UNIT 20 WASTE MANAGEMENT

Objectives

Upon completion of this unit, you should be able to:

- conceptualise Waste
- realise the scope and need for a systems' approach to waste management
- identify the multi-disciplinary character of waste management
- establish the relationship between wastivity, productivity and resource management
- realise the need for adopting a preventive policy of waste generations
- devise and apply suitable means for waste reduction
- realise the importance of devising good systems for waste collection, recycling and disposal
- appreciate the necessity of introducing concept of waste in the traditional input-output model
- devise a method of cost accounting for wastes.

Structure

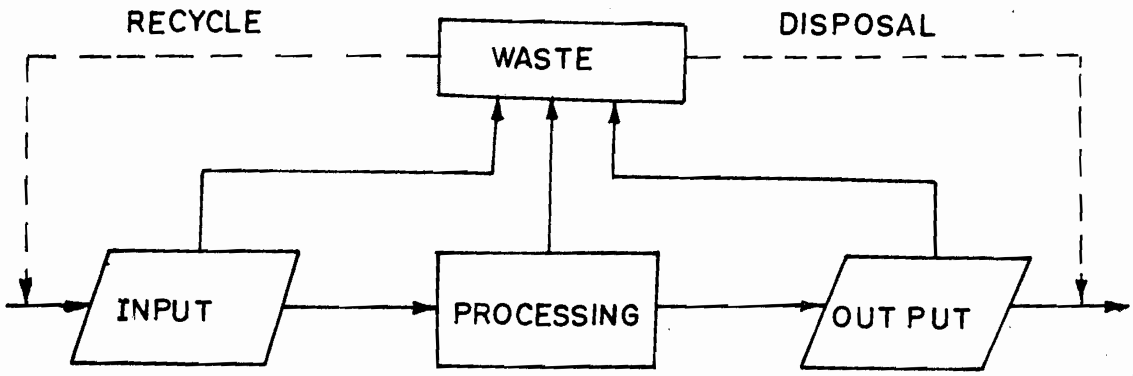
20.1 INTRODUCTION

The diverse and seemingly boundless developments taking place in industry bring with them a whole new series of complexities associated with waste. From a systems' viewpoint, waste is any unnecessary input to or any undesirable output from any system encompassing all types of resources. Waste Management (WM) is a multi-disciplinary activity involving engineering principles, economic, urban and regional planning, management techniques and social sciences, to minimise the overall wastivity of the system under consideration. A systematic approach to waste management encompassing the waste of all kinds of resources at all stages should be adopted. However, as the material constitutes a major fraction of the total product cost, material wasted are of critical importance.

20.2 COMPLEMENTARITY OF WASTE MANAGEMENT AND RESOURCE MANAGEMENT

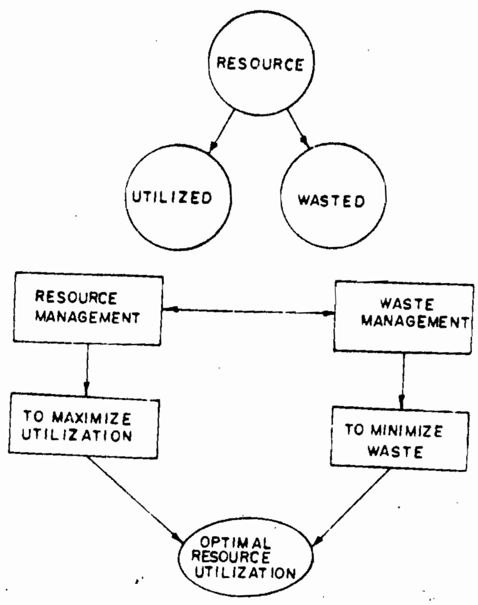
A system basically takes some input, processes it and gives the desired output, as shown in Figure I, i.e., some input is essential, in whatever form for the functioning of a system. An ideal system is conceptualised to transform the total input into useful or desirable output. In view of the known physical laws of nature the existence of an ideal system is not possible, i.e., 100 per cent utilisation of resources is not practically possible for any system. To paraphrase, some waste is inevitable in the functioning of any system.

Figure I: Input—Processing—Output System



The main objective of WM is to minimise the waste thus aiming at the ideal system, while the resource management aims to maximise the utilisation of the resources. The goal of waste and resource management is same, i.e., optimal utilisation of the available resources for higher efficiency and growth of the system; but the approaches are different. The relationship of waste and resource management is shown in Figure II.

Figure II: Complementary Relationshipd of Waste Management and Resource Management

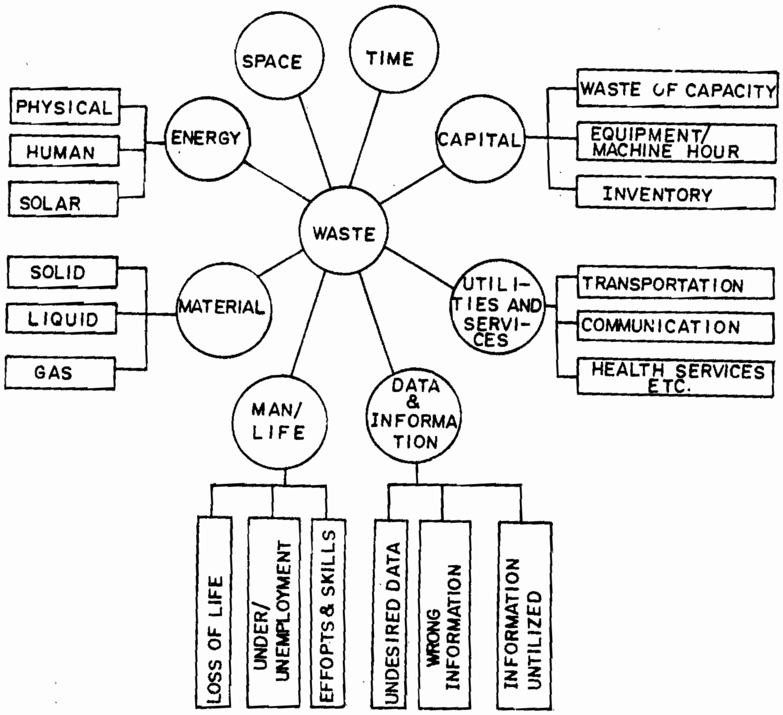


It can be said that waste and resource management are complementary to each other. If one is primal formulation of a problem, the other is a dual. Both approaches have their advantages and limitations. Depending upon the situations, the constraints and primary and secondary objectives, resource management techniques prove to be promising in some cases, while in others WM offers an added advantage.

20.3 TAXONOMY OF WASTE

Lack of coordinated work in the field of WM has given rise to multiplicity of terms and definitions of various types of wastes. The need for standardisation of the nomenclature has been felt for systematic research and effective implementation of WM programmes. Wastes can be classified in a variety of ways depending upon the purpose for which classification is done. There could be four basic classifications as follows:

Figure III: Resource Based Classification of Wastes.



a) **On the basis of the resource wasted:** Various types of resources are wasted at various stages in the system. Taking the resource as a basis the classification of waste is shown in Figure III.

b) **On the basis of source of origin:** The source of origin may serve as an efficient and practical way of classifying waste, e.g.,

i) Agriculture
ii) Industrial
iii) Municipal
iv) Residential or domestic
v) Commercial
vi) Office
vii) Construction and demolition etc.

c) **On the basis of property:** This classification is meant for material wastes only; depending upon the property that effects the environment, waste may be of two types:

i) Hazardous
ii) Non-hazardous

d) **On the basis of recoverability:** As per the characteristic of resource the waste may be:

i) **Recoverable:** The waste that can be converted into some useful resource, e.g. material waste, energy waste reused in other processes, etc.
ii) **Non-recoverable:** This includes the resources that are lost with time and cannot be regained afterwards, e.g. manpower, energy, capacity, services, etc.

20.4 DEFINITION OF WASTIVITY: GROSS AND NET WASTIVITY

Most of the productivity measures at present compare the total output to individual inputs, viz., material, energy, manpower, capital, etc., while they usually fail to directly compare the fraction of a particular input that goes into output. Further, it is difficult to measure the output of various individual inputs invested in various finished products, whereas it is comparatively easier to assess the waste of various inputs. Hence a new concept of "Wastivity" has been propounded, that can serve as an measure of ... of any system, and is rather easy to measure.

"Wastivity of any system is defined as the ratio of the waste to the input".

$$\text{Wastivity} = \frac{\text{Waste (W)}}{\text{Input (I)}}$$

Depending upon the level of waste under consideration the wastivity may be categorised as gross wastivity, and net wastivity.

"The gross wastivity is defined as the ratio of total waste generated by a particular system to the total input to that system".

$$\text{Gross wastivity} = \frac{\text{Net waste generated}}{\text{Total input}}$$

However, a fraction of total waste generated is intermediate to the system and gets recycled. Thus the net waste to be disposed off or reused in other systems is less than the gross waste generated.

Net waste = Total waste generated—Waste recycled within the system

"The ratio of the net waste to be disposed of to the total input to the system is termed as net wastivity". The net wastivity will be dependent on the extent of recycling.

$$\text{Net wastivity} = \frac{\text{Net waste generated}}{\text{Total input}}$$

Wastivity as a Performance Measure

An ideal or perfect system will be one that consumes just the right amount of resources, leaving no idle, unutilised (nonrecoverable) or lost resource, or any undesirable output. The presently known laws of nature obviate the existence of any such idea system, indicating that the occurrence of waste is inevitable. The concept of "Wastivity" which is yet in the rudimentary stages may prove to be a good measure of performance, both at macro and micro levels, and will be helpful in the sound planning and monitoring of various systems at different levels of hierarchy.

Wastivity and Productivity

Waste can indirectly serve as a good measure of productivity. "Productivity of any system has been defined as the ratio of the desired output to input". Most of the productivity measures at present compare the total output to individual inputs, viz. labour, material, energy, capital etc., while they usually fail to directly compare the fraction of a particular input that goes into output.

Hence a new concept of 'Wastivity' had been propounded, which can serve as an adequate measure of performance of any system and is rather easy to measure.

Let I_r be the wastivity index of rth resource and W_r be the relative weightage (depends upon a number of tangible and intangible factors) of rth resource, then

$$\text{Composite Wastivity Index} = \sum_{r=1}^{n} W_r \, I_r$$

For n types of resources

Where, $\sum_{r=1}^{n} W_r = 1$

It will be very convenient to measure the waste as well as input for each type of resource for a specified period.

We have,
I = O + W
Dividing both sides by I, we have

$$\frac{I}{I} = \frac{O}{I} + \frac{W}{I}$$

or 1 = Productivity + Wastivity
or Productivity = 1 − Wastivity

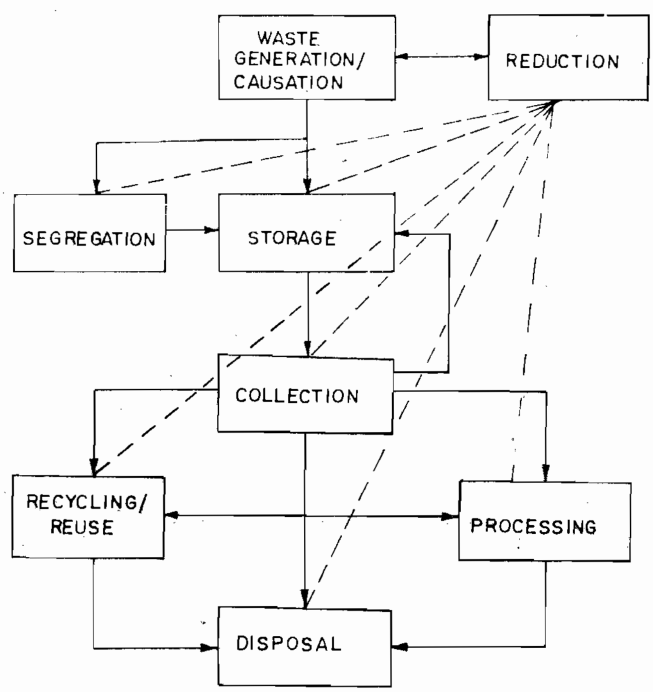
The Wastivity for each type of input thus indirectly assesses the productivity for each type of input. Both productivity and wastivity are complementary to each other, which bears in it the inherent cause effect phenomenon. If the cause, i.e. wastivity is checked, the effect, i.e. productivity, will automatically be improved.

20.5 THE FUNCTIONAL CLASSIFICATION OF WASTE MANAGEMENT

The problems associated with the management of wastes in today's society are complex and diverse in nature. For an effective and orderly management of wastes the fundamental aspects and relationships must be identified and clearly understood. The efficient WM comprises of the quick identification of the waste generated/caused, economic reduction, efficient collection and handling, optimal reuse and recycling, and effective disposal of waste leaving no environmental problems. WM can thus be functionally classified into five basic elements, viz., generation, reduction, collection, recycling and disposal. However, WM should be viewed in totality considering the inter-relationship of basic functional elements/system as shown in Figure IV. One of the objectives of WM is to optimise these basic functional systems to provide the most efficient and economic solution, commensurate with the constraints imposed. By considering each element separately it is possible to:

i) identify the fundamental aspects and relationships involved in each element,

ii) develop, wherever possible, quantifiable relationships for the purpose of making engineering comparisons, analysis and evaluation.



Generation of Waste

There may be numerous causes responsible for the generation of waste in different systems. However, some general causes of waste generation at different stages have been perceived. The check list of causes of waste generation is shown in Table 1 out of which some causes may be critical. If it is possible to account for the amount of waste generated against respective causes, then the most critical cause will be one that contributes to the highest aggregate cost of waste.

Table 1
Checklist of Causes of Generation

1	Ineffective policies
2	Lack of Planning
3	Political pressures
4	Defective organisational structure
5	More emphasis on sub-system objectives rather than organisational goals
6	Poor management
7	Faulty systems and procedures
8	Personal interests
9	Carelessness and neglect
10	Lack of individual responsibility
11	Non-acquaintance with latest technological development
12	Resistance to adopt automation and computerisation
13	Wrongly laid-down design standards
14	Lack of standardisation and codification
15	Wrong choice of raw material
16	Ignorance of inventory control
17	Inappropriate storage facilities
18	Poor handling of materials
19	Poor layout of facilities
20	Information delay
21	Improper work methods
22	Less emphasis on PPC function
23	Inadequate supervision and control
24	Improper recruitment and lack of training
25	Lack of motivation and incentives
26	Unhygienic work environment
27	Insufficient skill and use of unsafe practices
28	Poor labour relations
29	Frequent power failures
30	Poor maintenance
31	Less emphasis on quality control
32	Poor distribution network
33	Less emphasis on collection and segregation of waste
34	Technological obsolescence
35	Miscellaneous causes.

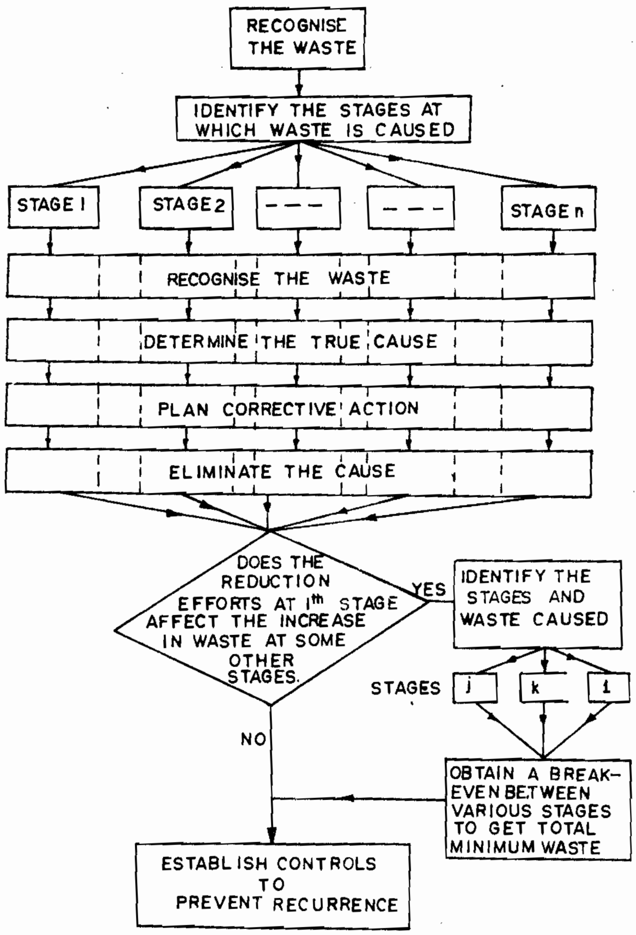
Accurate information on waste generation rates and composition provides a basis for the design and operation of various waste control programmes, recycling and processing plants, waste disposal projects, and the choice of most effective disposal alternative. The problems in obtaining the information on this aspect are complex and involve following factors:

- Various establishments may differ widely in their waste generating practices.
- Most firms are reluctant to reveal production and related statistics for fear of the data being used to the competitive advantage of others.
- Generally, the firms are reluctant to provide information on quantity and composition of waste for fear of it indicating non-compliance with pollution-control regulations.
- The quantum of waste generated reflects the inefficiency of the organisation.
- Some industrial activities are subject to seasonal variations.
- The extent of salvaging, recycling or other reclamation of wastes differ greatly among manufacturers.
- Many firms themselves have little understanding of, and few records on this aspect.

A Systematic Approach to Waste Reduction

A systematic approach to minimise the total system waste minimising the waste at individual stages in conjunction with other stages has been proposed in Figure V.

Figure V: Stage Wise Waste Reduction: A Systematic Approach.



It provides a scientific and systematic method for waste reduction at individual stages and finally for the whole system. The procedure for approaching from whole to part, and, then, from part to whole is proposed. The basic steps of the approach are as follows:

i) Recognise the waste for whole system.
ii) Identify the stages at which waste is caused/generated.
iii) Visualise the whole waste into fractions caused at various stages as identified in step (ii).
iv) Apply the systematic waste reduction procedure at each stage separately, i.e.,
   - recognise the waste,
   - identify the cause,
   - plan corrective action,
   - eliminate the cause.
v) Find the correlation of various stages to assess the effect on waste generation at one stage due to waste reduction at other stages.
   - If there is no such correlation, then establish controls separately at each stage to prevent recurrence of the cause of waste generation.
   - If such correlations exist and waste is caused, then find the stages affected.
vi) Try to obtain a break-even of wastes at the related stages so as to minimise the total aggregate waste at all the stages.
vii) Establish controls to prevent recurrence of the cause of waste generation.

Towards Zero Waste

The Waste Management systems for individual organisations, sectors as well as the whole economy should be designed to fulfil the goal of zero waste. Zero waste should not be misinterpreted as if no waste is generated. Such an interpretation will be neither feasible nor justified. As some waste is inevitable with the function of any system, a 100% efficient system is only hypothetical. Further, such a system will be closed and will have a zero growth rate which is not desirable. The main theme of the philosophy of zero waste is to first of all try to minimise the waste generated as far as it be technologically and economically feasible; and whatsoever little waste is generated should be put to some effective use.

The goal of zero waste should be visualised from systems point of view, i.e. to have zero waste of all types of resources simultaneously. Otherwise, it may be futile to aim towards zero waste for one type of resource if it cause the waste of another type of resource.

Waste Collection Systems

Waste collection has got a significant effect on subsequent functional elements, public health, aesthetics, housekeeping and public attitudes concerning the operation of the system. As collection and transportation constitute a major cost in waste treatment (up to 80 per cent), streamlining of collection techniques can greatly improve the efficiency, and effect a significant saving in the overall cost of WM. This will be beneficial in two ways, viz., reduced disposal efforts and advantages of resource recovery by effective recycling of waste.

The proposed strategies for waste collection are:

i) Design of economic basis to facilitate separation at source.

ii) To provide every organisation with a set of four standard bins to separately collect the metallic, plastic, paper and other miscellaneous waste, the bins should be designed after careful investigation of the types and quantum of waste generated.

iii) Design of appropriate collection system governed by public or private agencies to regularly collect the segregated waste at time intervals depending upon the generation rate.

iv) Incentives to encourage segregation of the waste at source.

v) Timely collection of scrapped organisations' appliances alongwith segregated waste, and its flow through salvage industry for ultimate reuse.

vi) Development of appropriate collection systems for the collection of miscellaneous organic and inorganic waste.

Recycling of Wastes

In the absence of conservation or recycling, certain of the World's finite resources will diminish to a level incapable of maintaining an acceptable environment and adequate life support. Fortunately, in India, there is a growing awareness to recycle/reuse the waste. The National Committee on Science and Technology (NCST) has identified a number of recycling projects.

The terms recycling, reuse, reclamation and recovery have different interpretations, though these terms are generally used as synonyms. In this study the term recycling is adopted to mean all these terms.

Recycling generally refers to the use of undesirable outputs or wastes as input to the same process or system, e.g., recycling of foundry scrap. Reuse may be termed as the use of waste generated from one process/system as input to some other process/system as a raw material, or for the generation of power or by-products.

The conversion of damaged, rejected and undesirable outputs into the desirable outputs by repair or processing is termed as reclamation. The term recovery is utilised to denote the gain of resources from the wastes.

Waste Disposal Systems

This element links the waste management system with environment and other systems, and has got a significant impact on the same. The adoption of poor disposal practices have resulted in severe environmental pollution in different parts of the world, particularly in the big industrial centres and have posed serious threat to human life. Some of the developed countries have taken the problem on war-footing and have started developing and adopting latest technology in this regard. In India the awareness has grown recently and the design of effective waste disposal systems has become a challenging problem area. From disposal viewpoint wastes may be categorised into:

i) Salvable waste, and
ii) Non-salvable waste.

The wastes that have got some salvage value are termed as salvable waste. The scrap, rejected goods, surplus/obsolete items and equipments etc. fall under this category. The well designed disposal system for salvable wastes may provide best return to the organisation, contribute to cost reduction and higher profit and aid to material conservation.

Wastes which do not have any salvage value, but need further processing and treatment for disposal are termed as non-salvable waste. The non-salvable wastes are primarily responsible environmental hazards. Proper management of salvable wastes may amount to resource recovery and reduced environment and other social costs.

a) Guidelines For Disposal of Salvable Wastes: The salvable waste, e.g. scrap, surplus/obsolete stores and equipment, unserviceable appliances and machinery, abandoned vehicle etc. is generated in almost all sorts of manufacturing and service establishments. No particular attention has been paid in most of the organisations for the disposal of salvable wastes. The most common practice is to dispose the scrap/surplus through auctioning. No systematic procedures have been developed in this regard. Another mode of disposal adopted is to salvage the scrap through specialised agencies. The traditional "Kabaris" or Junkmen are performing this work. Directorate General of Supplies and Disposals (DGS & D) is playing a vital role in public disposals. It disposes the stores worth 50 crores of Rupees approximately, every year for various Government Departments. A special Surplus Disposal Committee was set up for analysing the large quantities of accumulated surplus. The Committee in consultation with Metal Scrap Trade Corporation and MMTC has suggested some procedures for the manner of disposal and the market analysis of the huge ferrous and non-ferrous scrap in the country.

The procedures for the disposal of different types of salvable waste vary from situation to situation. Some broad guidelines have been suggested to aid the design of systems and procedures for disposal in individual cases:

i) First of all the feasibility of recycling should be analysed to dispose the scrap.
ii) Try to use the scrap for producing by-products.
iii) Try to transfer the surplus from one department to another or to other plants in case of multi-plant organisation.
iv) Analyse the feasibility to sell the scrap as raw material to other plants.
v) To sell the scrap/surplus to external export agencies dealing with it.
vi) Selling of scrap through advertisement and auctioning. The frequency of auctioning should be decided after analysing the generation rates and by obtaining a break-even between the scrap/surplus carrying cost and auctioning cost.
vii) Selling the surplus in open market, or to the employees itself, particularly in case of consumer goods. If the product is not meeting the quality requirement, then classify it as seconds and give a discount. This may act as an incentive to employees.
viii) To consult the vendor and return the surplus to vendor.
ix) To sell surplus/obsolete equipment through advertisement and invite the offers from other parties.
x) In case of damaged equipments try to sell after the parts after classifying into good serviceable, repairable or reclaimable, and scrap.
xi) To donate the rejected material to charitable organisations to gain socio-economic respect.

b) Processing and Disposal Techniques for Non-salvable Waste: Processing techniques are used in solid waste management system to improve the efficiency of operations, i.e., to reduce storage requirements, facilitate disposal to recover resources, conversion products and energy, and to minimise environmental effects. Disposal is the 'no alternative' option and the ultimate fate of all wastes that are of no further value. Various alternative processing/disposal techniques have been briefly discussed as follows:

Mechanical Processing: The mechanical processing of the waste is done to reduce its volume and size for easy handling and disposal and to recover valuable materials by separation.

i) **Compaction:** This technique reduces the volume of the waste by mechanical compaction.

ii) **Baling:** This is also a mechanical volume reduction method which uses specialised compaction equipment to produce solid wastes in block or bales of various sizes. This offers the advantage of less landfill requirements, land reclamation, less leachate production, neat and clean operation of land filling, easy transportation saving in cost of covering material etc.

iii) **Shredding:** This refers to the mechanical size reduction of wastes by pulverising. The volume is reduced up to 50% and a homogeneous mass is obtained which is relatively odourless, unattractive to flies and vermins, and is relatively non-combustable leading to easier disposal. Milled refuse can be disposed of at locations close to residential areas.

iv) **Component Separation:** Component separation is a necessary operation in the recovery of resources from solid wastes both manual and mechanical method can be used. The separation may be done at the source or centralised separation may be adopted.

Thermal Processing: Thermal processing of wastes result in volume reduction, generation of energy and by-products. The overall heat contents of solid wastes including moisture and ash etc. is approximately 10.5 million BTU/Ton, which is most nearly comparable to that of low rank lignites.

i) **Incineration:** High temperature oxidation of the organic and toxic compounds present in gaseous wastes is employed to destroy the offensive effluents and odours by converting them into harmless gases, i.e. O_2 and waste vapour.

ii) **Pyrolysis:** The pyrolysis of solid wastes strictly refers to the destructive distillation or the thermal decomposition of the wastes in an inert atmosphere.

Bio-Processing: For agriculture based economy like India bio-processing is becoming an important research field to produce fertilisers, alternative fuels and feeds etc. Some bio-processing methods are composting, fermentation, hydrolysis etc.

Composting: Composting of solid wastes may be defined as the bio-chemical stabilisation of these organic materials to a humans like substance through scientifically producing and controlling an optimum environment for the process.

There is vast potential for composting as a disposal process in India. It has been used from link time in rural area, but there is a need to make the people aware of its benefits and rigorous organised efforts should be made.

Ultimate Disposal: Ultimately something must be done to solid wastes that are of no use and are left after recycling, processing etc. The major options available are the disposal on or in the earth's mantle (e.g. land filling) and disposal at the bottom of the ocean.

Sanitary land-filling: Sanitary landfills have been proclaimed as the low cost, safe way of disposing of municipal refuse. Rain water and surface run off water percolates through the landfills and the resulting leachate has a high concentration of organic wastes and harmful salts. Also, the evolution of methane gas from the refuse can create fire and explosion hazards.

c) **Design of Effective Waste Disposal System:** The design of effective waste disposal system is an important aspect of waste management. The system should be designed to promote the maximum possible recycling/reuse of wastes, and for minimum environmental hazards. The flow diagram of waste disposal system has been shown in Figure VI.

First of all the technical economic and social feasibilities of recycling/reuse should be analysed and attempts should be made to recycle the waste as it is without any processing. If the residue left after optimal recycling reuse is disposed as it is, then the mode of disposal should be selected; otherwise various processing techniques should be evaluated by considering various social and economic factors. Both the source as well as centralised processing methods should be selected properly. Finally, plans should be prepared for the ultimate disposal.

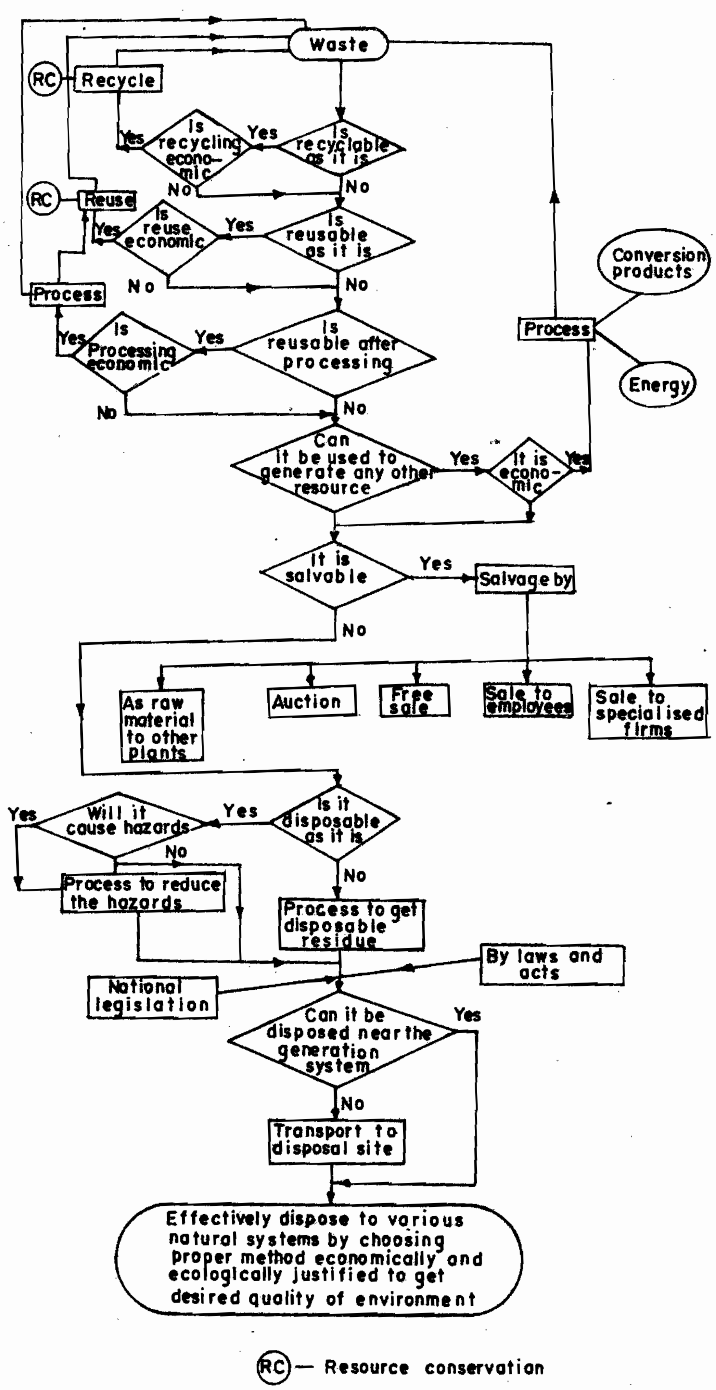


Figure VI: Flow Diagram of Waste Disposal System

Various factors that should be considered in the design of waste disposal system are:

i) The public attitudes

ii) The regional and national policies

iii) The economic considerations

iv) Land availability

v) Equipment requirements

vi) Ground water protection

vii) Environment control

viii) Fire prevention

ix) Litter control

x) Operation plans

xi) Employer facilities

xii) Equipment maintenance

xiii) Operational records

20.6 OUTLINE OF I-O-W (INPUT-OUTPUT-WASTE) MODEL

It has been visualised that it is possible to take waste as an explicit parameter and the existing input-output model can be modified to incorporate WM constraints. To provide a closer representation of real life system it is proposed to remodel them in the framework of an I-O-W (Input-Output-Waste) model. The proposed model will be able to define the resource balance more realistically by incorporating the reduction, recycling, abatement, disposal and related functions of WM. The I-O-W physical system defines the resource constrained for every viable system as the balancing of inputs to the sum of outputs and wastes for each type of resource:

$$\text{Input} = \text{Output} + \text{Waste}$$

Basic Framework: The basic framework of I-O-W model defines I-O-W flow matrix, I-O-W coefficient matrix and consistency equations. The I-O-W flow matrix consist of a set of conventional intermediate demand or resource flow matrix extended to include WM sectors final demand matrix plus added waste flow matrix. An aggregated I-O-W matrix is shown in Table 2.

Table 2
I-O-W Flow Matrix

Intermediate demand or Resource flow matrix		Final demand matrix	Total output
Input of resources		Total final demand	
		Waste flow matrix	Total waste
Total input=Resource inputs	+	Recycled Wastes	

The I-O-W coefficient matrix consists of technological coefficient matrix, final demand coefficient matrix and WM coefficient matrix partitioned for intermediate and primary inputs, and intermediate and final wastes as shown in Table 3.

Table 3
I-O-W Coefficient Matrix

Consuming Sectors		
	Technological coefficient matrix (intermediate input coefficient)	Final demand coefficient matrix
	Primary input coefficient	Primary input to Final demand
	WM Coefficient Matrix Intermediate Waste Coefficient	Final Waste Coefficient

The model may be generalised for 'n' production sectors and 'm' WM sectors. The source of primary inputs are aggregated as trade, habitat and nature, whereas the final demand is clubbed into domestic consumption trade and change of stocks. The inter-sectoral waste flow is treated as intermediate waste, while final wastes include waste recycled in habitat by changing life styles, waste disposed of by trade and the wastes ultimately disposed of to nature.

20.7 TREATMENT OF WASTAGE IN COST ACCOUNTS

It is realistic to expect that all materials put into process will not end up as good saleable product. Some loss, scrap and wastage in inevitable in process industries. These losses must be computed in advance before the processing operation begins. Process loss can be divided into two categories; (i) Normal loss, (ii) Abnormal loss. Normal loss is the loss which is unavoidable, uncontrollable and expected in normal conditions. It may be inherent in the manufacturing process. If the loss is inevitable. i.e. unavoidable and within the limit, it is called normal process loss. Abnormal process loss is controllable and generally caused by abnormal or unexpected conditions, such as bad designing, poor materials, accident and negligence, etc.

The treatment of normal and abnormal losses differ in inprocess accounts. Normal losses are absorbed by good production. Assume, for example, that 25,000 units of a mixtures were put into process and that during processing 5,000 units were lost through evaporation. This is an unavoidable loss. If the total cost recorded was Rs. 25,000 the remaining 20,000 units would be assigned a unit cost of Rs. 1.25

$$\frac{\text{Cost of production}}{\text{No. of units completed}} = \frac{\text{Rs.}25{,}000}{\text{Rs.}20{,}000} = 1.25$$

Abnormal losses are valued as good units. The unit cost which is used to value good units is also applied for the valuation of abnormal loss units. The cost of abnormal loss units computed in this manner is transferred to a separate abnormal loss account and credited to the relevant process account. Subsequently, this loss is transferred to the costing profit and loss account and the abnormal loss account is thus closed.

The following procedure will help in the preparation of process cost accounts that do not present any difficulty:

1 Normal loss should be computed on the basis of information given in the question.

2 The cost per unit of production, after making into account normal loss units, should be determined assuming that abnormal loss does not exist. The cost per unit is calculated on the basis of the following information:

   a) Normal production, i.e., inputs (units) minus normal loss units.
   b) Normal cost of production, i.e., all costs incurred (appearing on the debit side of a process account) minus proceeds (if any) realised from the sale of normal loss units.

Normal cost of production divided by normal production will give the cost per unit of output.

3 The cost per unit determined as above is used to value abnormal loss units and that would be the cost of abnormal loss.

4 The abnormal loss account is debited and the relevant process credited with the amount and quantity of abnormal loss as calculated in (3) above.

5 The cost per unit as obtained in (3) will also be applied to determine the cost of good production units produced by the process.

6 The proceeds realised from the sale of normal loss representing scrap (if any) is transferred to the relevant process account.

7 The proceeds realised from the sale of abnormal loss representing scrap is transferred to a separate abnormal loss account and not to the relevant process account.

8 The abnormal loss account is closed by transferring the total cost of abnormal loss units to the costing profit and loss account if there is no scrap. In case abnormal loss represents scrap, only the net amount (total cost of abnormal loss units minus scrap) will be transferred to the costing profit and loss account.

20.8 CONCLUDING REMARKS

The problem of Waste Management should be visualised in a broader perspective and an organised systems' approach to Waste Management should be adopted. It is unfortunate that despite the cruciality of Waste Management in socio-economic resource structure in its ecological and environmental compatibility, it has been ignored most of the time. There is a need to standardise the taxonomy of the wastes and to critically analyse the functional elements of waste management. Waste management is a dynamically emerging field with vast scope. Though awareness in this field is growing slowly, if proper attention is paid, it may rapidly gain momentum.

20.9 SUMMARY

In this unit we have proposed a new enlarged concept of waste and wastivity. The best way of waste management is not to generate waste at all, viz. a preventive policy of waste generation is advocated. We have established the close relationship between wastivity, productivity and resource management. A seven step systematic approach has been given for waste reduction. Guidelines for waste collection, recycling and disposal have been discussed. Some processing and disposal systems have also been overviewed. A brief outline of an input-output waste model has been given. It is difficult to accurately account for all wastages. Yet another procedure has been suggested that will help in the preparation of appropriate cost accounts.

20.10 KEY WORDS

Gross Wastivity: Ratio to total waste generated to total input.

Incineration: High temperature oxidation of the organic and toxic compounds present in gaseous wastes that is employed to destroy the offensive effluents and odours by conversion into harmless gases.

Productivity: Ratio of output to input.

Pyrolysis: Destructive distillation or the thermal decomposition of solid wastes in an inert atmosphere.

Waste: Any unnecessary input to or any undesirable output from any system encompassing all types of resources.

Waste Management: A multi-disciplinary activity involving engineering principles, economic, urban and regional planning, management techniques and social sciences.

Wastivity: Ratio of waste to input.

20.11 SELF-ASSESSMENT EXERCISES

1 Explain how the system concept can be used in explaining the terms waste and waste management.

2 'Waste Management' is complementary to 'Resource Management'. Critically comment.

3 Differentiate between wastivity and productivity and explain whether reducing wastivity and increasing productivity imply one and the same thing.

4 Why are the basic waste generation stages in a production system? Explain with the help of an example.

5 Explain how would you proceed in designing a waste disposal system for a manufacturing enterprise.

6 Write short notes on:
   a) Systematic waste reduction procedure

b) Wastivity Indices

7 Write short notes on:
  a) Identification of waste
  b) Taxonomy of wastes

8 Briefly explain what vou understand by the term I-O-W (Input-Output-Waste) model.

9 Devise a method of cost accounting for wastes.

20.12 FURTHER READINGS

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