not required, we can still conduct a short impact study and follow an EMP plan to minimize environmental damage.It will be interesting to do an EIA of a supposedly eco-friendly activity, as is depicted in the following case study.

CASE STUDY: EIA and Its Role – A Case Study on River Rafting Industry

EIA is a modern versatile contrivance for framing strong policies considering the environment, society and economy as a whole for better development planning and resource management.
It is a tool that seeks to ensure sustainable development by evaluating and providing mitigation measures for the impacts which might arise from a major activity that would likely affect the present state of environment adversely. Hence, this process can be seen as to be anticipatory, participatory and systematic in nature that relies on multidisciplinary input. Thus its aim is to predict the various environmental, social and economic impacts at an early stage while project planning and designing, find the means to reduce adverse impacts and shape out the project to suite the local environment and present the predictions and options to decision makers.

A study was undertaken to assess the various impacts of River Rafting, a well established industry along the banks of Ganges in Uttarakhand, India. The basic approach for the study comprised collection of various primary and secondary data from field surveys and government records. A Participatory Rural Appraisal (PRA) was conducted and various impacts were postulated. The impact on the local identity and traditional culture though moderate were also apparent and reported by locals. Environmentally, it lacks the monitoring of solid waste management generated from kitchen as well as by the visitors directly to defecation within submergence zone. Man-animal conflict is also expected in this area. Hence,

a comprehensive EIA study can help in identifying and quantifying the adverse impacts of this industry, thereby leading to sustainable planning and development.

Summary

Environmental Impact Assessment is the most potent tool to study the impact of any project. For policy making, or broad scale activities, we use a Strategic Environmental Assessment. An Environmental Management Plan is creates as a result of the EIA. This can guide the way forward for sustainable development. These three tools have the means to assess, measure, mitigate and monitor to prevent ecological as well as socio-cultural loss in the name of development.

Self-Assessment Test

1. Explain SEA. Describe the differences between and SEA and an EIA.
2. What is the purpose of an EIA?
3. How is an EMP implemented on site? Who are responsible for its proper implementation?

Reference Books

1. EIA Manual of Ministry of Environment, Forests and Climate Change. http://www.moef.nic.in/division/eia-manual
2. Convention on Biodiversity: https://www.cbd.int/programmes/cross-cutting/impact/search.aspx

References

1. Air Pollution: National Toxics Network, Australia.14 Oct 2014, https://ntn.org.au/10-reasons-why-burning-waste-for-energy-is-a-bad-idea/
2. Bee Pollination: Pennsylvania State University.https://news.psu.edu/story/416642/2016/07/06/research/bees-ability-forage-decreases-air-pollution-increases
3. Bio Char: Mohd. Asif Naeem, Pakistan https://www.tandfonline.com/doi/full/10.1080/03650340.2017.1325468
4. Bhopal Remediation: Aug 28, 2017 Technical guidelines for cleanup at the Union Carbide India Ltd (UCIL) site in Bhopal, Madhya Pradesh, India, Greenpeace International, 2002 https://www.cseindia.org/technical-guidelines-for-cleanup-at-the-union-carbide-india-ltd-ucil-site-in-bhopal-madhya-pradesh-india-greenpeace-international-2002-7840
5. CBA: Rajgopal R, Cox R, Lambur M, Lewis E. Cost-benefit analysis indicates the positive economic benefits of the expanded food and nutrition education program related to chronic disease prevention. J NutriEducBehav. 2002;34(1):26-37.
6. Case Study SEA of Human River Irrigation Project, Maharashtra: https://www.cbd.int/impact/case-studies/cs-impact-nl-ibsea-in2-en.pdf
7. Case Study EIA on River Rafting: Parth SarathiMahapatra, H.B.Vasistha , Rajiv Pandey, International Journal of Environmental Sciences Volume 1, No 5, 2011, Socio environ impact of river rafting industry on Ganges in Uttarakhand, India, http://greencleanguide.com/eia-its-role-a-case-study-on-river-rafting-industry/
8. Case Study: Jindal Power plant: CSE, Jan 2010, https://www.cseindia.org/eia-analysis-of-jindal-thermal-power-plant--464
9. Case Study: India Looks to South Korea: Ramandeep Singh and Soyen Park, King's College, University of Cambridge. Feb 21 2018 https://www.livemint.com/Opinion/V2CgeiUq89kl1k2fDwJXML/Swachh-Bharats-waste-management-problem.html
10. Cost of species services: BBC Wild magazine, 9 May 2018, https://www.pressreader.com/uk/bbc-wildlife-magazine/20180509/282729112508531
11. Cellphone Recycling: Ananya Bhattacharya, 21 Dec 2017, Quartz India, https://qz.com/india/1161447/theres-an-e-waste-crisis-lurking-behind-indias-boom-in-cheap-phones/
12. Kimberley Button, Feb 2016, Earth 911, https://earth911.com/eco-tech/20-e-waste-facts/
13. Peter Holgate, 8 Nov 2017, Recode, https://www.recode.net/2017/11/8/16621512/where-does-my-smartphone-iphone-8-x-go-recycling-afterlife-toxic-waste-environment
14. Consumerism: SofieHuysman, *et al*, Feb 2015, Toward a systematized framework for resource efficiency indicators, Elsevier, Resource Conservation and Recycling. https://www.sciencedirect.com/science/article/pii/S0921344914002328
15. Consumerism: AfruzaKhanom, BRAC University Journal, vol. VI1, no. 1 & 2, 2010, pp. 61-66 , Postmodern Visions: Consumer Culture's (Re)Making of the Gaze https://core.ac.uk/download/pdf/61801185.pdf
16. Cost and Benefit of Waste Management: Kushal Pal Singh Yadav Down to Earth, 16 September 2015 https://www.downtoearth.org.in/coverage/waste/costs-and-benefits-of-india-s-waste-disposal-options-5623
17. DALY: Population Services International,2014 https://www.psi.org/publication/what-is-a-daly/ World Health Organization, 2018, http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/

18. Detergents: Eric Bagai March 13, 2018 https://sciencing.com/chemical-pollution-caused-day-detergents-6664097.html
Maureen NandiniMitra, February 16, 2012, Earth Island Journal, http://www.earthisland.org/journal/index.php/articles/entry/not_only_using_detergents_simply_washing_clothes_is_bad_for_our_oceans
Umbra, 4 Sep 2014, https://grist.org/living/what-kind-of-laundry-soap-is-lightest-on-the-land/
19. Dhapa: The Guardian, Oct 24, 2016 https://www.theguardian.com/cities/2016/oct/24/difficult-breathe-inside-kolkata-india-rubbish-dump-permanently-fire, 2016
20. Dumpyard in Kochi: Deccan Chronical 28 Sep2018, https://www.deccanchronicle.com/nation/current-affairs/280918/kochi-waste-plant-sits-on-a-powder-keg.html
https://www.thenewsminute.com/article/walk-through-ghost-village-brahmapuram-deserted-thanks-kochis-garbage-41040
21. Ecosphere Volume 7, Issue 11, 08 November 2016, https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.1556
22. Ecolabeling: Source: http://www.ecolabelindex.com/ecolabels/?st=country,in
23. Efficiency of resource consumption: SofieHuysman, *et al*, Feb 2015, Toward a systematized framework for resource efficiency indicators, Elsevier, Resource Conservation and Recycling. https://www.sciencedirect.com/science/article/pii/S0921344914002328
24. EIA: Mohd Taheri et al. 11 Mar 2014Environmental impact assessment of municipal solid waste disposal site in Tabriz, Iran using rapid impact assessment matrix. https://www.tandfonline.com/doi/full/10.1080/14615517.2014.896082
EIA in India- Industry and Environment Unit, Centre for Environment and Science, 2006https://www.cseindia.org/understanding-eia-383
25. EIA vs SEA: EIA training resource manual , 2nd Ed. 2002, UNDP
26. Environmental Costs Full Cost Accounting on Municipal Solid Waste Management at US-EPA, *www.epa.gov*, US Environmental Protection Agency, Accessed 24.11.06
27. GHG Emissions: Ecologise, 18 Oct 2018 https://www.ecologise.in/2018/10/18/un-says-climate-genocide-is-coming-its-actually-worse-than-that/
28. HFC: www.epa.gov
29. Kerala Floods: Times of India Sep 4, 2018, 10:18 IST http://timesofindia.indiatimes.com/articleshow/65665883.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
30. LCA: Anders Damgaard& Morton A. Barlaz, NC State University,The Application of Life-Cycle Analysis to Waste Management, https://people.engr.ncsu.edu/barlaz/Lectures/5%20lca%20part%201.pdf
31. LCA and CBA: Mette Skovgaard, Waste Management World, Mar 2008, CBAs and LCAs: Learning from Nordic best practice https://waste-management-world.com/a/cbas-and-lcas-learning-from-nordic-best-practice
32. Leachate Application: CY Cheng, CK Tsang, RSK Wong and LM Chu, 2011 International Conference on Environment and Industrial Innovation IPCBEE vol.12 (2011) © (2011) IACSIT Press, Singapore http://www.ipcbee.com/vol12/56-C40000.pdf
33. Leachate Pollution in Bhandwari Landfill: Prayag Arora-Desai Aug 22, 2018 03:28 IST Hindustan Times, Gurugram
34. Loss of Biodiversity: United Nations Environment Programme. "Marine Liter: Trash that Kills." Web Accessed April 25, 2015. https://www.dosomething.org/us/facts/11-facts-about-pollution
35. Mangroves: UNEP, 4th Aug 2017. https://www.unenvironment.org/news-and-stories/story/coastal-crisis-mangroves-risk

36. Microplastics:
https://www.researchgate.net/publication/312222906_Microplastic_pollution_in_Vembanad_Lake_Kerala_India_The_first_report_of_microplastics_in_lake_and_estuarine_sediments_in_India
Laura Parker 22 October 2018 National Geographic
https://www.nationalgeographic.com.au/nature/in-a-first-microplastics-found-in-human-poop.aspx
37. MoEF Coastal Cleanup: Green Clean Guide June 2018, http://greencleanguide.com/environment-ministry-forms-19-teams-to-undertake-cleaning-of-beaches-river-fronts-and-lakes-in-nine-coastal-states/
38. Occupation Hazards: BaluNatha Mote, SuhasBalasahebKadam, ShrikantKishorraoKalaskar, Bharat ShivajiraoThakare, Ambadas Suresh Adhav, ThirumugamMuthuvel. Occupational and Environmental Health Hazards (Physical & Mental) Among Rag-Pickers in Mumbai Slums: A Cross-Sectional Study. Science Journal of Public Health. Vol. 4, No. 1, 2016, pp. 1-10. doi: 10.11648/j.sjph.20160401.11
39. Online Shopping: Akhileshwari Reddy, Down to Earth, 3 Aug 2018, https://www.downtoearth.org.in/news/waste/online-shopping-means-cutting-billions-of-trees-61296
Rajanya Bose, Anirban Bhattacharya, May 15, 2017,Hindustan Times, https://www.hindustantimes.com/india-news/unrecognised-and-unpaid-ragpickers-are-critical-for-waste-management-in-india/story-jk3Q84Q2j3MTXTQqrXTA8H.html
40. Plastic Boat in Thattekad: Deccan Chronicle, Feb 2016, https://www.deccanchronicle.com/nation/current-affairs/120216/thattekkad-rows-safe-with-plastic.html
41. QALY: LievenAnnemans, Jan 2017https://www.celforpharma.com/insight/do-you-know-what-qaly-and-how-calculate-it
42. Right Way to Use Shopping Bags: Trevor Thorton, 8 Aug 2018, Down to Earth https://www.downtoearth.org.in/news/waste/here-s-how-many-times-you-actually-need-to-reuse-your-shopping-bags-61339
43. Risk Management: B John Garrick, Safety Science Vol 2, June 2002
https://www.sciencedirect.com/science/article/pii/S0925753501000352?via%3Dihub
Rajgopal R, Cox R, Lambur M, Lewis E. Cost-benefit analysis indicates the positive economic benefits of the expanded food and nutrition education program related to chronic disease prevention. J NutriEducBehav. 2002;34(1):26-37.
44. Tyre Burning: http://www.rerubber.com, https://salmanzafar.me/tyres-burning-health/
45. WHO. Worldwide Burden of Selected Conditions Among Adults Aged 30-44 Years by Sex, Measured by DALYs (2002). WHO Global Health Estimates website.
http://www.who.int/healthinfo/global_burden_disease/en/index.html. August 13, 2013.
46. Waste Production in India: The Hindu, July 03, 2015 15:09 IST
47. Waste-picking: Caroline Hunt, 2000, a review of the health hazards associated with the occupation of waste picking for children, Department of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine. London, UK.

Films:

1. Say no to open burning of rice straw short film, Duration 5 min ,
https://www.youtube.com/watch?v=Vf6XgUJaQcM
2. How To Make A Biochar Machine – TLUD, Duration: 6 min
https://www.youtube.com/watch?v=YIbGkmt1VdE
3. How to inoculate biochar. Duration 5 min:https://www.youtube.com/watch?v=f-yAq2LBVkU)
4. What Could Happen in a World That's 4 Degrees Warmer | WIRED Brand Lab, Duration 15 min,
https://www.youtube.com/watch?v=__Kt_oU9iss

5. Recycling tyres: road to success - business planet, duration: 4 min, https://www.youtube.com/watch?v=6kD9YJ9iSfc
6. Deonar fire, 3 min https://www.youtube.com/watch?v=2yeKYfhjviM
7. The Plastic Cow: Duration 33 min. https://youtu.be/SifRIYqHfcY
8. Best out of waste: Duration 1 hour: SatyamevJayate Season 2 | Episode 3 | Don't Waste Your Garbage |
9. Full episode (English Subtitles) https://www.youtube.com/watch?v=lS0_FCBzI_w
10. What is driving India's growth? Duration 5 min https://www.youtube.com/watch?v=uyyjcior9Vo)
11. E-commerce is changing the complexion of recycling: CNBC News, Duration 2 min.
12. Packaging Waste: https://www.nbcnews.com/nightly-news/video/why-online-shopping-boxes-are-to-blame-for-cities-growing-garbage-dump-costs-970745411861?v=railb&
13. EIA Part 1: https://www.youtube.com/watch?v=nrv1zBMAEL8
14. EIA Part 2: https://www.youtube.com/watch?v=Q_sYi3-eBJg
15. EIA Part 3 :https://www.youtube.com/watch?v=Hi9EZEey8R4)

Books for Reference

1. Wealth from Waste - Agricultural food and chemical Processing Waste by S.C.Bhatia
2. Solid Waste Management of Municipalities Dr P.S Ajith & Dr P.N. Hari Kumar
3. Solid Waste Management - Present and Future Challenges - Jagbir Singh & AL Ramanathan
4. Smart Cities - Transforming India - Prof M.P Dube
5. Waste Management Practices by John Pichtel
6. Solid wastes management by Stephen Burnley
7. Eco-Economy: Building an Economy For The Earth by Lester R.Brown
8. Not in My Backyard - Solid Waste Mgmt in Indian Cities by Sunita Narain & Swati Singh Sambyal

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