III. Municipal Solid Waste Management Master Plan

Ⅲ MUNICIPAL SOLID WASTE MANAGEMENT MASTER PLAN

In Chapter Ⅱ, the importance of SWM planning at national level was emphasized. SWM planning is also required at operative service level (local governments) for the efficient, effective and equitable service delivery. Plans at this operative service level are called as municipal SWM master plans in this book. This Chapter is written to show WHY a master plan is necessary, WHAT a master plan is, and HOW TO formulate and implement a master plan.

3.1 NECESSITY OF A MUNICIPAL SWM MASTER PLAN

The first question we have is WHY a municipal SWM master plan is necessary. If the managers of municipal SWM services do not have a clear recognition of this necessity, they will never find out a time to prepare for the future because they are always very busy being inundated by day to day businesses.

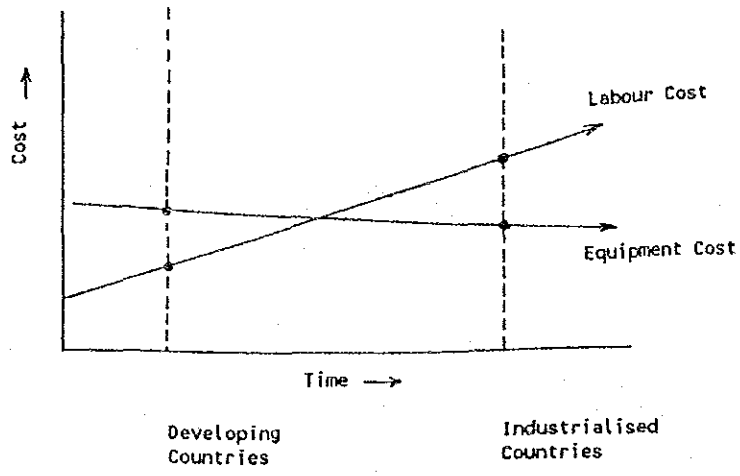
In many developing countries, municipal SWM is already putting a heavy financial burden on local governments. For example, in Malaysia, a large portion of municipal expenditure is spent for SWM services as shown in TABLE 2-1. Approximately 30 per cent and 50 per cent of the total expenditure is spent for SWM services in the case of large-medium size and small size local governments respectively. As such, it is quite difficult to get more municipal financial resources allocated for SWM services.

On the other hand the demand for SWM services is increasing in a drastic manner including the demand for better service. First of all, the level-up of the living standard will GENERATE more waste; MAKE the waste composition more complex; DEMAND more convenience and comfort; and MAKE the citizens more service quality conscious. At the same time, underserved urban population is increasing with accelerated speed bacause of the rapid urbanization experienced in many developing countries. Many of the underserved urban population are illegal squatters and they do not pay taxes. However, they also need public services such as refuse collection. A group of experts who met at the International Expert Group Seminar on Policy Responses Towards Improving Solid Waste Management in Asian Metropolises 16-21 October 1989 Kitakyushu, Japan declared that "SWM is an essential service and should be extended to low income, marginal settlements regardless of affordability and legal status of land tenure". This means that an unprecedented increase of SWM service demand will take place in the cities of developing countries.

Therefore the task to be achieved in municipal SWM services in developing

countires is to do more with less. The recognition we have to have is that in a society with drastic changes this task can not be achieved properly if the traditional style SWM, which is characterized by intuitive and ad-hoc base management, continues to be practised. As mentioned above, the environment of service demand is changing rapidly. At the same time the environment of service supply is also changing drastically. For example, socio-economic development in a country is causing the increase of labour cost while the equipment cost stays relatively unchanged or decreases in some cases because of the development of local automotive industries as shown in Figure 3-1. Under these circumstances, a labour intensive system which is appropriate today may not be appropriate tomorrow and gradual mechanization is required along with the change of the society.

Figure 3-1 Time-Cost Relationship of Service Supply



To do more with less is, in other words, for local governments to increase the efficiency of municipal SWM service, decrease its cost and create a financial margin to upgrade the service quality and extend the service coverage towards underserved population. In a society with rapid changes as mentioned above, only a systematic approach consisting of planning, implementation, monitoring (evaluation) and plan readjustment can achieve these objectives continuously. Its component processes are also required to be carried out in a systematic manner. For example, the planning process should include, among others, the study of (a) all the relevant factors, (b) their possible changes in the future, and (c) various alternative approaches to overcome such changes. It is also a must to clarify in the planning process all the necessary coordinations both intra and inter agencies.

To develop SWM activites in a rapidly changing society with the least possible waste of management resources, it is also indispensable for local governments to set goals and targets of their SWM services so that local governments would have a clear perspective of the future and that their

performance could be evaluated quantitatively and qualitatively day by day, month by month, and year by year.

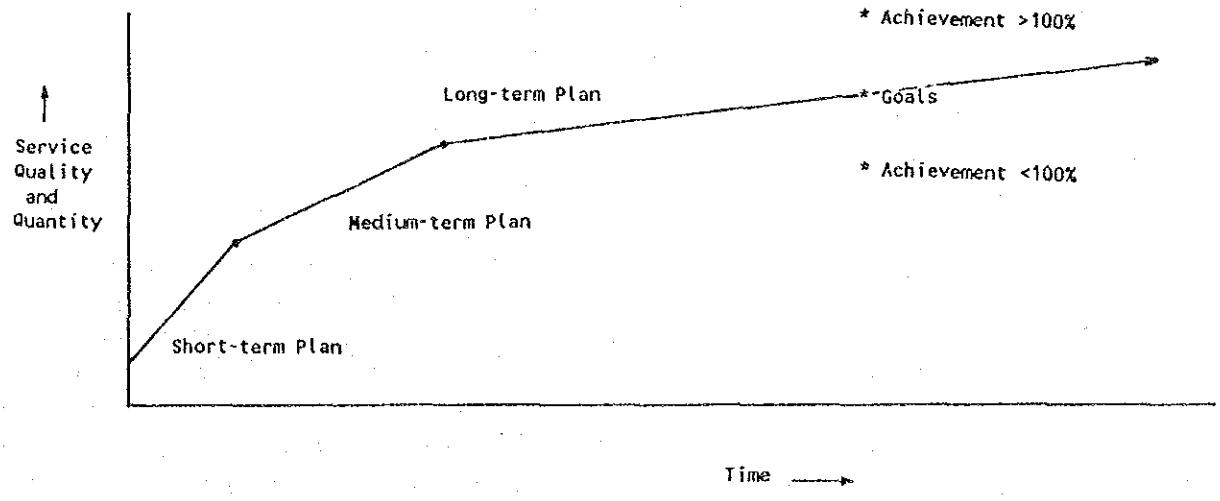
All the above-mentioned indicates the necessity of master plan formulation and implementaion.

3.2 CONTENTS OF A MUNICIPAL SWM MASTER PLAN

The second question we have is WHAT a master plan is.

First of all, a master plan will (a) study present situation of municipal SWM (diagnosis), (b) identify problems and constraints, and (c) project future conditions. Secondly, a master plan will (d) establish, based on these study results, resonable goals and targets of the municipal SWM services (determination of service level and service coverage along the time scale). Thirdly, a master plan will (e) study various alternatives which could overcome the identified problems and constraints, and achieve the established goals and targets. Then a master plan will (f) select the most appropriate alternative from these alternatives. In other words, a master plan will present a technically and socio-economically appropriate and feasible course of modification/adjustment of SWM sytem which could achieve the established goals and targets while continuously balancing the service supply with the changing service demand. This image is shown in the Figure 3-2.

Figure 3-2 Course of Modification/Adjustment



It is very important to understand here that like all other organizations the departments responsible for SWM have to have five component organizational functions shown in TABLE 3-1 which should be carried out continuously by corresponding organizational systems. Although the service (namely "operation") is delivered through the Operating System, the operation function will deteriorate irreparably if the other four functions are neglected. Therefore, in the analysis of the present situation as well as the elaboration of the master plan, all the five functions and the corresponding five systems should be studied and addressed. The principle to be used in the formulation and implementation of a master plan is to strengthen the weak systems while leaving the working systems as they are.

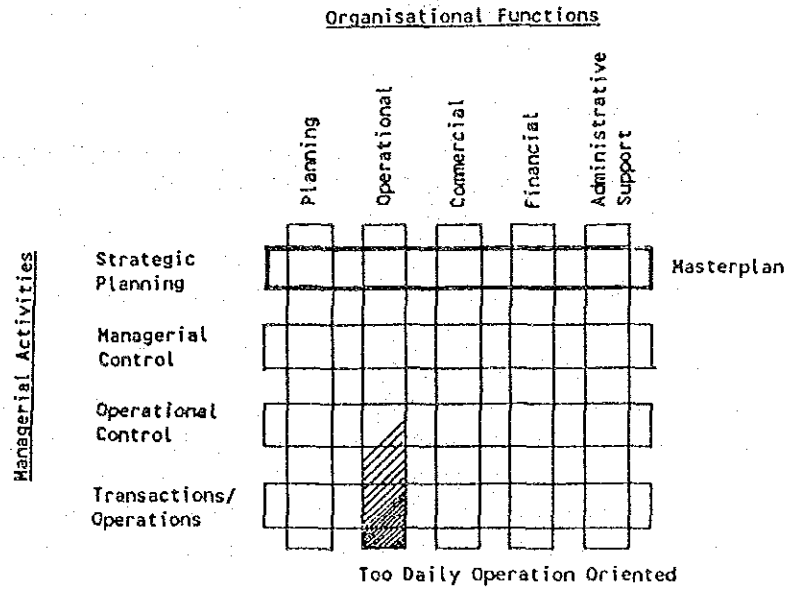
TABLE 3-1 Organizational Functions and Organizational Systems

Organizational Functions	Organizational Systems
(1) Planning.....	Planning System
	- Subsystem of General Planning
	- Subsystem of Programming
	- Subsystem of Control
(2) Operation.....	Operating System
	- Subsystem of Projects and Works
	- Subsystem of Street Sweeping, Collection and Final Disposal Operation
	- Subsystem of Equipment and Facility Maintenance
(3) Marketing.....	Marketing System
	- Subsystem of Marketing
	- Subsystem of User List
	- Subsystem of Measurement
	- Subsystem of Billing and Colletion
(4) Financing.....	Financial System
	- Subsystem of Accounting
	- Subsystem of Financial Resources Administration
(5) Administrative Support.....	Administrative Support System
	- Subsystem of Human Resources Management and Development
	- Subsystem of Supplies Management
	- Subsystem of Assets Management
	- Subsystem of Social Communications

Five organizational functions mentioned above are to be carried out through corresponding organizational systems guided by a series of decision makings. As shown in Figure 3-3, these decision makings, which can be called as managerial activities, are classified into (1) strategic planning, (2) tactic planning and managerial control, (3) operational planning and control,

and (4) transactions/operations, from the top management level to the bottom operators level. In these managerial activities, the master plan corresponds to the strategic planning. This means that master plans can work only when they are supported and complemented by lower level managerial activities and that lower level managerial activities can be carried out properly only when they are guided by master plans. It is also very important to understand that these decision makings can be done properly only when necessary informations are supplied to the decision-makers timely. Therefore, a Municipal SWM Information System (MSWMIS) as shown in Figure 3-4 should be established in each municipal SWM service although its level of sophistication can vary from manual data processing to computerized processing depending on the affordability of each service.

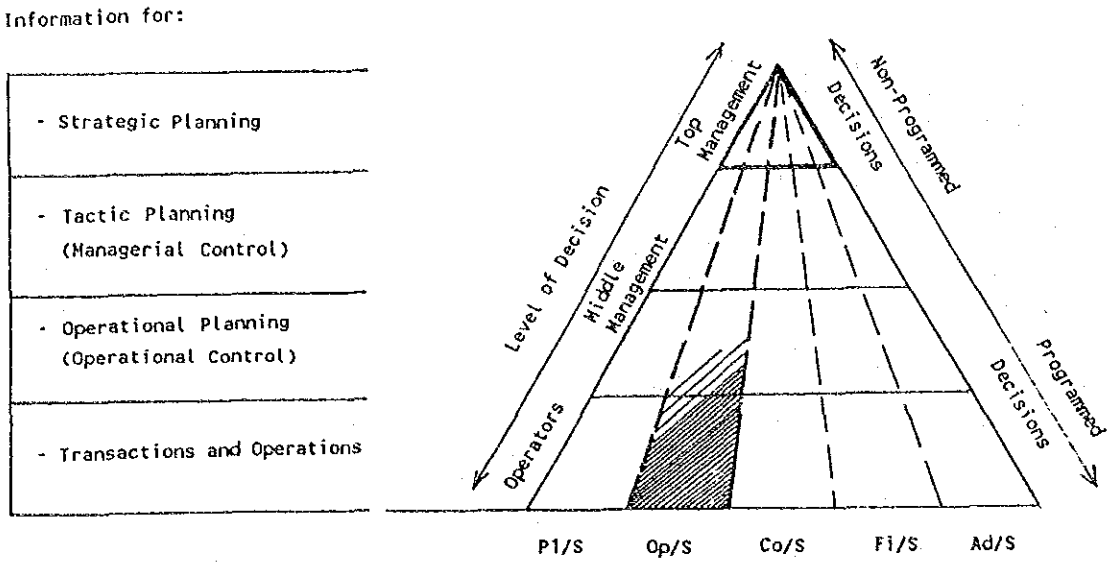
Figure 3-3 Matrix of Organizational Functions and Managerial Activities



Source: Acurio, G. & Gónima, A. 1982. Aspectos Institucionales de los Servicios de Aseo Urbano, p.9. CEPIS/PAHO/WHO.

A municipal SWM master plan can be elaborated through the above-mentioned six steps (a) ~ (f), namely, (a) to study present situation; (b) to identify problems and constraints; (c) to project future conditions; (e) to establish reasonable goals and targets; (e) to study various alternatives to overcome problems and constraints and achieve goals and targets; and (f) to select the most appropriate alternative. The elaboration process and its product (master plan itself) should be concisely recorded in the master plan document so that the intention of planners be understood correctly by all the parties concerned. A typical table of contents of master plan documents is shown in TABLE 3-2.

Figure 3-4 Municipal Solid Waste Management Information System (MSWMIS)



Source: Acurio, G. & Gónima, A. 1982. Aspectos Institucionales de los Servicios de Aseo Urbano, p.9. CEPIS/PAHO/WHO.

TABLE 3-2 Contents of a Municipal SWM Master Plan

1. General condition of the planning area
2. Present condition of SWM
3. Identification of present problems and cnstraints, and recommendations for immediate improvement
4. Projection of future conditions
5. Planning framework
6. Generation of alternatives
7. Selection of the most appropriate alternative
8. Master plan
8.1 Collection and haulage
8.2 Cleansing services
8.3 Processing and final disposal
8.4 Equipment and facilities
8.5 Organization and institution
8.6 Privatization
8.7 Stage plan
8.8 Financial plan
8.9 Administrative support services
8.9.1 Personnel trainning
8.9.2 Resident cooperation promotion
8.9.3 Equipment maintenance
9. Recommendations for implementation

3.3 BASIC REQUIREMENTS FOR SUCCESSFUL PLAN FORMULATION AND IMPLEMENTATION

As in the case of national SWM action plans, municipal SWM master plans become useful only when they are implemented successfully. And the followings are the basic requirements for the successful formulation and implementation of municipal SWM master plans:

(1) Existence and effective functioning of a planning unit which works as the planning system mentioned in TABLE 3-1 are crucial for a master plan to be formulated and implemented successfully. However, many SWM services do not have this unit and even in the case of services with this unit its function is usually very weak. Therefore it is a must to create or strengthen this unit. The formulation of a municipal SWM master plan may require an involvement of consulting companies. In such cases, the terms of reference on the jobs to be done by consultants should be prepared by the unit;

(2) Municipal SWM master plans should be formulated in conformity with the national SWM policies and national SWM action plans, if such a national framework does exist, so that a systematic support from the central government could be obtained.

(3) Scope of municipal SWM master plans (target wastes, target area and target year) should be clearly defined. Because in many SWM services it is an imminent necessity to achieve tangible improvement effects within a short or medium time period, it is recommended to set the target year not too far from the starting year. Preferable plan period is from 5 to 10 years although it can be extended gradually after accumulating the experiences of plan formulation and implementation. Within the time frame of master plans, the activites to be carried out in each year by each component organizational system should be duly planned;

(4) Any proposals in master plans should have application feasibility in the socio-economic context of the local governments in question. Therefore in the case of new proposals it is recommended to test their applicability through pilot projects before massive application. Because the implementation of pilot projects require substantial amount of resources, it is better to stagger their implementation in order to avoid the jam of managerial functions. In other words, the improvement should be carried out in a stepwise manner taking into account the technical and financial capabilities of the municipal SWM services in question;

(5) Any proposals in master plans should be selected through a comparative study of various alternatives. In the alternatives, it is recommended to include the systems used with good performance in other local governments with similar conditions;

(6) The structure of master plans as well as their implementation strategies

should be as simple as possible in order to promote the fast attainment of objectives; and

(7) Master plans should establish a periodic evaluation system to check the performance of municipal SWM services. The evaluation result should be fed back to planners to facilitate the timely adjustment of master plans. It is recommended for the central government agency responsible for the municipal SWM sector to develop a standardized system of Municipal SWM Macro-Indicators (MSWMMI) so that local governments could carry out this evaluation in a systematic and comparable manner. Annex 4 shows an example of MSWMMI.

3.4 GUIDELINES FOR THE FORMULATION AND IMPLEMENTATION OF A MUNICIPAL SWM MASTER PLAN

The third question we have is HOW a master plan can be formulated and implemented. The general steps of master plan formulation and implementation are shown in TABLE 3-3, and the answer to this question is to carry out properly the steps shown in this TABLE one by one.

3.4.1 Preparatory Works

The first step for the formulation and implementation of a master plan is to carry out all the necessary preparatory works. This step is very important for the master plan planners to conduct effectively the works in the subsequent steps from No.2 to No.7. The followings are to be included in these preparatory works:

(a) Preparation of the terms of reference for the job of master plan formulation;
(b) Organization of a working group (WG) for master plan formulation and implementation;
(c) Organization of a supervisory committee (SC) which consists of related authorities for decision making;
(d) Acquisition of necessary resources for master plan formulation;
(e) Contracting of consultants for the job of master plan formulation, if necessary; and
(f) Preparation of a work plan.

As mentioned in 3.3 (1), the planning unit of the SWM service has to work as the promoter agency of the master plan and take all the necessary initiatives in its formualtion and implementation. The first initiative to be taken is to prepare the terms of reference (TOR) for the job of master plan formulation while the second being to organize both a workig group (WG) and a supervisory committee (SC). Jobs of the WG and the SC should be specified based on the TOR.

TABLE 3-3 Seven Steps of Master Plan Formulation and Implementation

No.	Steps	Works To Be Done
1	Preparatory Works	• Organization of the Working Group • Preparation of the Work Plan • Preparation of the terms of reference for the consultants
2	Diagnosis Study	• Systematic identification of problems in the five organizational systems
3	Master Plan Study	• Projection of future conditions • Determination of planning framework • Preparation of possible alternatives to overcome the identified problems • Selection of the most appropriate alternative • Preparation of organizational, institutional and financial plans • Preparation of the Stage Plan and the Selection of the First Priority (First Stage) Project
4	Feasibility Study	• In-depth study of the First Priority Project (Technical/financial/social/environmental)
5	Detail Design	• Detail design of the facilities included in the First Priority Project
6	Implementation/ Operation	• Allocation of financial resources, construction of facilities and procurement of equipment
7	Evaluation/ Monitoring	• Systematic evaluation of master plan performance followed by master plan readjustment

As the preparation of TOR requires experiences, it is recommended that the ministry responsible at the national government level for the municipal SWM provides the local governments with model TOR for master plan formulation. The TOR should include the following contents:

(a) Title of the work (master plan formulation);
(b) Planning area;
(c) Background information;
(d) Objectives of the work;
(e) Scope of the work;
(f) Work schedule;
(g) Reports to be prepared;
(h) Work organizations; and
(i) Related data, materials and information.

Although master plans can improve the cost-effectiveness of SWM services, local governments may think that allocation of funds for master plan formulation is very difficult. As such, it is recommended for the same ministry to promote the master plan formulation and implementation through the establishment of a special financial support programme. A grant programme is preferable as the financial support programme to promote the master plan

formulation. If that programme is not feasible, then revolving fund programme should be considered.

The WG should consist of the members of the planning unit and the staffs of other units in the same SWM service while the SC should consist of the decision makers of all the related departments of the Local Government such as Health Department, Engineering Department, Financial Department and Administrative Department. Although it may be cumbersome, it is indispensable for the WG to get the supervision of the SC so that all the related departments would support the implementation of the master plan once the plan is ready. Organization of the SC implicitly implies that all the participating departments are committed to the formulation and implementation of the master plan.

If the planning unit considers that the formulation of a master plan requires an involvement of consulting companies, universities and some external experts, then the unit has to prepare the terms of reference for the works to be done by them. It is also necessary for the unit to acquire the financial resources for the contracting of consulting companies and the procurement of other services.

A work plan has to be prepared by the WG and/or the consultants based on the TOR. The master plan will be formulated according to that work plan. The work plan should include the following contents:

(a) Detail of the works to be done;
(b) Work schedule;
(c) Work assignment;
(d) Arrangement to be taken by the SWM service; and
(e) Work organization.

3.4.2 Diagnosis Study

The first work to be done by the WG is the diagnosis study. The diagnosis study is the study of present conditions including the systematic identification of problems in the five organizational systems. Present conditions are broken down into the general conditions of the planning area and the present situation of SWM.

3.4.2.1 General conditions of the planning area

Data collection and analysis should be made with regards to:

(a) Natural conditions

- Location and area of the Local Government
- Topographical feature (topographical map and aerial photograph)
- Meteorological feature (climate, temperature, wind rose and rainfall)

(b) Area conditions

- Land use
- Road condition
- Housing
- Public service and utility (water supply, sewerage and electricity)

(c) Present and future social and economic conditions

- Population
- Business activity
- Regional economic growth
- Revenue of the Local Government

(d) Urban development planning

- Future land use
- Housing development
- Road construction

(e) Relevant projects

- Toxic and hazardous waste management project

(f) Status of public health and public awareness

The WG should contact relevant agencies both inside and outside the Local Government to collect the data on the above-mentioned items.

3.4.2.2 Present situation of SWM

A study and analysis should be made by the WG on the current SWM system covering the five organizational systems shown in TABLE 3-1.

As for the Operating System, the study should include such aspects as waste discharge, storage, collection, haulage, processing and final disposal practices as well as cleansing services (street sweeping, drain cleansing, grass cutting, beach cleansing, etc.) and equipmemt maintenance services.

Even in a small city there are many types of areas with different features. Usually different operating systems have been developed for them based on the local conditions of the areas in question. As such the analysis of the Operating System should be carried out for each type of area. The following is an example of the area classification system:

- Ordinary residential area (high income area);
- Ordinary residential area (middle income area);

- Ordinary residential area (low income area);
- Marginal settlements;
- Commercial area;
- Rural town and village; and
- Large waste amount discharger (market, hotel, shopping complex, flats, etc.).

It is very important to study and understand at this stage the historical and socio-economic background of the present system. There should be some reasons for any system to have been selected for the use. It may cause problems if one proposes the change of the present system without understanding the reasons why it has been selected.

This study and analysis should include, among others, the following items:

(a) Amount and composition of solid wastes;
(b) Methods of waste storage and discharge;
(c) Collection and haulage systems;
(d) Street sweeping, drain cleansing, grass cutting and beach cleansing systems;
(e) Processing and disposal systems including illegal dumping;
(f) Salvaging of reusable materials;
(g) Equipment and their maintenance system;
(h) Organization and institution framework;
(i) Financial situation and user charge system;
(j) Personnel administration;
(k) Legislation and enforcement;
(l) Privatization;
(m) Status of public health in relation to SWM;
(n) Other related studies carried out in the planning area;
(o) Existing standards, codes of practices and guidelines; and
(p) Groundwater quality around the existing landfills.

3.4.2.3 Present situation of SWM in sample areas

Time and human resources available for the master plan formulation are usually very limited. Therefore, it is almost impossible for the WG to carry out a detail study and analysis of the present situation of SWM in the whole area of the Local Government although in-depth knowledge of the present system is indispensable for the master plan formulation. As such, it is recommended that the WG carries out a detail study and analysis of the present SWM system in sample areas. The number and the size of sample areas should be decided based on the availability of study resources.

The items to be studied and analyzed in the sample areas are, among others, as follows:

(a) Refuse collection system (frequency, collection points and storage

containers);
(b) Cleansing service systems (frequency of and labourer assignment to street sweeping, drain cleansing, grass cutting and beach cleansing);
(c) Interview to residents about SWM services in their areas; and
(d) Location and the name of large amount dischargers in the area.

As for the the items (a) and (b), a time and motion study of a collection vehicle or a cleansing labourer will give detailed data on present system, especially on its efficiency. A detailed explanation on how to carry out a time and motion study is available in Chapter Ⅳ.

3.4.2.4 Solid waste amount and composition

The data of solid waste amount and composition are fundamental for the planning of the Operating System. The type, size and number of collection vehicles as well as processing and final disposal facilities can be properly determined only when the planners are provided with these data including the trends of waste amount and composition. Therefore, periodical study and analysis (at least once a year) should be done to know these trends.

It is better, however, to carry out the measurement of the solid waste amount continuously for each trip of collection vehicles using weighbridges installed at the entrance of final disposal sites (See Figure 2-4) because it will facilitate the productivity monitoring of public SWM services and the control of collection work done by the private companies. If such continuous measurements are done, the results can be used also for the planning purpose.

A simple procedure for the study and analysis of solid waste amount and composition is shown in the Chapter Ⅱ of the Management of Solid Wastes in Developing Countries by Frank Flintoff (WHO Regional Publications South-East Asia Series No.1). Waste composition analysis (physical analysis) is usually made on two different bases: wet base and dry base. The procedure introduced by Flintoff is wet base analysis. This analysis will give informations on density of wastes, proportions of salvageable constituents, proportion that could be incorporated in compost, and so on.

If a refuse dryer is available, determination of water content can be done after drying the sample for 5 to 7 days with the temperature of 90℃. Dry base physical analysis can also be carried out for the dried sample. If the dried sample is burnt in an electric furnace for 2 hours with the temperature of 800℃, then ash content and the ignition loss will be available. Thus the informations on three components (ignition loss, ash content and water content) of the waste will be available. It is also possible to estimate the lower calorific value of the waste based on the informations on waste composition (wet base) and water content according to the procedure shown below. These informations will be very useful for the preliminary assessment of the technical feasibility of incineration technology.

PROCEDURE FOR THE ESTIMATION OF LOWER CALORIFIC VALUE

(1) Estimation of higher calorific value (HCV)

Composition	Wet base (%)	Dry base (%)	HCV (kcal/kg)
a. Paper	a	a	$\frac{(a+b+c+d-W)\times 4,000}{100}$
b. Cloth	b	b	
c. Wood and leaves	c	c	
d. Food wastes	d	d	
e. Plastics and rubber	e	e	$\frac{e \times 9,000}{100}$
f. Metals	f	f	$\frac{(f+g+h) \times 0}{100}$
g. Glass	g	g	
h. Soil and other items	h	h	
i Water	-	W	
Total	100 %	100 %	40(a+b+c+d-W) + 90e

$$HCV(kcal/kg) = 40(a+b+c+d-W) + 90e$$

(2) Estimation of lower calorific value (LCV)

$$LCV(kcal/kg) = HCV - \frac{W \times 600}{100} = \underline{40(a+b+c+d) + 90e - 46W}$$

(3) Technical criteria for the incineration of solid wastes (This criteria has nothing to do with the financial feasibility. Financial feasibility should be studied separately.)

(a) For incineration without auxiliary fuel, LCV should be at least 1,000 kcal/kg.
(b) For incineration with energy recovery, LCV should be at least 1,500 kcal/kg.

If the introduction of an incineration or composting plant is to be examined seriously in the master plan, then chemical and element analyses will be required in addition to the physical analysis in order to assess their technical feasibility. The most important items to be analyzed at this stage are the calorific value, carbon (C) content and nitrogen (N) content.

In many developing countries, the waste amount and composition at disposal sites differ considerably from the ones at generation sources because of the insufficient collection service and the active resource recovery by informal sector. Therefore, the study should be done at both places.

The types of waste to be sampled at each generation source for the study of waste amount and composition are classified as follows:

(a) Domestic waste (high income, middle income, low income and marginal settlements);
(b) Commercial waste (market, office and shops);
(c) Factory waste accepted by the Local Government; and
(d) Other waste.

However, it is very difficult to carry out sampling of wastes at disposal sites according to this classification because wastes generated in small shops and factories are discharged and collected together with domestic waste. Therefore it is more practical in this case to classify the waste by collection type such as collection system for houses, collection system for small shops and small factories, special collection system for large amount dischargers, and direct haul to disposal site.

In the study of solid waste amount and composition, the analysis of seasonal and historical change should not be forgotten. In tropical countries, remarkable increase of waste amount and change of waste composition are observed in fruit season. For example, in some Malaysian local governments, an increase of waste amount by 30 per cent can be observed in durian* season. Durian skins are thorny as shown in Figure 3-5 and very troublesome for collection workers. In the countries with temperate climate such as China, Korea and Turkey, the consumption of coal briquette for heating purpose causes a remarkable increase of briquette ash in winter time as shown in TABLE 3-4. However, ash content is decreasing very rapidly in recent years because of the modernization of lifestyle, namely, the conversion of domestic energy source from coal briquette to city gas or cylindered propane gas.

* Durian is called as the King of fruits and it is produced in Malaysia, Indonesia and Thailand.

Figure 3-5 A Heap of Durian Skins Left for Collection (in Malaysia)

TABLE 3-4 Seasonal Change of Waste Composition in Seoul

(Unit : %)

Composition	Spring	Summer	Autumn	Winter	Average
Paper	16.10	22.81	14.33	8.06	14.35
Rubber, plastic	8.56	8.81	6.48	2.05	6.06
Fabric, leather	1.90	2.59	0.92	0.67	1.41
Garbage	26.16	45.03	23.34	16.84	25.93
Wood, etc.	2.71	1.75	2.64	1.45	2.12
Sub-total/Combustibles	55.43	80.99	47.71	29.07	49.87
Coal ash	37.21	10.29	45.02	68.84	44.23
Glass, metal, etc.	7.36	8.72	7.27	2.09	5.90
Sub-total/Non-combustibles	44.57	19.01	52.29	70.93	50.13

Source: Jung-Wk Kim, October 1989. Policy Responses Towards Improving Solid Waste Management in Seoul City. p.18. (Paper presented at the International Expert Group Seminar on Policy Responses Towards Improving Solid Waste Management in Asian Metropolises 16-21 October 1989, Kitakyushu, Japan).

Note: Seasonal change is observed not only in the waste composition but also in the waste amount. In Seoul, solid waste generation in December is 1.5 times larger than that in August.

3.4.2.5 Identification of problems and constraints

A clear understanding of the problems and constraints associated with the existing SWM system is of crucial importance to determine the main components of a master plan such as goals, targets and immediate improvement measures. Identification of problems should be carried out in such a manner that elabloration of remedial measures would become easier. In other words, the WG should try to answer not only to the question "What problems does the existing SWM system have ?" but also to the questions "What are causing such problems ?" and "What kind of remedial measures are available ?". The following points should be refered to in the course of the identification of problems and constraints:

(a) Service coverage in terms of population and area
(b) Service level of waste collection
  - Collection frequency
  - Collection point
  - Type of waste covered by municipal SWM service
(c) Service level of street sweeping, drain cleansing, grass cutting and beach cleansing
  - Service frequency
  - Length and classification of street, drain and beach covered by the municipal SWM service
(d) Solid waste amount
  - Total amount generated at sources
  - Collection amount
  - Disposal amount

(e) Efficiency of waste collection
  - Vehicle efficiency
  - Labourer efficiency
  - Cost efficiency
(f) Efficiency of street sweeping, drain cleansing, grass cutting and beach cleansing
  - Labourer efficiency
  - Cost efficiency
(g) Working conditions
  - Safety
  - Sanitation
  - Work load
(h) Sanitary and environmental conditions
  - Storage and discharge
  - Collection and haulage
  - Processing
  - Final disposal including illegal dumping
  - Scavenging
  - Marginal settlements
(i) Resource recovery
  - Source separation
  - Resource recovery at processing plants
  - Scavenging
  - Market for recovered resources
(j) Management of equipment
  - Shortage of equipment
  - Selection of equipment
  - Use of equipment
  - Maintenance of equipment
(k) Public attitude
  - Storage and discharge manner
  - Preparedness to pay fees
  - Complaints
  - Fine
(l) Attitude of decision makers
  - Awareness of decision makers on SWM
  - Priority given to SWM by decision makers
(m) Revenue and expenditure of SWM service
  - Budget allocation for SWM service
  - Collection fee
  - Tipping fee
  - Cost of waste collection, waste disposal, street sweeping, drain cleansing, grass cutting and beach cleansing
(n) Administrative support
  - Planning capability
  - Personnel administration
  - Public relations and health education
  - Privatization and its management
(o) Institution and organization

- Institutional setup of SWM service
- Coordination with other related parties (departments of the same Local Government, nearby local governments, ministries and agencies at national government level, private sectors, NGOs, etc.)
- Coordination with toxic and hazardous SWM system

(p) Legislation and enforcement
- Laws, regulations, standards and guidelines related to SWM
- Law enforcement

(q) Support from federal/central and state/provincial governments
- Technical support
- Financial support

3.4.2.6 Recommendations for immediate improvement

Upon the identification of problems, it becomes necessary then to indicate the problems which require urgent attention and may be quickly solved without spending much time and money, and prepare an immediate improvement plan. Achievement of tangible improvement effects in the near future is instrumental for the planners to win the support from decision makers for the master plan formulation and implementation.

An immediate improvement plan must satisfy, among others, the followings:

(a) It can be immediately implemented.
(b) It does not require substantial investment.
(c) It does not hinder the development of long-term plan.
(d) The improvement effects can be measured in a short period of time.
(e) The plan scale is moderate.

Once the immediate imrovement plan is ready, the WG should ask the SC (Supervisory Committee) to review and approve it including the resource allocation for its implementation.

3.4.3 Master Plan Study

Master plan study consists of the following component works. Contents of each work will be explained one by one:

- Projection of future conditions;
- Determination of planning framework;
- Preparation of alternatives for future systems;
- Site selection for major facilities;
- Preliminary environmental evaluation of alternatives;
- Selection of the most appropriate alternative;
- Stage plan and identification of the first priority projects;
- Equipment procurement and facility construction plan;
- Financial plan;
- Organization and institution; and

- Recommendations for the implementation of the master plan.

3.4.3.1 Projection of future conditions

(1) Population

Future population is the base of the municipal SWM master plan. It should be projected until the target year (the last year of the plan period) at least for each five (5) years covering the whole area to be included in the master plan.

However, demographic data in many developing countries have only limited reliability because of the existence of huge non-registered urban population. As such, it is not wise for the WG to spend a lot of time in the projection of future population. It is better for them to use the population projections made by other plans such as development plans and town plans, and review the master plan periodically incorporating the latest population projection into the revised plan.

Projection of daytime population may be necessary to estimate the amount of commercial and institutional wastes when the difference between nighttime population and that for the daytime is too large to be ignored. This happens frequently in the case of large cities.

Change of city boundaries should be taken into account in the projection of future population, if such a change is expected. Sprawl of urban settlements in nearby rural areas and the amalgamation of urbanized areas in metropolitan areas are making this change inevitable more often than not.

(2) Socio-economy

Both the future demand for SWM service and the corresponding service supply capacity depend very much on the size of future regional economy. It is a well known fact that the waste generation amount and the size of regional economy have a high correlation coefficient. Many local governments cover the SWM expenses by general revenue and its main source is local tax. The size of tax base is directly linked to the size of regional economy. As such, the size of future regional economy and other socio-economic conditions should be estimated including the following items:

(a) Projection of regional economic growth;
(b) Future financial scale of the Local Government;
(c) Housing development plan;
(d) Road construction plan; and
(e) Improvement programmes for marginal settlements.

(3) Waste amount

The future solid waste amount should be estimated with 5 years interval

up to the target year. The solid waste amount will increase according to the following reasons:

(a) Increase of population;
(b) Expansion of service coverage;
(c) Increase of per capita generation rate with the rise of living standards*; and
(d) Increase in economic activities.

* Increase of per capita generation rate should be estimated based on the past trend. If enough information is not available, then a 2 % per year increase can be used as an approximate figure on the condition that the revision of the master plan be made based on the past trend.

In the following example, a simple estimation method of the future solid waste amount is shown based on the hypothesis of a 2 % per year increase of per capita generation rate.

(EXAMPLE)

1990: Population	500,000
Service coverage	70%
Generation rate of domestic waste	600gr/capita/day
Commercial and institutional waste	50ton/day
Total amount = $500,000 \times 0.70 \times 600 \div 10^6 + 50 =$	260ton/day
1995: Population (4% per year increase)	608,000
$500,000 \times 1.04^5 = 608,000$	
Service coverage	80%
Generation rate of domestic waste	662gr/capita/day
$600 \times 1.02^5 = 662$	
Commercial and institutional waste	73ton/day
(8% per year increase)*	
$50 \times 1.08^5 = 73$	
Total amount = $608,000 \times 0.80 \times 662 \div 10^6 + 73 =$	395ton/day

* Annual increase rate of commercial and institutional waste is usually greater than that of domestic waste. In this example, annual increase rate of domestic waste is 6% (2% + 4%). Therefore, 8% per year increase is adopted for the commercial and institutional waste.

(4) Waste composition

With the rise of the living standard, the waste composition will change generally as follows:

- Paper.....Increase

- Plastic.....Increase
- Non-combustibles (metal and glass).....Increase
- Garbage and wood .....Decrease
- Ashes.....Decrease

The above-mentioned change of waste composition will cause the following change in the density, moisture, lower calorific value and recyclable constituents of the waste:

- Density.....Decrease
- Moisture.....Decrease
- Lower calorific value.....Increase
- Recyclable constituents.....Increase

These changes and the seasonal variation mentioned in 3.4.2.4 should be properly taken into account in the selection of technologies and the design of technical systems.

3.4.3.2 Determination of planning framework

(1) Plan period

Plan period should be compatible with the life span of major facilities included in the master plan. The share of investment cost in the total cost of municipal SWM is very low, ranging usually from 5 to 20 per cent. In addition, the major part of the investment is usually assigned for the purchase of refuse collection vehicles and their life is as short as 5 to 10 years. Therefore, the plan period can be as short as 5 to 10 years from the year the master plan is prepared.

A plan with 15 year period may be required when the introduction of an intermediate treatment plant or the construction of a large disposal site is included in the master plan.

A master plan with 10 year period may be broken down into the following stages in order to facilitate stepwise implementation:

- Immediate Plan Stage (0 year to 1 year)
- Short-term Plan Stage (1 year to 2-3 years)
- Medium-term Plan Stage (2-3 years to 5 years)
- Long-term Plan Stage (5 years to 10 years)

(2) Planning area

Usually a SWM master plan is requested to cover the whole area under the jurisdiction of the local government in question, including urban area, semi-urban area and rural area. In other words, the planning area is the whole area of the local government. However, SWM services are primarily required in urban area. As such, it is convenient to establish priority planning area

focusing on the urban area and the prospective urban area in order to formulate the master plan in a cost-effective manner. It is very important therefore to know the future development plans so that the demarcation of priority planning area be properly done.

It may be difficult in some cases to find out future final disposal sites within the jurisdiction of the local government. In such cases, inter-municipal approach should be considered with regard to final disposal. This approach means the expansion of planning area.

(3) Planning wastes

In the master plan, planning wastes and the priority planning wastes should be clearly defined. The planning wastes should be defined as widely as possible covering all the solid wastes generated in the local government regardless of their management responsibility. It is not advisable to restrict the scope of planning wastes only to the wastes managed by the Public Cleansing Department, because the SWM master plan has to clarify the management responsibility for all the solid wastes. It is also necessary for the WG to determine in the master plan the coordination to be made among the various responsible parties. The wastes to be managed by the Public Cleansing Department should be classified as the priority wastes and the master plan has to show in detail how to handle these wastes.

(4) Planning population, planning waste amount and planning waste composition

Based on 3.4.3.1, planning population, planning waste amount and planning waste composition should be established at least for each five years. Population to be served, waste amount to be collected and waste amount to be disposed of should also be established taking into account the service coverage targets to be set under (6) infra.

(5) Service level

Determination of reasonable service levels is a crucial decision in the work of master plan formulation, because the WG is requested to strike a good balance between the demand for better SWM service and the demand for other municipal services within the very limited financial capacity of the Local Government.

Reasonable service levels can be determined based on the establishment of priorities for SWM services. These priorities should be established both within the solid waste sector ("internal priority") and among all the local government service sectors ("external priority").

Firstly, the following issues should be addressed in establishing "internal priorities" and then setting standards for service:

(a) Which categories of wastes are included within the accepted

responsibility of the Local Government for collection and disposal?

(b) What level of control is desirable over waste categories that are not serviced by the public sector ?

(c) What portion of the waste generated in each category is the target for collection service ?

(d) What level of citizen participation and convenience is acceptable in the collection system ?

(e) What type of household storage bins are acceptable in the collection system ?

(f) What frequency* of collection is acceptable ?

* Three times per week collection satisfies the minimum health requirements even in tropical countries as long as the service delivery is reliable.

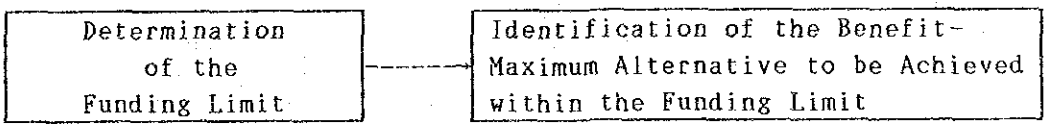
(g) Which informal sectors / recycling / resource recovery are to be preserved / enhanced / discouraged ?

(h) Which environmental issues should be addressed in planning adequate disposal systems ?

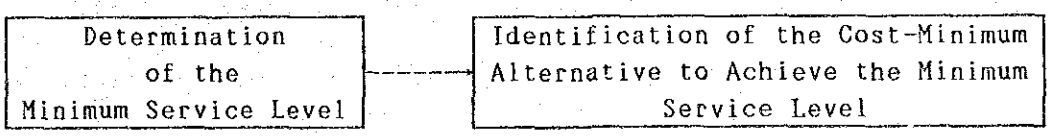
Secondly, "external priorities" for SWM service should be established among all the local government service sectors such as water supply, sewerage, drainage, housing, transport, health, education and fire fighting. Limited resources should be allocated to various sectors in such a manner that the well-being of the residents would be maximized.

However, the quantification of well-being to be achieved by each service is not so easy. Therefore, qualitative judgement concerning the local priorities should be addressed through a multi-disciplinary assessment by the various officials and departments involved.

Once "external priorities" are established, the funding limit can be determined based on such priorities, and the level of service becomes whatever one can achieve within that amount.



The service level thus determined may not satisfy the demand for SWM services quantitatively and qualitatively. Therefore, the approach starting from the determination of the minimum service level should be taken simultaneously. If the minimum level of service is determined based on the health requirements, service users' convenience, etc., then the portion of the budget available for SWM becomes whatever is the least cost amount to achieve that level.



In the determination of reasonable service levels, equity and local customs should be duly considered in addition to health requirements, cost and service users' convenience. As far as the equity is concerned, service levels for urban fringe areas and protocol areas should be carefully determined to achieve a good balance.

The WG should determine reasonable service levels by integrating the above-mentioned approaches and considerations.

(6) Goals and targets

Reasonable service levels thus deteremined should be expressed as the goals and targets of the master plan.

Goals of the master plan should be clearly established and presented to the parties concerned and the general public. Goals should be the ones that are acceptable for them from the socio-economic point of view. Goals are usually written in a descriptive manner.

Targets are the quantitative translation of goals. Targets to be achieved by respective target years should be established as quantitatively as possible. Master plan implementation should be monitored and evaluated quantitatively based on targets.

Targets must be established with respect to the following aspects:

(a) Planning System

- Preparation of projects
- Control and monitoring of the master plan implementation
- Readjustment of the master plan

(b) Operating System

- Service coverage of waste collection, street sweeping, drain cleansing, grass cutting, beach cleansing, etc.
- Waste amount to be collected and disposed of
- Storage and discharge method at generation sources
- Service level of waste collection
- Collection method and equipment to be provided
- Service level of street sweeping, drain cleansing, grass cutting, beach cleansing, etc.
- Materials and equipment to be provided for street seeping, drain cleansing, etc.
- Intermediate treatment facilities to be introduced
- Resource recovery
- Final disposal method (level of leachate management, etc.)
- Final disposal site(s) to be constructed
- Equipment maintenance

- Efficiency of waste collection and other cleansing works
- Efficiency of intermediate treatment
- Working conditions in terms of work load, safety and sanitation

(c) Marketing System

- Measurement of waste amount at disposal site

(d) Financial System

- Allocation of budget
- Development of user charge system for waste collection service and waste disposal

(e) Administrative Support System

- Allocation of personnel
- Training
- Public participation
- Preparation of by-laws and regulations for SWM
- Enforcement of by-laws and regulations for SWM
- Promotion of privatization
- Establishment of efficient organizational structure

(7) Division of Responsisbility

Besides the public cleansing department/division which is directly responsible for SWM, there are many agencies involved in SWM inside and outside the Local Government. Some of them are responsible for operations while the others are responsible for financing, procurement, recruitment, training, education, equipment maintenance, etc. Therefore, the roles of these agencies in dealing with different types of solid wastes and administrative support functions should be clearly determined. TABLE 3-5 and TABLE 3-6 shown below may be used to indicate the division of SWM responsibility.

(8) Contracting-out

Although the privatization of public services is a worldwide tendency, it is very important for each local government to study very carefully the advantages and disadvantages of privatization for their case. The factors to be included in this study are, among others, as follows:

- National privatization policy;
- Technical, financial and managerial capacity of existing public cleansing service; and
- Technical, financial and managerial capacity of private sector.

TABLE 3-5 Division of Operational Responsibility and Solid Waste Flow

Flow / Sources	Collection/ Cleansing	Trans- portation	Intermediate Treatment	Final Disposal
- Household				
- Business Establishment				
- Markets				
- Factories				
- Roads				
• National Roads				
• State Roads				
• Municipal Roads				
- Drains				
• Roadside Drains				
• Monsoon Drains				
- Public Facilities				
• Sports Stadiums				
• Beaches				
• Parks				
• Toilets				

TABLE 3-6 Division of Administrative Support Responsibility for SWM

Function	Responsible Agency	Related Agencies
- Financing		
- User charge billing and collection		
- Procurement of equipment and spare parts		
- Equipment maintenance		
- Personnel recruitment		
- Personnel training		
- Public relations		
- Legislation		
- Enforcement		
- Contracting-out		
-		
-		
-		
-		

Based on this study, the rates of contracting-out for collection, cleansing service, final disposal and equipment maintenance should be determined for each year of the planning period.

(9) Financial conditions

Budget size of the Local Government and the share of the budget for SWM should be stated for each year of the planning period.

If the budget of the Local Government and the budget for municipal SWM do not keep up with the growth of regional economy discussed in 3.4.3.1 (2), it will be very difficult to maintain the SWM service level against the service demand to be increased in proportion to GRDP (Gross Regional Domestic Products). As such, special attention should be paid for forecasting future budget size of the Local Government.

3.4.3.3 Preparation of alternatives for future systems

(1) Policy for the generation of alternatives

The environment of the SWM is changing very rapidly. Even in the case of well managed systems, they will become inappropriate systems in the future if they can not accomodate such changes. Each function and organizational system of SWM should be studied and evaluated in light of future possible changes in socio-economic conditions, environmental requirements, technical development and public awareness.

Expansion of service area and establishment of sanitary landfill system are the major goals to be achieved in many local governments. Therefore, the WG is requested to establish in the master plan the measures to achieve, at least, these two goals.

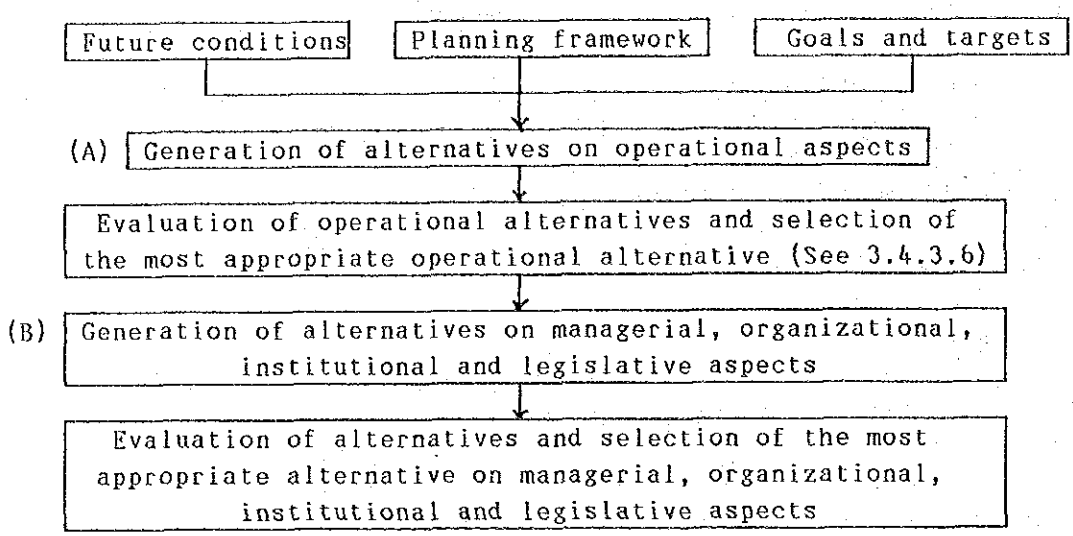
Alternatives that would achieve such goals under the changing conditions should be generated as the preparatory steps for the selection of the most appropriate alternative. As shown in Figure 3-6, generation of alternatives should be carried out in two steps, namely, (A) generation of alternatives on operational aspects, and (B) generation of alternatives on managerial, organizational, institutional and legislative aspects. The alternatives generated in the step (A) should be evaluated in terms of (a) technical desirability, (b) economic/financial viability, (c) transactional facilitation requirements, and (d) environmental acceptability. Based on the evaluation results, the most appropriate operational system should be selected and the step (B) should be done for the most appropriate operational system thus selected. Evaluation and selection procedures are shown in 3.4.3.6 infra.

(2) Operating subsystems of SWM

Operating system for SWM consists of the following subsystems:

- Storage and discharge;
- Collection and haulage;
- Street, drain and beach cleansing and grass cutting;
- Intermediate treatment and recycling; and
- Final disposal.

Figure 3-6 Steps for the Generation of Alternatives



Each subsystem has its own alternatives and the municipal SWM master plan is to be developed based on the most suitable combination of the operating subsystems. If ten alternatives are generated for each of the above-mentioned five operating subsystems, then the number of possible combinations will be as large as one hundred thousands (10^5 = 100,000). Obviously it is impossible to select the best combination from the evaluation of all the possible combinations. In addition, many combinations thus generated are irrelevant because they ignore the compatibility required between operating subsystems. Therefore, it is very important to generate only very reduced but relevant combinations. The following guidelines seem to be useful to achieve this task:

(a) GENERATE alternatives for each operating subsystem, SCREEN them from technical, economic/financial, social, and environmental point of view, and REDUCE the number of alternatives (if possible, SELECT the most appropriate one) for the operating subsystem in question.

Note: Selection does not mean the selection of one system to cover the whole area and the whole wastes of the Local Government. It means the selection of an appropriate system for each type of area and waste taking into account the area conditions and waste characteristics.

(b) CHECK the compatibility between selected alternatives. If there is any incompatibility, then MODIFY the alternatives or REPLACE the alternatives with compatible ones.

(c) PREPARE relevant combinations with reduced alternatives in such a manner that a comparative study on strategic decision making issues would become possible. The total number of combinations should not exceed ten. In the following, some of the possible combinations

are shown:

- Combination with/without processing;
- Combination with/without (a) transfer station(s); and
- Combination with/without inter-municipal cooperation in processing and/or final disposal.

In this case, the total number of combinations will be eight ($2^3 = 8$).

Relevant combinations thus prepared will be treated as operating system alternatives.

(3) Possible alternatives for operating subsystems

Each operating subsystem mentioned in (2) sufra has the following alternatives (This list is not exhaustive.):

(a) Storage and discharge
- Solid waste separation
  - Mixed discharge
  - Separated discharge (Source separation)
- Refuse bins
  - Plastic bins
  - Plastic bags
  - Oil drums / half drums
  - Concrete bins
  - Bamboo baskets
  - Communal containers (hauled or stationary)
  - Others
- Storage and discharge points
- Discharge frequency

(b) Collection and haulage
- Collection frequency
- Mixed or separate collection
- Collection points
  - Door-to-door backyard collection
  - Door-to-door curb-side collection
  - Station collection
  - Communal container collection
- Working time
  - Daytime collection
  - Night time collection
- Collection equipment
- Haulage method
  - Motor vehicles
  - Ocean-going vessels
  - Railway
  - Hydraulic system

- Pneumatic system
- Transfer stations
  - With/without transfer stations
  - Sites for transfer stations
  - Type and capacity of transfer stations

(c) Street, drain and beach cleansing and grass cutting
- Cleansing frequency
- Cleansing service area or length
- Cleansing method
  - Manual
  - Mechanical
- Cleansing equipment
- Working time

(d) Intermediate treatment and recycling
- Possible intermediate treatment method (Characteristics of each method are shown in TABLE 3-7)
  - Composting
  - RDF (Refuse Derived Fuel)
  - Pyrolysis gasification
  - Slagging pyrolysis
  - Incineration
  - Crushing and shredding
  - Mechanical or manual sorting
- Facility sites
- Recycling
  - Manual (Recycler or scavenger at dump sites)
  - Mechanized

(e) Final disposal
- Disposal sites
- Disposal methods
  - Open dumping
  - Controlled tipping
  - Sanitary landfill
- Landfill structure (See Figure 3-7)
  - Anaerobic landfill
  - Anaerobic sanitary landfill
  - Improved anaerobic sanitary landfill
  - Semi-aerobic sanitary landfill
  - Aerobic sanitary landfill
- Removal and recovery of landfill gas (methane gas)
  - With/without gas removal
  - With/without gas recovery

(4) Possible alternatives on managerial, organizational, institutional and legislative aspects

After the selection of the most appropriate operating system alternative, possible alternatives on managerial, organizational, institutional and legislative aspects should be generated for that operating system

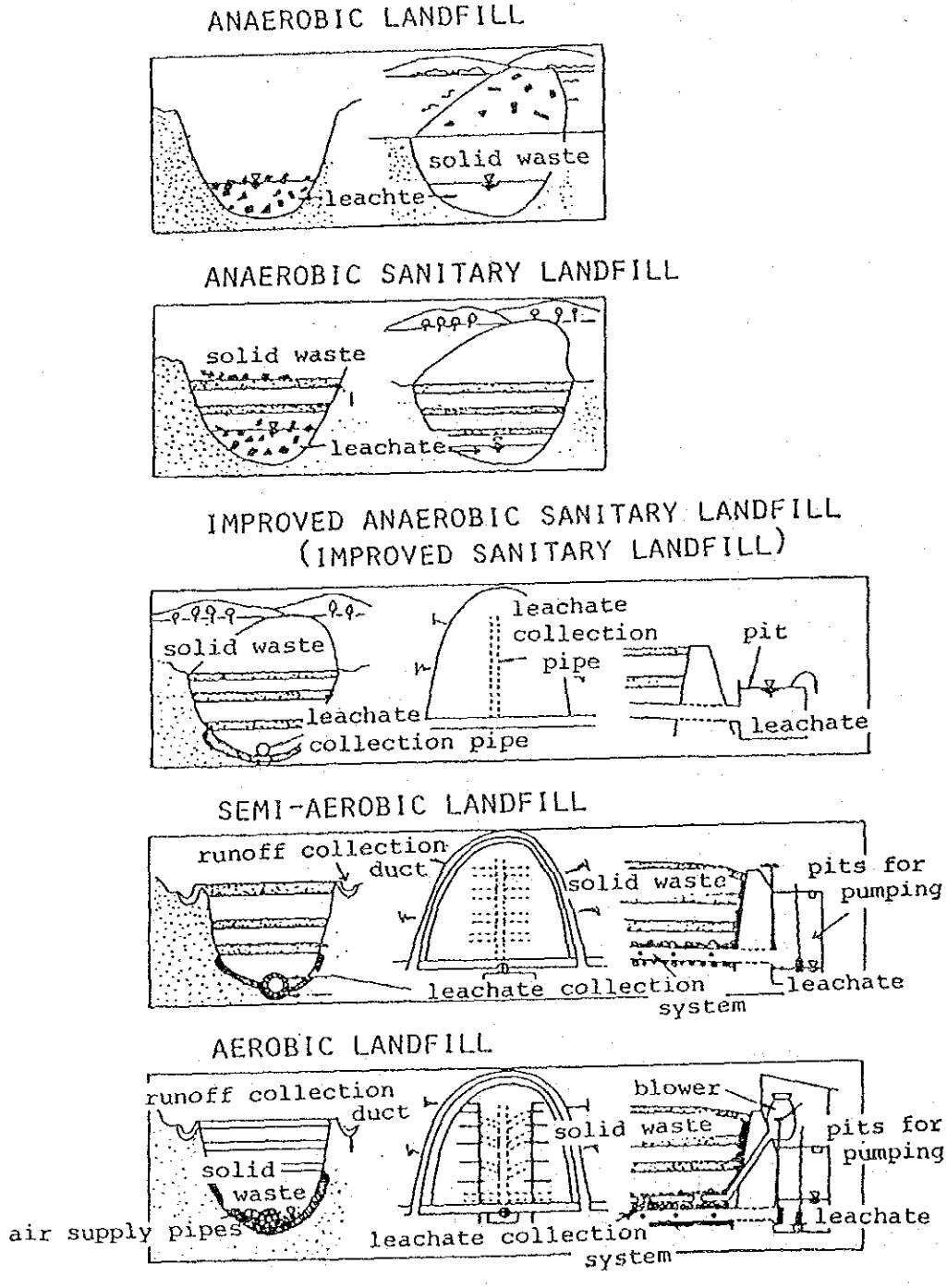
TABLE 3-7 Characteristics of Possible Intermediate Treatment Methods

Inter-mediate Treatment Facilities	Re-covered Material	Main Purpose of System	Contribution to Landfill			Special Cautions								Remarks
			Volume Reduction	Harmless	Stabiliza-tion	Reliabi-lity of Technology	Pre-Treatment	Back-end treatment	Rejected Substances	Acceptabi-lity of Refuse Quality	Initial & Operation Cost	Marketabi-lity of Recovered Material or energy	Environ-mental Impact	
① Composting	Compost	Conversion to Fertilizer	F	F	F	E	F	F	Glass, Stone, Plastic, Dry Cell	F	F	F	F (Odor)	·Stability of product market is crucial ·Pre-treatment and back-end treatment are necessary ·Limitation in waste quality
② R D F Plant	Solid Fuel	Conversion to Fuel	F	F	F	F	F	F	Incombust-ible	F	F	P	F (Noise & dust)	·Marketability of products ·Pre-treatment and back-end treatment are necessary ·Limitation in waste quality
③ Pyrolysis Gasifi-cation	Gas or Oil		G	G	G	F	F	F	Incombust-ible, Carbon	F	P	P	G	·Incomplete technology ·High initial/running cost ·Pre-treatment and back-end treatment are necessary ·Limitation in waste quality
④ Slagging Pyrolysis	Gas and Slag	Volume Reduction & Preven-tion of Water Pollution	E	E	G	F	F	G	—	G	P (Additional Fuel Expenses)	F	G	·Large consumption of supplementary fuel ·Difficulties in operation ·Pre-treatment when required only ·Back-end treatment is not necessary
⑤ Incine-ration	Heat (Residue) Ash (cover-soil) Ferrous (Reuse)	Volume Reduction & Energy Conversion	G	G	G	E	G	G	—	E	F	F (Electri-city and heat)	G	·High initial/running cost ·Possibility to get revenue ·Need to find users of heat if no buyer for electricity is found ·Pre-treatment and back-end treatment are not necessary
⑥ Crushing & Shredding	Ferrous etc.	Volume Reduction	F	F	G	G	F (Extra-ction of Explosive objects)	F	Discarded Material	F	F	F	F (Noise & dust)	·Large consumption of electricity ·High expenses for maintenance ·Possibilities of explosion ·Limitation in waste quality
⑦ Sorting (Mecanical or Manual)	Ferrous, Glass Paper, Plastic etc.	Recycling	F	F	F	E	F	F	Discarded Material	F	F	G	G	·Stability of market for sal-vaged material is important ·Pre-treatment when required only ·Back-end treatment is necessary ·Limitation in waste quality

Legend : E : Excellent
G : Good
F : Fair or ( ) to be considered
P : Poor and ( ) shows reason

Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

Figure 3-7 Landfill Structure



Source : Hanashima, M. October 1976. Japan-United States Governmental Conference on Solid Waste Management.

alternative, as shown in Figure 3-6, followed by the selection of the most appropriate alternative on these aspects. Some of the possible alternatives on these aspects are shown in the following:

(a) Division of responsibility
  - Division of operational responsibility (See TABLE 3-5)
  - Division of administrative support responsibility (See TABLE 3-6)
  - Establishment of new organization
(b) Multi-municipal approach
  - With/without multi-municipal approach
(c) Scope and content of privatization
  - Mode of privatization (contracting-out, franchise, etc.)
  - Services and areas to be privatized
  - Lump sum basis payment vs. payment based on collected waste amount
(d) Finance
  - Capital financing
    • Loan or grant
    • Leasing
    • Current revenue capital financing
  - Operating revenues
    • Tax financing
    • User charges
(e) Manpower management
  - Incentive systems (task system, fixed working hour system, etc.)
  - Training
(f) Public cooperation
  - Measures to obtain the public cooperation
  - Responsible bodies for the promotion of public cooperation
(g) Legislation and enforcement
  - Establishment or revision of laws and regulations
  - Enforcement measures

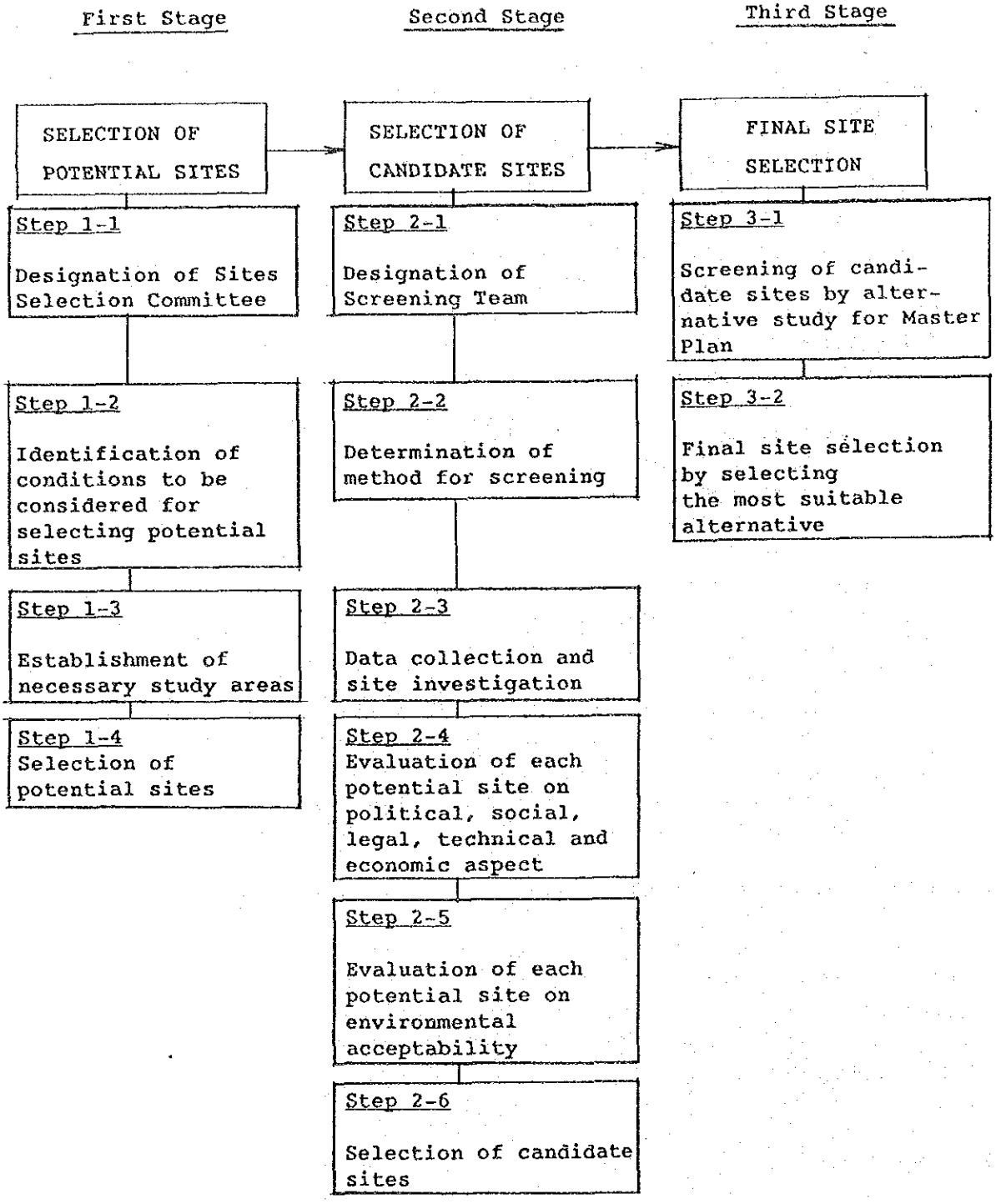
3.4.3.4 Site selection for major facilities

Generally, it takes a long time to acquire the lands for the construction of SWM facilities because of the difficulty in obtaining administrative clearance and public consensus. Therefore, actions for site selection should be initiated as early as possible. It may be convenient for the planning unit to form a special working group for site selection with membership broader than that of the WG involving all the related departments.

(1) Steps of site selection

It is not practical to evaluate all of the land in the planning area for site selection. Staged procedure is recommended by dividing the selection work into the following three steps:

Figure 3-8 Three Step Site Selection Procedure



Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

- Selection of potential sites;
- Selection of candidate sites; and
- Final selection.

Three step site selection procedure is illustrated in Figure 3-8.

(2) Selection of potential sites

From five to ten potential sites for each facility should be listed up by the special working group for further study. In this listing up, the following points should be borne in mind as the guiding principle:

- Size of the site should be larger than the minimum area requirement for the construction of the SWM facility.
- The site should have some possibility of land acquisition.
- The site should have some possibility of getting neighbouring consensus.
- The location of the SWM facility should have a good chance to have compatibility with regional development plan and land use plan.

(3) Selection of candidate sites

From two to three candidate sites should be selected for each facility from potential sites after their evaluation. The evaluation of potential sites should be done based on the compilation of existing data and informations. The checklist shown in TABLE 3-8 may be useful to carry out this evaluation.

TABLE 3-8 Checklist for the Evaluation of Potential Sites

(1) Possibility of land acquisition
(a) Land use restriction
(b) Land ownership
(c) Necessity of compensation
(d) Other considerations
(2) Possibility of getting neighbouring consensus
(a) Necessity of neighbouring consensus
(b) Necessity of "out of sight" measures
(c) Necessity for isolation from noise, dust and odour
(d) Other considerations
(3) Compatibility with regional development plans
(a) Competitive development plans
(b) Conformity with regional development plan and land use plan
(c) Direction of urbanization towards the site

(d) Other considerations

(4) Technical, economic and financial feasibility

(a) Distance from main waste generation area
(b) Area of the site
(c) Life expectancy
(d) Availability of cover material
(e) Accessibility
(f) Estimated land price
(g) Estimated cost of compensation
(h) Availability of public services
(i) Present conditions of the site (land use, type of surface soil, depth of ground water, etc.)
(j) Technical considerations
(k) Economic value of the site upon completion

(5) Environmental acceptability

(a) Possibility of drinking water pollution
(b) Impact by surface water pollution
(c) Impact of flooding
(d) Impact by groundwater pollution
(e) Distance from airport and other public facilities
(f) Distance from densely inhabited area
(g) Possibility of dust, noise and odour hazards
(h) Compatibility of land use of adjacent area
(i) Slope stability
(j) Impact on inshore or river fishery
(k) Impact on terrestrial vegetation and wildlife
(l) Impact on aquatic/marine fauna and flora
(m) Impact on natural landscape
(n) Impact on historic places or structures
(o) Impact on religious places or structures

(4) Final selection

Before the special working group for site selection proceeds to the work of final selection, it would be better for the group to brief the top management of the Local Government at the SC (Supervisory Committee) on the process and result of site selection work so far realized. The objective of this briefing is to get a green signal for the inception of the final selection work.

After receiving a green signal, the special working group should carry out a detailed study of selected candidate sites on financial feasibility and environmental acceptability. For this purpose, rough cost estimation (See 3.4.3.6 infra) and preliminary environmental evaluation (See 3.4.3.5 infra) will be required. After that study, selected candidate sites should be

treated as the site alternatives of the operating subsystem of final disposal. Therefore, the final site selection is to be done through the selection of the most appropriate combination of alternatives (See 3.4.3.6 infra).

An approval from the relevant agencies should be obtained through formal procedure after the selection of the suitable sites. It is also advisable to consult with the communites to be affected by the facilities from the early stage of site selection. In addition, the lands decided as construction sites of SWM facilities should be clearly stated in the urban/town planning documents and maps in order to avoid their use for other purposes.

3.4.3.5 Preliminary environmental evaluation of operating subsystem alternatives

Proposed alternatives for the operating system should be evaluated from various viewpoints for the selection of the most appropriate operating system alternative. One of the viewpoints is the environmental aspect. Although SWM systems are intended to contribute to the improvement of living environment, they may cause negative environmental impacts especially in the form of air pollution, water pollution, noise hazard, and ecological disruption. The followings are the typical negative impacts that may be caused by SWM:

- Air pollution
  - Air pollution from incinerators
  - Bad odour from composting plants
  - Air pollution by open burning
- Water pollution
  - Surface water and groundwater pollution by landfill leachate
- Noise hazard
  - Noise from collection vehicles (around transfer stations, intermediate treatment plants and final disposal sites)
- Environmental disruption
  - Disappearance of mangrove forests by the construction of landfills

In some developing countries, EIA (Environmental Impact Assessment) regulations require that the project initiators of SWM facilities carry out preliminary-EIA studies at the site selection stage. However, even in the countries without such regulations, it is recommended to evaluate the above mentioned negative impacts to avoid future problems.

Preliminary-EIA studies are considered to be sufficient for master plans because preliminary-EIA facilitates the reasonable screening of alternatives from environmental point of view with moderate resource input. However, the environmental agencies may require the project initiators to carry out detailed-EIA studies at the feasibility study stage.

EIA studies can be used for the selection of alternatives which are less problematic from environmental point of view. They, especially the detailed-EIA, will also show the mitigation measures to be taken in order to keep the

negative impacts within permissible limits. For example, it is very probable that leachate treatment facilities be required to satisfy the effluent standards. However, such mitigation measures will surpass more often than not the affordability of the Local Government. Therefore, it will be necessary in many cases to prepare staged improvement plans. To convince environmental agencies with the necessity of such stepwise approach, EIA should be done also for the without project scenario because it will show the improvement effects of the project.

3.4.3.6 Selection of the most appropriate SWM system alternative

(1) Selection procedure

Once operating system alternatives are prepared, the WG has to proceed to the selection of the most appropriate SWM system alternative. The selection procedure is shown in Figure 3-9. It consists of the following steps:

- Evaluation of each operating system alternative based on four evaluation criteria;
- Synthesis of individual evaluation results (overall evaluation);
- Selection of the most desirable operating system alternative;
- Development of possible alternatives on managerial aspects; and
- Selection of the most desirable alternative on managerial aspects.

(2) Evaluation criteria

In the evaluation of operating system alternatives, the following four criteria should be used:

- Technical desirability;
- Economic/financial viability;
- Transactional facilitation requirements; and
- Environmental acceptability.

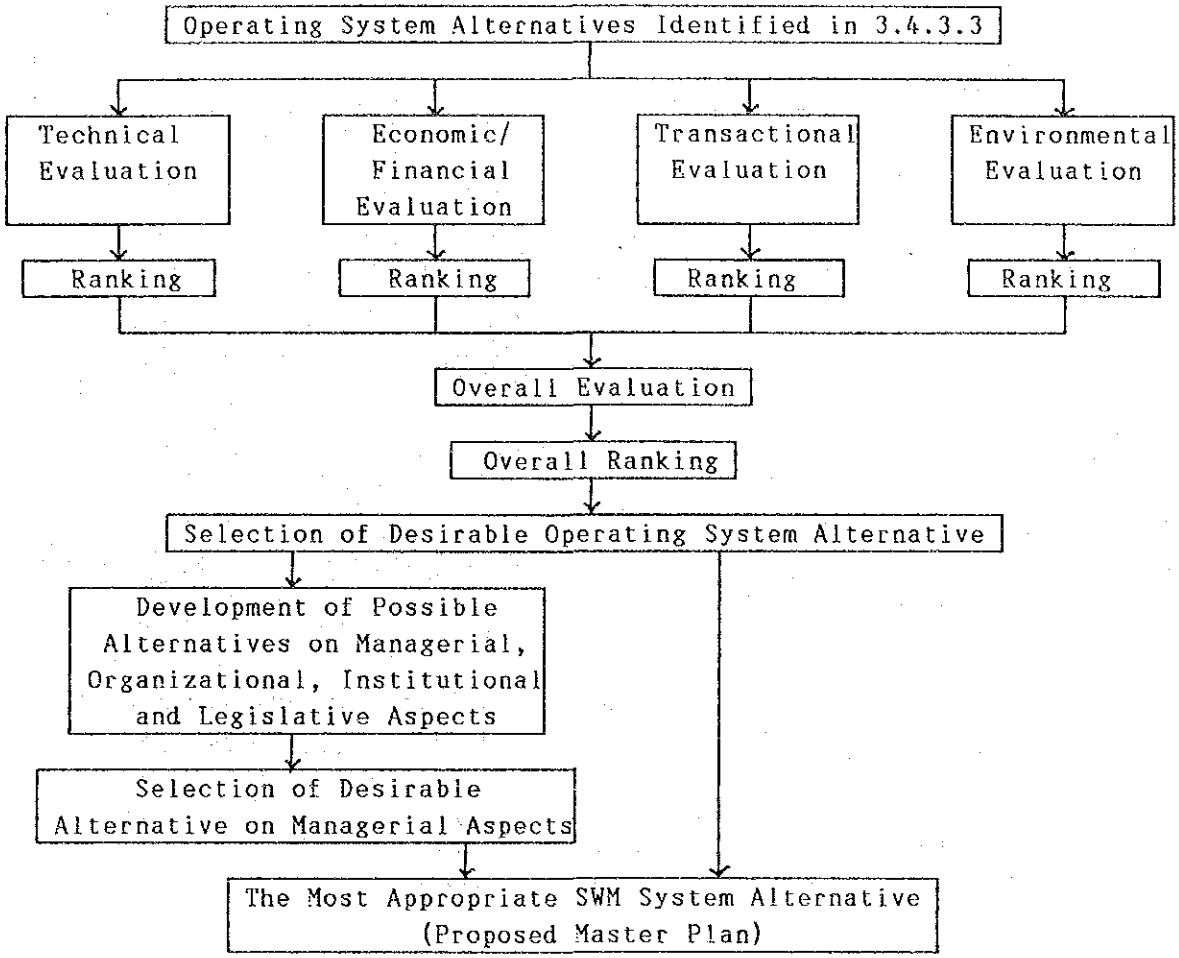
The operating system altenatives identified in 3.4.3.3 are ranked on the basis of quantitative as well as qualitative examinations for each of the above-mentioned criteria. Individual rankings are integrated into the overall ranking by checking the domination of certain alternatives over others. This integration is done without assigning weights for four criteria.

(3) Technical evaluation

The technical evaluation of each operating system alternative should be conducted on the basis of the folowing four factors and the alternatives should be accordingly ranked:

(a) Working conditions
- Safety and hygiene
- Equal workload and work suitability

Figure 3-9 Selection Procedure of the Most Appropriate SWM System Alternative



(b) Operation and maintenance
- Facility reliability and maintainability
- Emergency preparedness

(c) Construction
- Land acquisition and landfill method
- Equipment availability and technical know-how

(d) Indirect advantages
- Prospect of future technical development
- Contribution to fostering or upgrading of engineers

An example of the technical evluation result is shown in TABLE 3-9.

(4) Economic and financial evaluation

SWM is an indispensable service although it is practically impossible to calculate its economic benefits in a reliable manner. As such, generally accepted procedure to select the best operating system alternative from

TABLE 3-9 An Example of the Technical Evaluation Result

Criteria \ Alternatives	1	2	3	4	5	6	7	8
(1) Working Conditions	B	B	A	B	B	B	A	A
(2) Operation and Maintenance								
(a) Stability and in good	B	B	B	B	B	B	B	B
Maintenance order	A	B	C	A	B	B	C	C
(b) Emergency preparedness	B	A	A	C	A	B	A	B
(3) Construction								
Land Acquisition	B	B	A	B	B	B	A	A
Construction of disposal facility	B	C	B	C	C	C	B	B
(4) Indirect Merits	C	B	A	C	B	B	A	A
Overall Assessment	B	B	A	C	B	C	A	A

Score: A - Good
B - Fair
C - Poor

Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

economic point of view is to select the cost minimum operating system alternative which meets the prescribed objectives. The evaluation steps to be followed are as follows:

(a) To calculate the present value of the cost of each operating alternative according to the following formula:

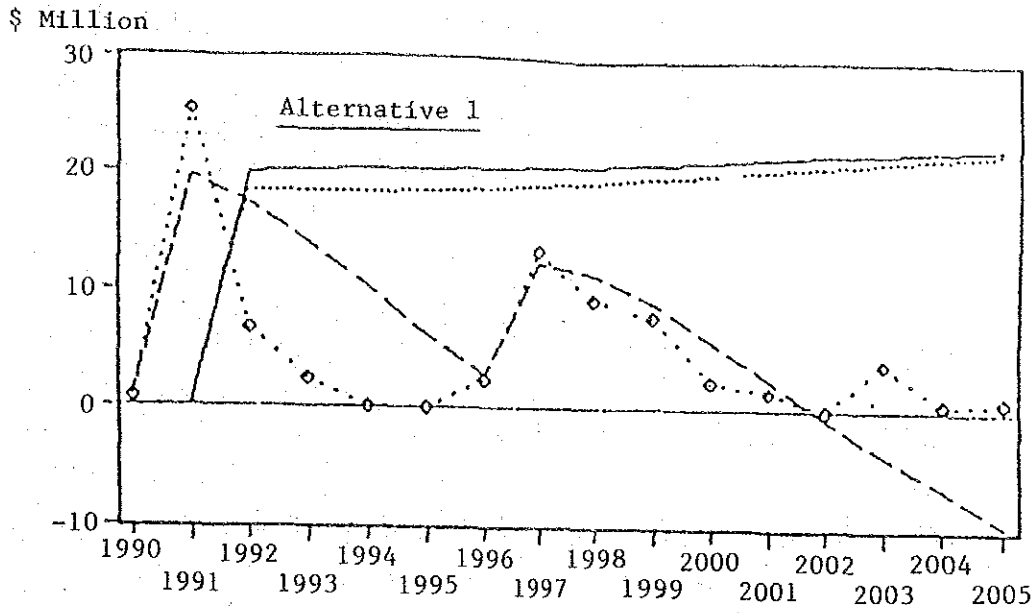
$$PV = \Sigma (C_n - B_n)/(1+r)^n$$

Where PV = Present value (at the year 0)
C_n = Cost of the operating system alternative in the year n
B_n = Quantifiable benefit (such as the sale of electricity and compost) of the operating system alternative in the year n
r = Discount rate (Geerally r is set from 5 to 10 per cent. Namely, r = 0.05 ~ 0.10.)
n = 0, 1, 2, ..., m-1, m
m = Planning period (years)

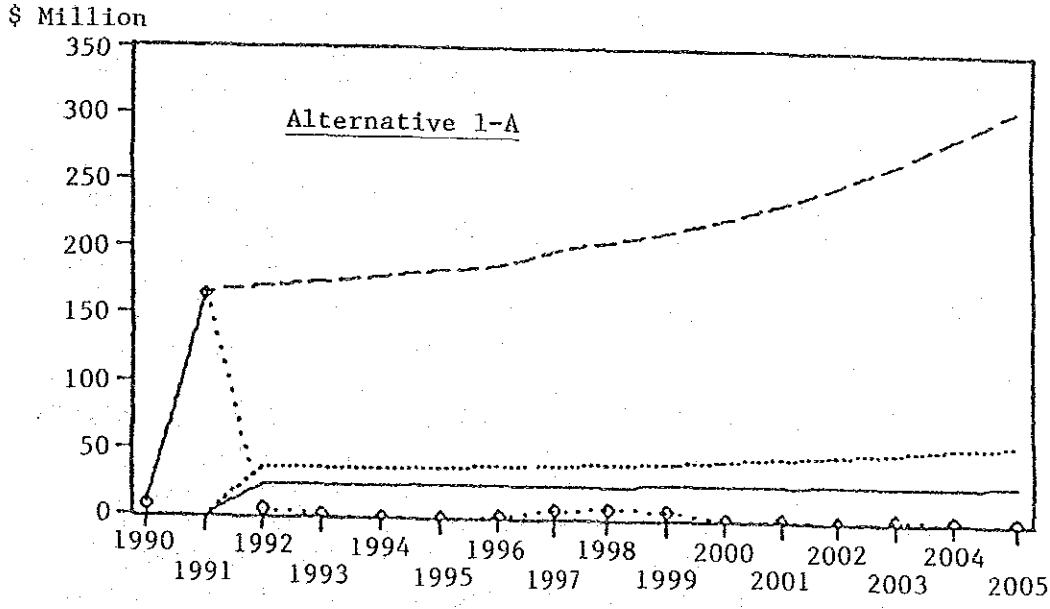
(b) To give higher ranking for the operating system alternative with lower PV.

The financial evaluation should be done through the study of cash flow of each operating system alternative as shown in Figure 3-10. For an alternative plan to be selected, its debt should become zero before the target year, if

Figure 3-10 Cash Flow Analysis (1)



— Budget + Revenue .... Annual Expense ◇ Investment Cost -- Total Debt



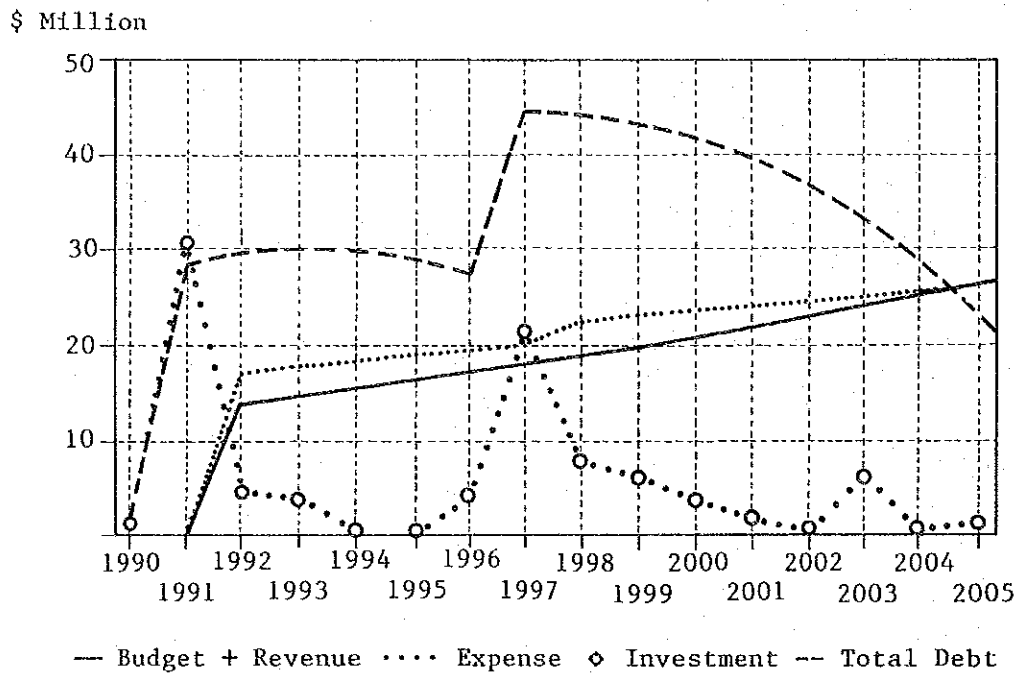
— Budget + Revenue .... Annual Expense ◇ Investment Cost -- Total Debt

Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

Note: The debt will become zero in the year 2002 in the case of Alternative 1 while the debt will continue to increase in the case of Alternative 1-A.

possible, as in the case of Alternative I. If it is not possible, the cash flow should show at least the possibility that the debt would become zero within several years after the target year as shown in Figure 3-11.

Figure 3-11 Cash Flow Analysis (2)



Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

Note: This figure shows that the debt will become zero within several years after the target year 2005.

If cash flow analysis is too complicated, then the following evaluation steps are recommended:

(a) To calculate the annual cost at the target year and the total investment cost of each operating system alternative. The annual cost should include the depreciation and interest for loan. The revenue from the sale of electricity and compost should be deducted in the calculation of the annual cost.

(b) To give higher ranking for the operating system alternative with lower annual cost and total investment cost.

Calculation of the cost should be carried out covering all the items of investment cost and annual expenses. They should include, at least, the following items:

(a) Investment cost
- Purchase cost of collection vehicles and communal containers
- Construction cost of major facilities such as final disposal sites, intermediate treatment plants, garages, workshops and cleansing offices
- Purchase cost of heavy equipment required in disposal sites or intermediate treatment plants
- Land acquisition

(b) Annual expenses
- Operation and maintenance costs
  - Emolument
  - Utilities
  - Spare parts
  - Fuels
- Depreciation

Combining the results of the above-mentioned evaluations, the ranking of economic and financial evaluation should be established.

(5) Evaluation of transactional facilitation

Any operating system alternative has its own needs for transactional facilitation to resolve sensitive and/or demanding issues associated with that alternative. If these needs are too much, then the plan will be given lower ranking because of difficulty expected in the implementation stage. The followings are some examples which require such transactional facilitation:

(a) Disruption of fishing villages located at or near the proposed disposal sites;
(b) Legal and/or coordination difficulties associated with inter-municipal SWM;
(c) Difficulties associated with realizing incineration options in terms of meeting the necessary financial, technical, managerial as well as public acceptance requirements; and
(d) Difficulties associated with the land acquisition and/or the land use as the SWM facility site (political settlement through compensation, etc.).

(6) Environmental evaluation

Environmental evaluation of operating system alternatives has already been done through 3.4.3.5 (preliminary environmental evaluation of alternatives). Therefore, the work to be done here is to summarize the evaluation result assigning scores for each alternative as shown in TABLE 3-10.

TABLE 3-10 An Example of Environmental Evaluation

Items for Evaluation	Alternatives 1	2	3	4	5	6	7	8
Impact on Surface Water Quality	B	B	A	B	B	B	A	A
Impact on Groundwater Quality	B	B	A	B	B	B	A	A
Noise, Odours and Dust Problems	B	B	A	B	B	B	A	A
Compatibility with Landuse of Adjacent Area	A	A	A	A	A	A	A	A
Impact on River Fisheries	B	B	A	B	B	B	A	A
Impact on Terrestrial Vegetation and Wild Life	-	-	-	-	-	-	-	-
Impact on Aquatic/Marine Flora and Fauna	-	-	-	-	-	C	-	-
Impact on Natural Landscape	A	A	A	A	A	A	A	A
Impact on Historical Places or Structures	A	A	A	A	A	A	A	A
Impact on Religious Places or Structures	A	A	A	A	A	A	A	A
Overall Assessment	B	B	A	B	B	C	A	A

Score: A : No Damage
B : Slight Damage or Adverse Effect
C : Damage
- : Further Survey Required

Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

(7) Overall evaluation

The evaluation results based on each of the four evaluation criteria should be summarized in a table to carry out the overall evaluation. TABLE 3-11 is an example of such a summarizing table.

TABLE 3-11 An Example of Overall Evaluation

	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5	Alt.6	Alt.7	Alt.8	Do Nothing
Technical Aspect	B	B	A	C	B	C	A	A	C
Economic Aspect	A	B	C	B	A	B	C	C	C
Transaction Aspect	B	B	B	C	C	C	C	C	B
Environmental Aspect	B	B	A	B	B	C	A	A	C
Overall Ranking	1	2	1	3	2	4	2	2	4

Note: "Do Nothing" refers to an alternative which employs the existing collection/haulage system and the sanitary landfill disposal system of Alternative 1.

Source: JICA, August 1989. Solid Waste Management Study for Pulau Pinang and Seberang Perai Municipalities.

As already mentioned, the ranking can be done by checking the domination of some alternatives over others. In the case of the example shown in TABLE 3-11, the following ranking results can be obtained by this method:

(a) Alternatives 2, 4, 5, 6 and "Do Nothing" are dominated by Alternative 1, regardless of any set of weights to be associated with the evaluation criteria;
(b) Alternatives 7 and 8 are dominated by Alternative 3, regardless of any set of weights to be associated with evaluation criteria;
(c) Alternatives 1 and 3 are not dominated by any other alternative and therefore they may be considered to be good alternatives;
(d) Alternative 3 may not be economically/financially feasible;
(e) Alternative 5 is inferior to Alternative 1 only with respect to the transactional aspect; and
(f) Alternatives 7 and 8 are inferior to Alternative 3 only with respect to the transactional aspect.

As the result of this overall evaluation, the most appropriate operating system alternative will be selected.

3.4.3.7 Stage plan and identification of the first priority projects

As already mentioned in 3.4.3.2 (1), a master plan with 10 year period may be broken down into the following stages in order to facilitate stepwise implementation:

- Immediate Plam Stage (0 year to 1 year)
- Short-term Plan Stage (1 year to 2-3 years)
- Medium-term Plan Stage (2-3 years to 5 years)
- Long-term Plan Stage (5 years to 10 years)

Achievement of goals and targets requires appropriate efforts at appropriate place and time. As such, the WG should clearly show in tha stage plan the efforts to be made in each stage. Stage plan should deal with, among others, the followings:

(a) Expansion of service coverage;
(b) Introduction of future collection system;
(c) Introduction of future system of street/drain/beach cleansing and grass cutting;
(d) Construction of major facilities such as intermediate treatment plants and final disposal sites;
(e) Procurement of equipment;
(f) Institution building; and
(g) Contracting-out.

In the case of the Immediate Plan, the problems which require urgent attention and may be quickly solved without spending much time and money will be dealt with. Some of the future systems may be tested at this stage through

pilot projects in order to confirm their feasibility. Such tests will be very useful to prepare really workable future systems. Immediate Plan Stage will also include the detail design of major SWM facilities.

The major works to be done in the Short-term Plan Stage will be the construction of major facilities, procurement of equipment and the introduction of future systems in the first priority areas. Institution building may also be initiated at this stage.

In the case of the Medium-term and Long-term Plan Stages, the major works will be the continued expansion of service coverage based on the future systems although the construction of major facilites and replacement of equipment will also continue.

Based on the stage plan, the projects that should be implemented with first priority in the Short-term and Medium-term Plan Stages should be identified. These projects can be divided into the following two categories:

(a) Investment projects such as the construction of major facilities and procurement of equipment; and
(b) Non-investment programmes such as training of workers, education of the general public, strengthening of supervision, contracting-out, and establishment of user charge system.

3.4.3.8 Equipment procurement and facility construction plan

Based on the stage plan, the Equipment Procurement and Facility Construction Plan should be prepared by the WG. This plan should include, among others, the followings:

- Type, number, procurement schedule and estimated cost of equipment; and
- Type (design concept), number, construction schedule and estimated cost of facilities.

Leasing alternative can be considered in the case of special equipment such as heavy equipment for landfills. Policy on contracting-out of SWM services will also affect the equipment procurement plan. In the equipment procurement plan, replacement should not be forgotten.

3.4.3.9 Financial plan

The possibility of securing the necessary investment and operation funds to achieve the master plan goals by the target year should be assessed from the long-term financial perspective.

Although the rationalization of SWM would contribute to a decrease in SWM costs, such decrease will not be large enough to offset the increase in SWM costs. The cost increase results from such factors as population increase,

expansion of socio-economic activities, longer distance to disposal sites from collection area, and changes in waste composition.

As it may be difficult to secure the initial investment funds because of the relatively small cost reduction effect in the immediate future, it is particularly important to clearly show that the rationalization of cleansing service based on the master plan will be very helpful in reducing future financial burden of the Local Government. The financial feasibility of the master plan should be examined through the following aspects:

- Total investment amount;
- Operation and maintenance cost;
- Transition of SWM budget ratio in the municipal budget;
- Forecast of user charges;
- Available loan and grant sources and their conditions;
- Cash flow; and
- Sensitivity analysis on major factors.

Based on these examinations, the WG should adjust the master plan in such a manner that the plan would have financial feasibility. It is also necessary to develop measures to strengthen the financial base of SWM. The results of these studies should be summarized in the financial plan.

3.4.3.10 Organization and institution

(1) Organization

The roles of SWM-related agencies in dealing with different types of solid wastes and administrative support functions should be clearly determined (See TABLE 3-5 and TABLE 3-6) taking into account the existing resources (manpower, equipment, budget, legislation, etc.) of each agency and the required resources for the target year.

More often than not, SWM operations and their administrative support functions are carried out by various departments and divisions of local governments with insufficient coordination. Therefore, measures to improve coordination should be worked out based on the results of diagnosis study on this aspect. It may be necessary, in some cases, even to reorganize the local government so that SWM operations and related functions would be handled in an integral manner by a department specialized in SWM.

Major functions of SWM departments are generally as follows although they depend on the size of local governments and the organizational systems employed:

- Collection;
- Street/drain/beach cleansing and grass cutting;
- Intermediate treatment and final disposal;
- Planning and development;

- Supervision;
- Procurement and maintenance of equipment;
- Administration and accounting;
- Public relations and education of the public; and
- Staff training and fostering of private companies.

In the case where some of these functions are assigned to other departments, the work assignment and the manpower allocation for each department should be clearly shown in the master plan.

(2) Privatization

As already mentioned in 3.4.3.2 (8), privatization policy ("Privatize or not?", "What service should be privatized?", "To what extent the service should be privatized?", "Which area should be privatized?", "What payment system should be used?", "How the contractors should be supervised?", etc.) should be studied carefully by each local government taking into consideration, among others, the following factors:

- National privatization policy;
- Technical, financial and managerial capacity of existing public cleansing service; and
- Technical, financial and managerial capacity of private sector.

For the privatization to be adopted as the policy of the Local Government, it should be confirmed that the privatized service would bring lower cost and/or higher quality compared with the direct service by the SWM department. Even in the favourable cases, the extent of privatization (contracting-out) will depend on the following factors:

- Extent of the difference in the cost-effectiveness between the contractors and the Local Government (Larger differences will make it feasible to contract out more);
- Availability of reliable contractors (Greater availability of reliable contractors will make it feasible to contract out more);
- Degree of current utilization of the Local Government's resources (manpower and equipment) (It is not rational to increase the contractiong-out when the Local Government's resources are under utilized. Full utilization should be promoted before increasing the contracting-out if the Local Government is unable to adjust the manpower immediately, which is always the case with the government sectors.).

Once the privatization policy is adopted, then it is required to carry it out properly. Proper privatization requires the following considerations:

- Proper tendering system to select reliable contractors;
- Proper contract scale to achieve scale economy and avoid monopoly;
- Proper payment system which gives incentives for better service;

- Proper supervision system; and
- Proper budget preparation for contracting-out.

The results of these examinations should be summarized in the master plan.

(3) Institution

Based on the results of the diagnosis study, laws and regulations to facilitate a smooth operation of SWM should be introduced and a legal system to enforce these laws and regulations should be established.

All the local governments should have the following regulations on SWM:

- Anti-litter regulation;
- Regulation for proper storage and discharge;
- Regulation for collection and tipping fees;
- Regulation for compound and enforcement; and
- Regulation of work time and work manner of labourers.

(4) Public cooperation

It is essential to have the active participation of residents (generators of solid waste) in the master plan. Measures to obtain the public cooperation on the following three points should be examined:

- Use of proper methods for the storage of solid waste;
- Discharge of solid waste on the specified day, time and place; and
- Cooperation to keep the city clean.

SWM systems should be changed from time to time to cope with the changing environment of service demand and supply (See 3-1) and the active participation of the public is indispensable for the successful change of SWM systems. Public relations and mass-education activities should be regularly conducted to increase the awareness of the importance of SWM on the part of residents to facilitate their cooperation to changes. Following arrangements should be made with the aim of promoting the public cooperation:

- Provision of a complaint desk;
- Mass-education activities (newsletters and supplementary textbooks, etc.);
- Promotion of district cleansing days;
- Promotion of recycling; and
- Promotion of cooperation with consumer, religious and other organizations.

3.4.3.11 Recommendations for the implementation of the master plan

In 3.4.3.7, a stage plan has been prepared in order to facilitate

stepwise implementation of the master plan. First priority projects have also been identified as the key projects to start up the master plan implementation. However, for their successful implementation, these first priority projects require a more detailed plan which can be prepared through a feasibility study. The feasibility study, in turn, requires various activities such as topographic survey and soil investigation of major facility sites, and a detailed-EIA which imply substancial study cost.

Therefore, recommendations to the decision makers of the Local Government should be made on the approval of the master plan and the preparation of budget for the feasibility study. Interim measures during feasibility study and construction of facilities should also be included in the recommendations.

3.5 FEASIBILITY STUDY

When compared with a master plan, a feasibility study has limited scope but it analyses the subject more in detail. Both are very important because they identify the first priority projects and give the detail of such projects in a cost-effective manner.

The objective of the feasibility study is to confirm the technical and financial feasibility of the first priority projects. The study will also contribute for the development of various measures to make the projects feasible. Because of the experiences required for this kind of work, the use of consulting companies may be convenient as in the case of master plans.

Detail explanation of feasibilty study methodologies will not be made in this Chapter because the activities to be carried out in a feasibility study are very similar to those for a master plan study although the scope and the depth of two studies are different.

The activites to be included in a feasibility study are as follows:

- Confirmation of planning framework;
- Comparative study of operating subsystems and selection of a combination of subsystems;
- Topographic and geological survey of the sites for major facilities;
- Preliminary design of major facilities;
- Study of required equipment;
- Estimation of project cost;
- Environmental impact assessment;
- Organization and personnel plans;
- Financial and managerial plans;
- Public cooperation;
- Project evaluation; and
- Implementation plan.

Once the technical and financial feasibility is confirmed, then the step of detail design (Step No.5) comes as shown in TABLE 3-3. This step consists of the detail design and preparation of tender documents including technical specifications. This type of work requires the assistance of consulting engineers. Construction of facilities (Step No.6) can also be supervised by the same consulting engineers.

The last step is evaluation and monitoring (Step No.7). This step is very important to confirm the progress of plan implementation and identify any deviations from the plan. The master plan should be readjusted periodically based on the evaluation results. As such, an evaluation/monitoring system should be established in the municipal SWM service regardless of the size of the Local Government in question. Even a simple system will contribute a lot to the improvement of municipal SWM system compared with the case which lacks that system.

The same thing can be said to the process of planning. All the municipal SWM services should have their own master plans regardless of their service size. In the case of a small service, they may think that the methodology shown in this Chapter is too complicate. If that is the case, they should prepare their plan using a simplified methodology. Even a simple plan, it is far better than nothing. They can improve gradually their planning capability by accumulating their own experiences of planning, implementation and evaluation.