Strategic planning and policies

This lecture describes the management procedure for waste recycling program. A waste management program should include as many alternatives as possible to enable the decision-making process to reach a cost-effect solution. A sequential approach in the management of an organic waste recycling program generally comprises of: planning, technology and site selection including cost benefit analysis, institutional arrangement, compliance with regulatory guidelines and standards, and monitoring and control of facility performance. Each of these aspects and some case studies are presented below.

PLANNING FOR WASTE RECYCLING PROGRAMS

Waste recycling program has been practiced in many countries for decades, but proper planning procedures and institutional set-up are yet to be developed. The overall success of a waste-recycling program depends greatly on its planning and implementation.

Planning for a waste-recycling program requires the following aspects for consideration.

1. Raw materials: Wastes from households, industries and public institutions are the ingredients of a waste recycling program and the outcome is the useful products as well as other benefits, such as public health improvement and pollution abatement. The program has to envisage the limitation of the waste quality and quantity over the planning period.
2. Manpower: Various levels of skill are needed for the execution of the program. Present and future requirements of manpower are to be estimated, and future development of manpower planned.
3. Capital: A waste recycling program or project has to be financially viable. It may be necessary to initially fund the programs by local authorities or by international agencies. Later on, collection of fees for waste collection and treatment and sale of the recycled products have to be implemented which should be satisfactorily accepted by the public.
4. Technology: Collection, handling, processing and final disposal/reuse of the waste and by-products need efficient methods so as to maximise the benefits and minimise the environmental pollution.
5. Market study: all the resources and effort devoted to recover and recycle the wastes will not be useful if there is not market for the recycled products. Waste recycling technology and facilities must be able to consistently meet the user's quality, quantity and reliable delivery period, when required.
6. Political will: This is an important aspect of a waste-recycling program. Education of the people at all levels to promote public awareness and to realise the importance of waste recycling has to be done continuously. Uncertainties and myths have to be clarified, such as the aspects of public health and environmental impacts due to waste recycling programs.

The above-mentioned aspects inter-relate and influence each other with respect to a decision to proceed with a waste recycling program. In general, steps that should be considered in the planning of waste recycling program (Figure 10.1) are:

1. Identification of objectives
2. Constraints
3. Data collection
4. Analysis of principal options
5. The decisions and process of review

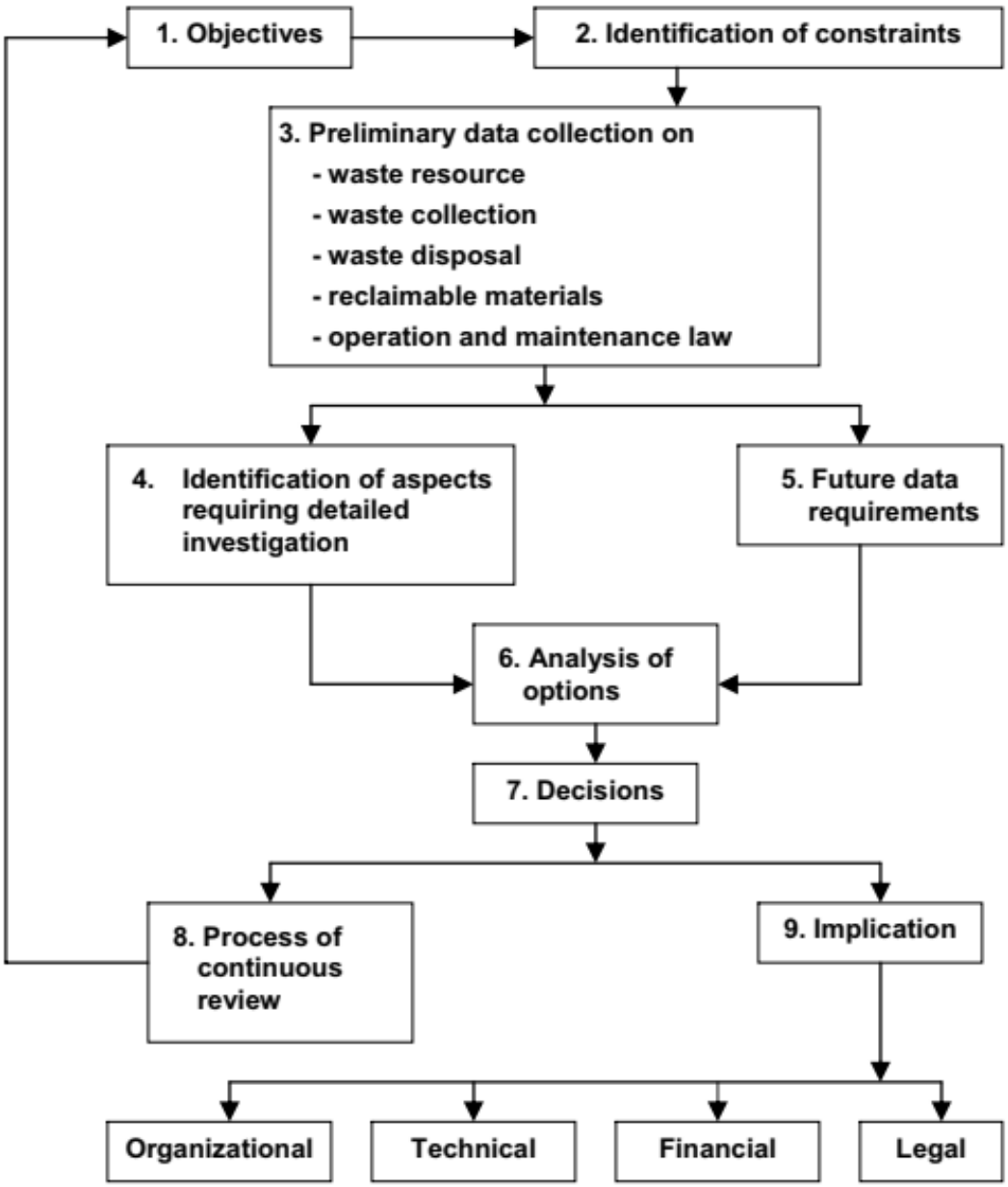

Figure 10.1 Principal steps in the development of a waste-recycling program

Identification of objectives

The objectives should identify the purpose of the waste recycling program, that is to be able to reclaim, reuse and at the same time to treat the waste to a certain degree that it does not cause health hazard or environmental pollution. In considering the cost effectiveness of a waste-recycling scheme, the benefits to be gained from pollution control and public health improvement should also be taken into account.

The objectives should, in particular, include what the plan is to encompass in terms of:

1. geographical area, where waste collection and treatment/recycling can be planned on a regional basis to minimize expenditures and to yield effective management of the system;
2. types of waste, so that appropriate waste recycling program can be selected;
3. time period of the plan, which depends on local circumstances and needs such as the waste quantity and characteristics and long-term needs of the recycled products.

Constraints

There are a number of constraints that will tend to limit the available waste recycling alternatives. By recognizing these at the outlet, a great deal of unnecessary work can be avoided; their recognition will also be of assistance in the eventual selection of appropriate recycling scheme. These constraints are:

1. Financial constraints, which may limit the use of capital-intensive high technology for recycling the waste, unless the advantages or market for the recycled products are promising. For example, it may not be appropriate to employ a Dano composting unit (Figure 3.18) to produce compost fertilizer where farmers still prefer to use chemical fertilizers available cheaply. In addition, the production of virgin materials often enjoys a wide range of subsidies and incentives that make them cheaper then the recycled products.
2. Manpower constraints; the manpower constraint in the planning of waste recycling program should be taken into account such as the need for skilled technicians to operate some biogas digesters and high-rate algal ponds.
3. Land use constraints; some waste recycling systems are not suitable for urban and suburban areas due to shortage of land. Existing land uses will provide the best guideline that is likely to prove more or less acceptable.
4. Environmental constraints; hydrogeological characteristics of the waste recycling area must be considered so that the environment of the site and nearby is not affected by this practice.
5. Public acceptance constraints; the recycled products from the waste recycling processes should be acceptable to the public, otherwise the recycling process is of no use. In general, people do not want to have waste recycling sites located close to residential areas.

Data collection

Preliminary information requirement

The following information will be required for the planning of waste recycling program:

1. population, housing, industries, or agricultural activities;
2. waste quantity, composition and source;
3. waste storage, collection and transportation;
4. treatment and disposal/reuse methods; existing methods, future capacities, plant's life, local hydrogeology, land availability;
5. existing waste recycling system and benefits achieved, if any;
6. public acceptance of reclaimed products
7. management and law, organization, regulations and their enforcements.

Detailed investigation

In particular, there is often a shortage of information on the quantity and composition of waste, and the amount of reclaimed products. Hence, detailed surveying and estimating the quantity and composition of waste should be carried out before planning a waste-recycling program.

Both waste quantity and composition are subject to daily and seasonal fluctuation. Waste recycling facilities must be provided to cope with peak waste load rather than the average, and seasonal variations in the quantities of available materials may have impact upon the extent of resources recovery. In addition, data on national average characteristics of the wastes can be significantly different from local characteristics of the wastes of concern.

For the treatment and recovery of products (e.g. composting - material recovery; anaerobic digestion - energy and materials; pond system - food production), the waste composition is an important factor.

Where specific problems have been identified, a more detailed investigation on waste composition and quantity will be required to provide sufficient data for the options or decisions to be made. The detailed investigations should also take into account the amount and value of reclaimed products as well as their public acceptance. Long-term outlets for these reclaimed products should also be considered.

Analysis and decisions

Where a number of options for waste recycling scheme are available, it is necessary to evaluate each option for capital and operating costs, the benefits and associated health and environmental impacts.

Alternative technological options and waste recycling plans are assessed against a set of criteria which will normally encompasses economic, technical, environmental and political objectives. Possible subdivisions of each category are suggested in Table 10.1. The selection and definition of criteria are dynamics, with feedback occurring from later stages of the planning process. For example, the criteria may be revised or the emphasis given to a particular criterion may be altered when practical implications rather than initial abstractions are considered.

With regard to cost and benefits, all elements in the systems should be costed for comparisons on the options and for evaluation of improvements in performance. Costs and benefits should be expressed in terms of cost and benefit per ton of waste recycled in the system. The costs include capital and operating cost in terms of its present value whereas the benefits should include not only in terms of financial benefits but also its pollution control and public health impacts.

Table 10.1 Criteria for the assessment of waste recycling plans

Economic
Capital costs
Land costs
Operating costs
Revenues:
Extent of market commitment
Stability of markets
Net recycling cost per ton of wastes
Net present cost of the recycled products
Sensitivity of costs to market or other fluctuations
Uncertainty in cost estimates, i.e. financial risk
Technical
Adequacy of the technology:
Feasibility
Operating experience
Adaptability to local conditions
Reliability
Interdependence of components (can the system be operated if one component fails?)

Table 10.1 Criteria for the assessment of waste recycling plans

Safety
Potential for future development
Flexibility to cope with changes in:
Waste quantities
Waste composition
Source separation of materials
Dependence on outside systems:
e.g. vulnerability
Environmental
Public health
Water pollution
Air pollution:
Dust
Noxious gases
Odors
Quality and quantity of residual wastes
Noise
Traffic
Aesthetics
Political
Equity between communities or interest groups
Flexibility in location of facilities
Public acceptance
Number of jobs created
Employee acceptance
Use and conservation of resource
Products covered:
Market potential
Net effect on primary energy supply:
Energy requirements
Net effect on supply of materials:
Raw materials usage
Land usage:
Volume reduction
Land reduction
Water requirement

GUIDELINES FOR TECHNOLOGY AND SITE SELECTION

Definition of technology and its choice

Technology is often identified as knowledge about machine and processes, extending to skill, knowledge and procedures for making, using and doing useful things. It includes the nature and specification of what is produced as well as how it is produced. A complete description of technology used in a country must include the organization of productive units in terms of scale and ownership.

Limiting factors in the choice of technology

In general, people would select a technology that is suitable to its environment and economical to operate. However, technology selection is not an easy job. There are some factors that limit the choice of technology. The first factor is the incomplete knowledge of the techniques and methods. Technology is generally developed in industrialized countries. Although in some instances a certain technology can be adapted to developing country environment, no country is willing to try it because of the lack of knowledge of that technology. The absence of individuals or group involved in using the technology in the community also hinders technology selection. This is true when the individual or the community lacks the entrepreneurial spirit to innovate or try new. Unless the technologies from other countries are tried and tested, the choice of technology selection would be very limited.

Guidelines for technology selection are proposed to possibly reduce the failures in adopting technology from other countries. Although some techniques like the use of excreta for composting are acceptable in some region, they may not be socially acceptable in other countries. The following guidelines are recommended for the technology selection in waste recycling and recovery, but should be applicable to other categories of technology also:

1. The technology should be suited to the local environment economically and culturally
2. The operation and maintenance should be easily undertaken by the local manpower;
3. The technology should use, whenever possible, local materials and energy sources. In such case that imported materials are recommended, it must be affordable and easily obtainable;
4. The technology should be simple and easily understood by the local people and have certain flexibility for possible changes;
5. The technology should be innovative in order to improve the human and material conditions of the local people through the use of new organizational types and new technological devices;
6. The technology whenever possible could be sited in existing high density areas;
7. The technology should not directly or indirectly contribute to the pollution and destruction of the existing ecology;
8. The technology should enhance the health and sanitation and upgrade the economic well being of the community.

Site identification

An ideal site to be selected for organic waste recycling program should be the one that supports the community livelihoods and is acceptable to the people. A preliminary site screening should be conducted to obtain such important data as: soil characteristics, depth to ground water, site grades, land use patterns at present and in the future and haul distance of organic wastes from the community to the potential site. To minimise health risks and gain better public acceptance, the organic waste-recycling site should be located downwind and away from the community centres.

Important information needed for site selection is the land area requirement, which is usually dependent on the required degree of waste treatment and the technology of organic waste recycling to be employed. The design criteria and procedures outlined in Chapters 3-9 can be used in determining land area requirements. For composting, no special site investigation is required but impermeable barrier should be provided to protect groundwater contamination. In general the area estimate for aquatic weeds and land treatment of wastewater depends on the effluent quality required. The requirements for these systems include: proximity to surface water for effluent discharge, impermeable soil or liner, no steep slopes, out of flood plain or dike, no bed rock or ground water within excavation depth. A suitable location must have favourable climate to support growth of aquatic plants and other biological components. For constructed wetlands, impermeable soil or liner is required to prevent the soil and ground water contamination. The constructed wetlands should be built on land having slopes 0-3% and not located in flood plain.

For slow rate land treatment systems, soil should be clay loams and sandy loams. On the other hand, sandy loams and sands are required for rapid infiltration systems. For an overland flow system, land with relatively impermeable soils, such as clay and clay loams, is necessary. The slope of the land should be in the range of 0-15%. The depth to ground water and bedrock is not critical, but it should be kept at least 0.5-1m.

Apart from the purpose of wastewater or sludge management, local knowledge, technical and cost requirements including regulatory standards should be taken into account in the selection of a suitable site for the intended organic waste-recycling program.

Site evaluation

Site evaluation involves field surveys to confirm the data obtained from the preliminary site screening. The following aspects should be undertaken during site evaluation:

1. Soil investigation: This includes determination of soil texture and structure. Soil borings should be conducted to investigate the depth of soil and groundwater table. In the design of land treatment of wastewater, information on soil aggregation is necessary to make a decision on an appropriate system.

2. Soil chemistry: The chemical properties of soil such as pH, cation exchange capacity (CEC), and sodium absorption ratio (SAR) have effects on the removal efficiency of pollutants such as heavy metals and toxic organic compounds.
3. Soil infiltration and permeability: The ability of water to infiltrate and percolate a soil is a critical factor in the design of constructed wetlands and land treatment systems. Porosity, the ratio of void to the total volume of soil, should be determined (as a decimal factor or percentage) and incorporates in the design of concerned treatment/recycling systems.
4. Buffer zone: The concept of having buffer zone is based on aesthetic and public acceptance. Organic waste recycling technologies may create an obnoxious odor and the potential for aerosol transportation of pathogens during the application of wastewater, both problems can be minimised through the application of buffer zones.

Cost and benefit analysis

The cost of an organic waste-recycling program normally includes: investment costs for land, facility construction, site preparation and associated requirement, and operation and maintenance costs. Except for the land cost, the total investment, operation, and maintenance costs of an organic waste recycling system are generally lower than those of the conventional treatment systems. In addition, the valuable by-products obtained from organic waste recycling such as compost fertilizer, biofuels and protein biomass, etc., are financial benefits to be gained from this practice. As mentioned earlier in Chapter 1, other intangible benefits such as environmental protection and health improvement resulting from organic waste recycling programs should be taken into account.

INSTITUTIONAL ARRANGEMENTS

A critical dimension in the success of waste recovery and recycling programs concerns an institutional arrangement between the government agencies, municipalities, private corporations, and non-government organizations. All these institutions must join together and coordinate all activities in order to avoid conflicts and duplication of works and duties. Institutional arrangements may be considered for financing, administering and operating recovery and recycling projects. In developing countries, without government guidance it seems unlikely that other institutions can be expected to handle waste materials efficiently and optimally. Some government control, guidance and incentive are necessary to secure success in pursuing the program. A strategy or approach has to be developed, either regional or grassroots, to lay the foundation of work. Private corporations and non-governmental organizations including international agencies and foundations should be approached for financial or technical support. The municipality must cooperate with the government for the promotion and implementation of planning programs. Cooperatives or districts should be established to be directly involved in construction, operation and maintenance of recycling facility if there are any.

The development and application of science and technology should be conducive to waste recycling from the basis of comprehensive policy of these agencies. Furthermore, policy that takes into account natural, economic and social characteristics of each region or locality, if taken wisely, would secure more cooperation in creating recycling policy.

To make steady progress in waste recycling policy to produce more satisfactory result in this direction, all parties interested in recycling issues (such as government agencies, municipality, non-profit corporation, entrepreneurs, and inhabitants), should be aware of their respective roles and make continuous efforts befitting their positions. Government agencies, among others, have the leading role to make the program successful.

Close cooperation among interested parties (including government agencies, municipality, non-profit agencies, entrepreneurs, and inhabitants) is indispensable to enforce recycling policy that take into account either local or regional characteristics. Each of the institution has to have a role. The following institutional arrangement is suggested for the success of a recycling and reuse program.

Government agency

Its role is to:

1. Formulate policy, prepare guidelines, and undertake planning programs on waste recovery and recycling.
2. Extend technical, financial and management support to all participants of the program.
3. Promote and coordinate all activity related to waste recovery and recycling to assure public acceptance of the program and to avoid duplication of work.
4. Monitor success and failures of the program. Formulate alternate programs to reduce losses (in terms of investment).
5. Undertake manpower development and training programs for people involved in the program.

Municipality

Its role is to:

1. Assist the government agencies in the selection of the most appropriate recovery and recycling programs that would be established in community.
2. Act as a link between government agencies and the community for the continuous flow of information necessary to ensure success of recovery and recycling program.
3. Initiate acceptance and participation of the people on the government program through information dissemination.

4. Assume a leading role in the formation of cooperatives or a local district, which would have a direct responsibility over the implementation of recovery and recycling program in the community.
5. Assist the cooperative and district or individual in identifying problem areas. Recommend remedial solutions to prevent failure of the program.

Private corporation

Its role is to:

1. Assist the government agency and municipality in waste recovery and recycling program by extending financial and possibly technical support.
2. Embark on projects that would transform their wastes into useful products, this is possible for private corporations dealing with agro-based industry where large quantity of agro-industrial wastes are produced

3. Undertake some research for the development of sound technology in recovery and recycling program.
4. Participate in government programs by providing loans at low interest rate to community or individual who need capital for construction of equipment and facilities needed in recovery and recycling.
5. Assist in the promotion of the programs.

Non-government organization

Its role is to:

1. Assist government agencies and municipalities in waste recycling and recovery programs by extending financial and technical assistance.
2. Finance projects that may have low profitability but would insure the abatement of pollution and degradation of environment.
3. Assist in the promotion of pioneer or innovative technology in waste recovery and recycling.
4. Assist the government in the manpower development and training as well as the technology transfer.
5. Undertake research for the improvement of recycling technology.

Legislation in developed countries

It is well known that developed countries, such as the U.S.A., Japan, and Germany have paid much attention to environmental quality control for decades. Environmental legislations in these countries are very stringent and have been progressively developed for several years. Application of waste recycling technology in pollution control has been widely practiced in these countries. For example, Japan has achieved a waste-recycling rate of 55.4% (Environment Agency 1993) and the U.S.A. was expected to achieve a waste-recycling rate of

50% in the year 2000

Legislation in developing countries

One of the most difficult problems facing governments of developing countries is how to set up appropriate legislation on environmental quality control. Examples of such legislation include water quality standards, treated effluent standards for industrial and domestic wastes, ambient air quality standards, waste reuse and recycling regulation. Because setting of this legislation influences the cost of development projects (both capital and operation and maintenance costs), development of appropriate legislation requires knowledge of the receiving environment, available technology, and affordability.

UNEP (1991) reported that deaths due to infectious and parasitic diseases are six times more frequent in developing countries than in developed countries. One possible cause of the diseases is the severe degradation of water quality, which is due to less stringent water quality standards and ineffective implementation. Experiences in implementing the water quality standards in Japan reveal that actual effectiveness of a water pollution control system depends not on values of the regulated parameters, but on the supporting measure to implement the system itself.

In general, developed countries have rich experiences in waste recycling legislation, the most cited example being the Resource Conservation and Recovery Act (RCRA) of the U.S.A. On the contrary, most of the developing countries do not have any laws concerning waste recycling. Recently, however, waste recycling has been included in the national policies of some developing countries, either in the promotion stage and or in the drafting of the legislation. Therefore, investigation and evaluation of legislative instruments used in the developed countries should be made prior to formulating the legislation.

MONITORING AND CONTROL OF FACILITY PERFORMANCE

One of the essential aspects of waste recycling program is monitoring of facility performance. This is required for the analysis and evaluation of the chosen technology in achieving its objective. One of the many reasons why some of the objectives of a planned program are not attained are due to failures of the concerned persons or agencies to monitor the project implementation and evaluate operational problems which are generally dealt only at the critical stage. To avoid such failures and prevent the problems from becoming a crisis it is obligatory for all projects to formulate a monitoring program. A monitoring set-up for facility performance depends on:

1. Objectives defined for monitoring;
2. Data evaluation, analysis and documentation;
3. Equipment monitoring efficiency; and
4. Organizational infrastructure

Objectives defined for monitoring

In view of the present socio-economic situations of most societies, the pragmatic objectives of such monitoring system can be stated as:

1. Efficient control and regulation of the present system;
2. Emission analysis and evaluation;
3. Catering for the future needs; and
4. Analysis of public response for system interaction.

Effective control and regulation of the system

Monitoring is a present day scientific tool for efficient management of a system. As in most systems, efficiency is evaluated on an economical scale, and making sure that the system is working on the positive side. Based on the technology selected, the monitoring process is regulated depending on the inflow of the suitable wastes and demand of the recycled product. Examples for this are the slow-rate (irrigation) system where certain crops are grown from wastewater application

Emission analysis and evaluation

The purpose of monitoring in this context is to check the addition of pollutants to the environment from waste recycling programs. Practically it can be better explained by the analysis and evaluation of the recycled products such as pathogen contents in the wastewater-irrigated crops or fish raised in waste-fed ponds and nutrient balances in the composted products or digester slurry.

Catering for future needs

The present-day technologies are changing rapidly with time. Any system has to be flexible to cope up with future changes, and this applies to the case of waste recycling and recovery. One of the solutions therefore is to foresee the changing trend and restructure the waste recycling system to take care of future demands. The increased reuse of organic wastes may be cited as an example. In the past, animal manure was applied direct on a agricultural land, but currently it is being fed to anaerobic digesters to produce biogas and the digested slurry applied to crop lands in an engineered manner.

Analysis of public response for system interaction

A system can exist and grow only when it is patronized by the people for whom it has been established. In the context of developing countries, the waste recycling system adopted should coincide with the social attitudes and must be compatible to the people. A typical example is the gradually diminishing public defiance in Asian countries for consuming crops fertilized with composted materials or wastewaters.

An efficient monitoring system must then have its feed back from end users and should consider it with due concern.

Equipment monitoring

A major part of waste recycling technology is the various items of equipment used in the program. These can vary widely in nature according to use. Monitoring of these assets is equally important since they can influence the system efficiency to a great extent. For example, a leak in the gas holder tank of a digester can reduce its efficiency significantly.

Organizational infrastructure

The organization for monitoring depends largely on the extent and intensity of the program. In most cases the program is not for a central based system, but for large-scale people participation. For a centrally based recovery and recycling program, reasonably well-qualified technicians (but less in number) are required. Where the program is more public intensive and emphasis is placed on making it a social habit, a large number of people who may not necessarily be with higher qualification but with more dedication and commitment are required. In such cases large-scale training and apprenticeship are more beneficial.

The financial aspects of these establishments depend on their size and manpower involvement. In all cases the central organization should be adequately furnished with basic requirements such as laboratory and training units so that feedbacks from the field and the present knowledge can be better blended to support the implementation of the waste recycling programs.

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