PART A MUNICIPAL WASTE COLLECTION AND TRANSPORT

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CHAPTER 1 CONTENTS OF THE WASTE COLLECTION AND TRANSPORT PLAN

1.1 General

Of all the SWM activities this activity accounts for 70 to 90% of total SWM costs. It is therefore necessary to identify the objectives of this activity, select the suitable technical system, and strictly control and monitor operation in order to provide an effective and cost efficient service.

The objectives set up and technical systems selected should deal with the following major issues which have been identified based on the questionnaire survey to a number of urban communes and the study of Safi.

- Majority of municipal waste is collected daily from the door of the discharger and taken directly to the disposal site (door-to-door with minor transfer station operation)
- Little data maintained to analyze collection service operation (waste amount collected, collection service coverage, truck operation, operation costs, waste classified by types, etc.)
- Lack of communication between service operators and residents on such matters as discharge time and proper individual bin to be used
- No plans for new trucks procurement and extensive use of the less cost efficient dump trucks in waste collection
- Poor collection service operation in terms of long time spent of collection route, poor routing and no route maps, poor working conditions of the crews and insufficient supervision
- No recycling activity on the official level

The waste collection and transport plan is formulated from the long term improvement plan, mid-term action program and annual operation plan. Table A.1.1-1 describes each.

1.2 Collection Improvement Plan

The waste collection and transport activity shall be addressed in the overall SWM improvement plan. The SWM plan shall comprise a number of activities as defined in Book 2-Part 1 of this report.

It should be noted that the SWM improvement plan formulation depends on a number of very important factors as data collection, analysis ability and planning technical know-how. These factors are not considered at present to be available at the urban communes level in such a degree as to allow comprehensive master planning. The minimum items the improvement plan should cover are preparing a diagnostic study of existing conditions, developing forecasts of waste amounts, and defining the objectives and suitable technical systems for the collection and transport activity.

1.3 Action Program

The action program shall provide the details for implementing the improvement plan, and based on monitoring of the progress of the program, some modification to the improvement plan may be required. This program shall address specifics such as scheduling of objectives set out in the improvement plan and where they will be implemented. For example; expansion of service coverage to reach 80% within 3 years, starting with a specific cleansing section followed by an identified second section and so on. An urban commune is broken down into a number of cleansing sections by the cleansing authority, based on population distribution, land use, collection truck distribution, administrative borders, etc. This program will include a feasibility study on the associated costs which will assist the urban commune in estimating and justifying the necessary funding for purchase of equipment and hiring of manpower.

This plan will require a large effort in understanding existing conditions on a cleansing section basis.

1.4 Operation Plan

The operation plan shall be prepared annually by the responsible municipal engineer based on the action program. Equipment and manpower shall be distributed by cleansing section, and operation shall be monitored by the engineer and technicians to upgrade work efficiency where possible.

Table A.1.1-1 Contents of the Waste Collection and Transport Plan

Improvement plan	Action program	Operation Plan
(1) Duration		
10 to 20 years	5 to 10 years	Annual
(2) Function		
• Identify long term objectives and targets based on an understanding of the present conditions and forecast of future conditions • Propose suitable technical systems • Provide an understanding of the required effort in manpower and equipment and related costs	• Formulate an action program for specific projects belonging to the improvement plan preliminary phases • Formulate detailed plans by locations and scheduling such as priority areas for extending service coverage, areas where new technical system shall be introduced, etc. • Identify requirements by section in terms of manpower, equipment and costs and based on technical system most appropriate for the section in question • Identify specific locations for facilities proposed in the improvement plan such as transfer stations, branch offices, etc.	• Distribute the available equipment and manpower by cleansing section • Prepare procurement of equipment and hiring of manpower on a yearly basis • Prepare budget for the required procurement and hiring and prepare necessary administrative procedures for procurement • Assess and as necessary modify operation based on a stringent operation control monitoring system using truck scale (when available), waste collection amount data, and operation standards
(3) Contents		
• diagnose existing conditions and identify issues • project future conditions • set planning framework (objectives, constraints) • study technical systems and select appropriate alternative • calculate equipment and manpower required • calculate financial cost for implementing the plan	• phase the improvement plan objectives by section and time • detail study of each section and determine technical system • calculate equipment and manpower by section and prepare procurement and hiring plans • select suitable sites for proposed facilities based on selection criteria study • prepare cost studies so as to secure financing for the plan components	• consider number and type of equipment and manpower required by section • monitor operation to determine work efficiency and required strengthening • develop truck routes with equal shares of waste haul considering truck capacity • based on technical system applied, specify locations of communal containers, collection stations, and sections served daily, 3 days and 2 days per week
(4) Persons responsible		
• Urban development planners in the urban commune • Municipal engineer responsible for SWM • Private consultants	• Municipal engineer responsible for SWM • Commune architects, urban planners • Private consultants	• Municipal engineer responsible for SWM • SWM technicians • Community representatives • Private contractors

CHAPTER 2 DIAGNOSIS ON CURRENT SITUATION OF THE COLLECTION AND TRANSPORT SYSTEM

2.1 Need for the Diagnosis

A good understanding of the existing conditions in the Urban Commune will assist the planners in formulating a responsive plan and the decision makers in setting the required priorities and distributing the financial pie slices. The diagnosis and analysis will yield the following results;

1. Identify issues and problems in solid waste collection and transport
2. Set realistic objectives and targets for the service
3. Form a data base from the data collected to prepare the diagnosis

This chapter sets out the approach to be followed by the Urban Commune municipal engineer in identifying the issues that need to be dealt with in the waste collection and transport service.

2.2 Data Collection for Diagnosis Study

Usually the waste collection and transport improvement plan is formulated within the SWM master plan. To formulate that master plan a number of items must first be diagnosed. Only those items which are considered to have a close relation to the waste collection and transport improvement plan are described here.

Table A.2.2-1 provides a list of the data that should be collected for the diagnostic study. The table also suggests methods for data collection and the persons responsible.

The data is divided into two categories; (A) present waste collection and transport service, and (B) general conditions of the urban commune. Items listed under (A) have a higher priority than those of (B), and their collection is not considered to difficult.

2.3 Identification of General Waste Collection and Transport Issues in Morocco

2.3.1 General Diagnosis

Based on the diagnosis and prepared data base it will be possible for the commune municipal engineer to prepare a list of issues which should be considered within the collection and transport improvement plan. Table A.2.3-1 describes general issues identified in the questionnaire survey and urban commune visits implemented during the Study and reference figures set based on those realized in other cities.

2.3.2 Identification of Issues

Table A.2.3-2 shows an example of the municipal waste collection and transport issues that may be identified, their analysis and required improvement in an urban commune. Each Urban Commune should make the same exercise in order to understand its individual issues.

Table A.2.2-1 Data Collection for Diagnostic Study

Item	Content	Method
A) Present Waste Collection and Transport Service		
1. Service coverage		
- waste amount generated	• daily waste amount generated (in ton and by type as possible)	• annual waste generation unit rate survey (as discussed in Chapter 4)
- waste amount collected	• daily waste amount collected (in ton or m^3) • Seasonal waste composition (1-2 times a year) • classification of waste amount collected by waste type	• measurement by truck scale (if available) • maintain records at disposal facility for incoming trucks • daily trip number multiplied by truck capacities • sample analysis 1 - 2 times a year
- non-served areas	• population of area • location identified on maps	• collect information from field operators (cleansing sections)
2. Service Quality		
- collection frequency	• daily, 3 d/week, & 2 d/week collection areas identified on maps	• collect information from field operators (cleansing sections)
- collection points; door-to-door and station	• shares of door-to-door and station systems • maintenance at stations	• collect information from field operators (cleansing sections)
3. Technical Operation		
- collection equipment	• trucks and containers classified by type, age, capacities	• municipal engineer, workshop records
- manpower	• manpower classified by type; supervisor, driver, worker, mechanic	• municipal engineer, field operators
- technical system applied	• technical system by section (technical system described in chapter 6)	• municipal engineer, field operators
- primary collection	• areas served by primary collection • populations residing in these areas • type of primary collection service provided in these areas (hand cart, manual, animal pulled or hauled)	• municipal engineer, field operators
- operation monitoring	• cleansing conditions at collection points • trucks and crews operation • community cooperation and complaints	• municipal engineer, supervisors • operation records • time and motion surveys
- operation costs	• operating costs for each truck (includes crew salaries, truck depreciation, maintenance and repairs, fuel and depreciation)	• maintain an itemized accounting system at the cleansing sections (costs associated with workers) and the workshop (truck related costs)
- extent of "black points"	• major problem areas plotted on maps • frequency waste is hauled from these points and average total waste amount hauled at one time • deficiency of collection service in vicinity of black points	• municipal engineer, field operators • complaints from residents
- operation plan	• equipment and manpower distribution • route balancing and districting (waste amount hauled on route) • equipment procurement and manpower hiring planning	• municipal engineer, operators • annual planning

4. Operation Efficiency		
- worker efficiency	• waste amount collected per worker (ton/worker) • worker injuries, absentee rates, etc.	• operation records • time and motion surveys
- truck utilization	• trip number per shift • amount hauled per trip	• operation records • time and motion surveys
- truck maintenance	• downtime	• workshop truck records
- cost	• includes salaries, maintenance, equipment depreciation, fuel and oils • calculated in DH/ton of collected and transported waste	• actual expenditures based on records • depreciation calculated by standard formula or truck cost divided by number of years
B) General Conditions of the Urban Commune		
1. Natural Conditions		
- location and area	• characteristics of geographical location (seaside, desert, mountain, valley, etc.) • administrative borders • rainfall and wind	• maps, etc. • meteorological data
2. Urban Features		
- land use	• land use maps showing residential, commercial, industrial, public, green, mixed residential/commercial and other use areas • area in hectares (or km^2) by land use	• land use maps • urban development/planning departments data
- road conditions	• road lengths classified by type	• road network and transport maps
- housing	• number of housing units classified by type (type categories same as that used for census data collection) • population share living in each type	• statistical data
- slum areas	• slum area locations shown on maps • populations of these areas	• statistical data • urban development/planning departments
3. Socioeconomic Conditions		
- population	• present population by smallest administrative unit • population growth rates • population density by area (on maps)	• statistical data • urban development/planning departments
- economic characteristic	• urban commune position within the urban community, and on the national level • existence of major economic facilities, such as industrial estate, seaport, tourism center, etc.	• statistical data • urban development/planning departments
- employment	• employment shares by industry sector • unemployment share	• statistical data
- forecasts of population	• population projections and distribution by area	• available population forecast studies • other development studies • studies on other urban communes in Morocco with similar conditions
4. Urban Development Plans		
- future land use	• future land use maps showing population distribution • road network projects • commercial sub-centers • new settlements	• urban development/planning departments • transport department projects

Table A.2.3-1 Identification of General Waste Collection and Transport Issues

Issue	Ave. Moroccan figures*1	Reference figures
1. Service coverage in terms		
• population	• 94% (actual may be 60-70%)	• 100%
• area	• No data	• 100%
2. Service quality		
• collection frequency	• daily collection: 95%	• 3 days/week: 75%*2 1 day/week: 25%*2
• collection point	• door-to-door: 85% collection point: 15%	• door-to-door: 5%*2 collection point: 95%*2
3. Efficiency of operation		
• truck efficiency	• ave. trips/truck.: 1.5 - 2.0 ave. haul/truck: NA	• ave. trip/truck.: 3.0*2 ave. haul/trip: 3.67 ton*2
• worker efficiency	• ave. 0.6 ton/worker ave. 6.0 crew/truck.	• ave. 1.97 ton/worker*2 ave. 2.9 crew/truck. *2
• cost efficiency	• Data unreliable (@ 300 DH/ton)	• 200 - 250 DH/ton*3
• working conditions	• poor, unsanitary	• sanitary conditions
4. Sanitary and environmental conditions		
• discharge points	• poor; waste left after truck departs, waste discharged after truck departs	• discharge and collection hours at discharge points should be regulated, packed waste discharge
• collection and haulage	• poor; waste scattered from truck, leachate water leaking from truck, truck odor	• trucks should be covered during transport from collection route to disposal facility, daily truck washing, preventive maintenance
5. Management of equipment		
• shortage of equipment	• problem	• equipment renewal and addition should be based on procurement plans prepared annually
• selection of equipment	• technical basis for selection not clear, based on available funds	• equipment selection to consider efficient collection system, and collection section characteristics
• maintenance of equipment	• preventive maintenance lacking, central workshop fairly well equipped to provide maintenance works but sometimes time-consuming, use of private workshops not frequent	• daily preventive maintenance necessary, use of private workshops for some maintenance works should be considered
6. Community participation		
• discharge regulations, maintenance of collection points, complaints, etc.	• notable lack of communication between operators and community on discharge regulations, responsibility for collection point maintenance and following up on citizens complaints	• regulations indicating discharge time, discharge bin (plastic bag), collection point location necessary
• involvement in recycling activity	• recycling activity is largely carried out by the private sector through separation of the recoverable materials at dumping sites and collection points and separation of recoverable materials at the generation points by the citizens hardly exists	• develop targets for recycling of certain recoverable waste materials such as paper, plastics and glass

Notes:
*1 Study Team questionnaire survey and urban commune visits
*2 Data of Tokyo Metropolitan Government
*3 Refer to Chapters 6 and 10 for unit cost estimation

Table A.2.3-2 Analysis of the Waste Collection and Transport Issues

Issue	Analysis	Required improvement
1. Service coverage in terms		
• Population	• Urban Communes reported service coverage to be considerably high but site visits show that there is still much room for improvement. An areal coverage of 100% does not necessary equal a population coverage of 100% if the residents served are not aware of the service times and illegally dispose their waste.	• Target for achieving coverage of 100% may be set for the mid- to long term. A coverage of 100% means that every resident receives the service at least once a week.
2. Service quality		
• Collection frequency	• The large share of daily collection, ensures high service quality, but at a high cost	• Staged introduction of collection frequency to 3 days/week will reduce collection costs and expand coverage. Low collection frequency can be introduced in low density areas.
• Collection point	• The large share of door-to-door collection results in providing high quality service at a high cost	• Same comment as above. Collection station discharge can be introduced immediately in high density areas with walking distances to collection point kept at 50 to 100 meters.
3. Efficiency of operation		
• Truck efficiency	• Depending on distance to disposal facility, ave. 2 - 3 trips per truck is desirable	• Make time and motion surveys to determine optimum targets that can be set for the urban commune
• Worker efficiency	• Large crews increases cost but may speed up the work depending on collection system. In Morocco large crews engage in recycling on the route thereby increasing time spent.	• Reduce crew sizes within a collection system depending on collection stations and packed waste discharge.
• Cost efficiency	• While present costs quoted by Urban Communes in the questionnaire survey seem to be reasonable, basis for these estimations is not clear, and they are somewhat doubtful in light of the observed low cost efficiency of the service.	• Develop an accounting system where the collection and transport costs are classified into salaries, fuel, depreciation, maintenance and etc. Maintain records of waste amounts hauled. Then the unit costs may be clearly calculated.
• Working conditions	• Workers use primitive tools or their hands to collect the mostly unpacked waste. They have no gloves, boots or uniforms. This increases the risk of injuries and diminishes their status in the eyes of the public.	• Implement measures to improve working conditions and the lot of the workers, to decrease risks of injury and upgrade their social status.
4. Sanitary and environmental conditions		
• Discharge points	• Scattered waste remaining after the truck leaves the collection route decreases sanitary and aesthetic condition and encourages discharge of new waste long before the collection truck is scheduled to return.	• Clearly prepare and notify the citizens of the discharge time and forbid loose waste discharge. Monitor the collection crews to ensure that they are properly cleaning the discharge points.
• Collection and haulage	• Uncovered collection trucks scatter the waste on the road as they go to the disposal facility. Also trucks emit bad odor and leachate water.	• Cover the trucks with canvass (burlap) and wash daily.

5. Management of equipment		
• Shortage of trucks	• Trucks shortage results in using unsuitable trucks in some collection zones, such as small pick-up trucks in areas far from the disposal facility, without a transfer station.	• Prepare procurement plans based on suitable equipment and implement preventive maintenance to ensure truck downtime is kept at a minimum level.
• Selection of truck types	• Truck type is selected based on short term considerations such as available budget at the time, without considering where trucks will be operated in the commune, or the distances that need to be traveled if a new disposal facility is introduced or relocated.	• First consider appropriate collection system in each area of the Urban Commune and then decide equipment accordingly (Chapter 6 of this part).
• Maintenance of equipment	• Preventive maintenance is very poor and this reduces the life of the truck. Furthermore long time spent waiting at the central workshop for repairs or periodic maintenance prolongs the downtime of the truck.	• Ensure preventive maintenance is implemented using maintenance records and providing the tools at the depots. Study the feasibility of using private workshops for large maintenance and repair works, by weighing the possible higher costs against the shorter downtime.
6. Community participation		
• Discharge regulations, maintenance of collection stations, complaints, etc.	• There is hardly any communication between SWM operators and the community. This hinders smooth operation of the work and possible introduction of more efficient collection methods such as collection stations, 3 days/week discharge, and waste volume reduction efforts.	• Within each collection zone commence contacts with the community leaders in order to exchange opinions on the acceptable level of service, and volume reduction efforts. These leaders may then play a role in backing the operator's efforts among the residents of the zone.
• Source separation of recoverable materials	• Lack of any programs to encourage the citizens to separate the recoverable materials at the source of generation	• Based on a study of the waste composition and market demand for the recoverable materials, the Urban Commune should prepare a pilot project for recycling in order to decide the most suitable collection system for the materials and method to encourage community participation

CHAPTER 3 WASTE COLLECTION AND TRANSPORT SERVICE OBJECTIVES

3.1 Plotting the Course

Planners often talk about objectives, goals, aims and targets and it is sometimes confusing to understand the difference amongst these terms. Yet a plan without a set destination, both qualitatively and quantitatively is difficult to formulate.

Likewise Urban Communes should decide where they want to go, and what they want to achieve before embarking on the waste collection and transport improvement plan. While day to day operators may not have the patience, nor the time to sit back and think of the distant future, it is the duty of the Urban Commune decision makers and municipal engineer to decide what form the waste collection and transport improvement plan should take. These people are in a position to put this plan in context with the overall development plan envisioned for the Urban Commune, and the direction the officials and citizens of the commune want to go.

It is suggested here that these people set objectives and targets. The former shall be defined as setting up a qualitative condition while the latter shall represent actual quantitative figures to be achieved.

3.2 Objectives and Targets

The objectives and targets for the long term waste collection and transport improvement plan (I/P) (long term) shall be set based on the identified issues and the national strategies. A realistic national target would be to set collection service coverage rate at 100% by the year 2020. The targets for the mid-term action program (A/P) and the short term annual operation plan (O/P) shall be determined based on the individual characteristics of the Urban Commune. Table A.3.2-1 shows the guidelines for preparing the objectives and targets.

Table A.3.2-1 Objectives and Targets of Waste Collection and Transport Plan

Objectives	Present Condit-ion	Possible Targets			Consideration
		O/P (1yr)	A/P (5-10yr)	I/P (10-20yr)	
1. Service Coverage Expansion	100%-Y	100%-0.9Y	100%-0.5Y	100%	Where non-served populations are living in fringe urban areas mild targets are acceptable. In case of large non-served populations living in illegal settlements, usually low income areas, than it is advisable to set more ambitious targets in order to avoid social problems.
2. Service Quality					
(a) - Daily collection freq.	95%	95%	80%	30%	Where strong community organization and participation is expected, ambitious targets may be set. For densely populated areas a slower pace is recommended. In new service areas 2-3 days/ week should be introduced from the start.
- 3 d/wk collection freq.	5%	5%	20%	70%	
(b) - door-to-door collection	85%	85%	80%	30%	Again speed of implementation depends upon community participation and awareness. In densely populated areas a speedier pace is acceptable. In new service areas collection stations should be introduced from the start.
- collection station points	15%	15%	20%	70%	
3. Cost efficiency (DH/ton)	X	0.95X	0.9X	0.8X	Urban Communes with strong financial base can afford to set milder targets. Where SWM budget is limited and there is a need to urgently introduce other SWM facilities such as sanitary landfill and increase service coverage than more stricter targets are required.
4. Recycling	0.5-1%	1-1.5%	2-4%	5-15%	Share of generated waste to be recycled largely depends upon waste composition and market demand. Where business waste amount is large more ambitious targets for paper may be considered. High and middle income Urban Communes may also develop higher targets for plastics and paper. Market demand for recyclable items also influences targets.
5. Working Conditions					
(a) Workers	Very poor	---------	--------->	Optimum	Importance as a social issue as well as to overcome difficulty in hiring for SWM work. Review of salaries important to elevate status level of SWM workers.
(b) Community participation	Very poor	---------	--------->	Optimum	Improvement of community participation is closely related to items 3 and 4.

CHAPTER 4 SOLID WASTE AMOUNTS AND COMPOSITION

4.1 Need to Know Waste Amount and Composition

Based on the waste amount the Municipal Engineer can calculate the number of collection vehicles required for collection and transport and the capacity of the disposal facilities. Knowing the waste composition, it is possible to consider various suitable intermediate treatment facilities. For example a large organic content in the waste may encourage composting, and a high calorific value is an important factor in considering incineration. Large plastic and paper contents will have a bearing on the recycling efforts.

In addition the plan objectives and operation efficiency indices discussed earlier in this part are related directly to waste amounts (e.g. service coverage rates, ton/worker, DH/ton, ton/trip, etc.). Therefore it is necessary to understand the waste amount generated in the Urban Commune.

4.2 Preparation of Data Base

As shall be discussed in the following section, the waste amount shall be estimated from the unit generation figures which shall be surveyed. These figures are expressed mainly in per capita terms therefore it is necessary to know the population figures.

In addition waste generation differs by income levels; the high income bracket families tend to be more wasteful and generate more plastic and paper. It is therefore helpful to understand the population classified by income levels whenever that is possible. Definitions utilized in the national population census to classify income levels (e.g. by housing unit type) should be used when available.

The municipal waste covers, in addition to household waste, commercial, institutional and street sweeping wastes. Subsequently an understanding of the number of commercial enterprises in the Urban Commune (department stores, shops, markets, hotels, restaurants, etc.), the public facilities, and street lengths is needed.

Such information should be classified by cleansing section if the Urban Commune is broken down into cleansing sections and data for each is available, or the smallest administrative unit in the Urban Commune.

Table A.4.2-1 shows a list containing some of the required data base for the Urban Commune. In the case of Safi city it was possible to collect data on population, number of institutional buildings, numbers of commercial activities (shops, restaurants, hotels, etc.), street lengths and maps. On the other hand it was difficult to collect data on floor areas.

Table A.4.2-1 Urban Commune Data Base

Data	Cleansing section 1 (or admin. unit 1)	Cleansing section 2 (or admin. unit 2)
1. Population (total)		
(1) High income population		
(2) Middle income population		
(3) Low income population		
(4) Population forecasts		
2. Commercial activities (in floor area)		
(1) Large department stores		
(2) Shops		
(3) Restaurants (breakdown by large, medium and small may be necessary)		
(4) Hotels (breakdown by large, medium and small may be necessary)		
3. Institutions (in floor area)		
(1) Governmental buildings		
(2) Schools		
(3) Sports facilities		
(4) Others		
4. Street lengths (km)		
(1) Class I		
(2) Class II		
(3) Class III		
5. Maps		
(1) Land use maps - existing		
(2) Land use maps - future development/plan		
(3) Administrative maps		
(4) Road network maps		

4.3 Solid Waste Amount Surveys

The Urban Commune is responsible to collect the municipal solid waste generated at households, commercial facilities, public buildings, on the streets and in the gardens. Excluding the portion of the generated waste that is recycled, self treated or illegally dumped, the generated waste is transported to the disposal facility. The disposal facility here means intermediate treatment facilities, such as compost plants and incineration plants and the disposal site. It is therefore obvious that the generated waste amount will not equal the disposed waste amount.

Consequently an understanding of the waste amount is needed at both points. This may be accomplished as explained in the following sections.

4.3.1 Amount of Solid Waste Generated

Surveys for estimating the solid waste amount generation should be done periodically, if possible once a year or when significant changes have occurred which may influence population shifts. In case of once a year then different seasons of the year should be selected (i.e. first year in summer, second year in winter, etc.) in order to obtain an understanding of the seasonal fluctuations in waste amounts. The survey method is explained by waste types in the following sections.

1) Household Waste

A suitable number of households from each income bracket are selected, distributed in different areas of the commune. Taking into consideration costs of the survey about 20 to 50 households are surveyed from each category with a total of 60 to 150 households.

The waste is collected daily from each of the selected households for 8 consecutive days, and weighed. Figures for the first day are discarded. Population data is also collected for the surveyed households to estimate waste generation per capita. Average of seven days for each of income bracket is obtained. Knowing the share of the urban commune population by income bracket it is possible to calculate the average generated rate and total generated waste amount.

If figures on income levels are not available it may be possible to use another classification system such as house type (block, low-rise, semi detached or detached). The best way is to apply the same categories as those of the national census.

This survey can be carried out by the cleansing staff to reduce costs. Citizens will be asked to cooperate by discharging their waste in plastic bags. If budget is available then plastic bags may be purchased by the commune and distributed to the surveyed households to ensure their cooperation.

2) Commercial Waste

Commercial waste is usually difficult to accurately estimate, because of the numerous and varying types of commercial activities. Depending on the available data base sampling will be done. For example if the data base is categorized by large (department stores), medium and small (boutiques) shops than the same categorization may be used. The same applies for hotels (classified by number of stars) and restaurants. It is important to remember that the sampling should conform to the data base available. Markets such as open vegetables and fruits markets are also surveyed.

In the same manner as for household waste, the waste discharged in plastic bags shall be collected for 8 consecutive days from the surveyed concerns and weighed. Information shall be collected on floor areas and waste generation amount shall be defined in ton/m^2. Some commercial concerns are served by individual communal container, and in that case the container weight can be used to estimate the unit generation rate.

Lack of sufficient data base to expand the sample results makes this survey meaningless. In such a case it is preferable to implement a questionnaire survey directly to the commercial concerns. A list of shops, hotels, etc. may be obtained from the local chamber of commerce. This was the case for the survey conducted in Safi city.

3) Institutional Waste

The institutional waste generation amount shall be surveyed in the same manner as the commercial waste.

4) Street and Garden Waste

Road lengths are selected from road classes I and II. About 6 kilometers of roads representing six working groups may be surveyed and the waste swept daily is weighed and the average waste generated can be estimated in terms of ton/kilometer run. This survey may be implemented over 3-4 days.

In the same manner, garden wastes collected for a number of days are weighed and the garden waste generation rate is estimated in ton/ha.

4.3.2 Amount of Solid Waste Arriving at Disposal Sitet

If a truck scale is available at the disposal site then all the waste arriving there should be weighed and recorded. The records should show;

- collection vehicle license number (or designated number)
- vehicle full weight
- vehicle empty weight
- cleansing section where waste is coming from
- type of waste hauled; (usually the waste is household or mixed, but sometimes large commercial or institutional generators are served by individual vehicles)
- times of arrival to, and departure from the site
- vehicle ownership/operator

This information will allow the collection and transport operators to know the total amount of waste they transported daily, as well as other operation indices such as trip number/vehicle, haul/vehicle, amount transported by each cleansing section, etc. To give the Municipal Engineer an idea of the average daily amount of waste required to be collected, and if a truck scale is available at the disposal site the total waste entering the site from the Urban Commune shall be weighed for a period of about two weeks continuously.

However in Morocco only Casablanca disposal site has a truck scale. The national action program prepared in this study calls for introducing truck scales in all urban disposal sites by the year 2001. Up to then it is possible for the urban communes to rent a truck scale facility for one or two weeks for the purpose of the survey. This was done during this study for Safi, El Jadida and Sidi Abou Zeid.

4.4 Composition of Solid Waste

The composition of solid waste is studied in order to understand the following;

- physical composition expressed in terms of moisture, ash and combustible contents
- components such as organic, paper, plastic, glass, metal, etc.
- chemical characteristics such as carbon, hydrogen, nitrogen, oxygen, sulfur and chlorine

Waste composition has a close bearing on the evaluation of need and suitability of intermediate treatment system. Various systems are discussed in Part B, Chapter 8. In the case of composting, in addition to need for confirming market demand, and cost feasibility the organic content of the waste should be high in order for the composting to succeed. In Morocco while the waste organic content is high, the moisture content is too high (about 65% which exceeds the recommended 55%), a factor which must therefore be considered in adoption of composting option and selection of composting method. Incineration is another intermediate treatment system widely used in Japan and other developed countries. The success of incineration requires the waste to have a lower calorific value of not less than 1,200 Kcal/kg, a figure which is not satisfied by the highly moist, low combustible content Moroccan waste. Finally recycling is an important element of SWM and a sustainable recycling plan must be based on an understanding of the waste contents and the market for the recyclable products. Therefore estimates of the amounts of plastics, paper, glass and aluminum salvageable from the waste stream are required to prepare a feasible recycling plan.

Naturally depending on the degree of analysis the costs and equipment requirements will increase. On the other hand the detailed chemical information will assist the urban commune in deciding suitable intermediate treatment facilities.

At this stage it is proposed that the urban communities and communes concentrate on improving the open dumping conditions at the disposal sites and introducing control landfill as a first step towards sanitary landfill. Therefore urban communes should analyze the waste composition with a view point to obtain data on the bulk density and moisture content in addition to information on the components. Chemical analysis at this point may be required only in special cases. Information on the waste components may be used to assist the urban commune officials in evaluating recycling targets and schemes. Knowing the solid waste bulk density will provide a tool for conversion of waste volume into weight which is the more practical unit in solid waste management.

If ovens are available than the waste samples should be analyzed on a dry basis. Otherwise analyzing on a wet basis is acceptable.

4.5 Forecasts of Waste Amount and Composition

4.5.1 Socioeconomic Projection

The waste amount and composition forecast is based on the growth in population and affluence of the society. Both obviously lead to a larger amount of waste and a change in the waste composition.

The urban commune population forecasts have been discussed in Chapter 2 section 2 earlier. It is doubtful that all urban communes have forecasts and therefore national figures reasonably adjusted based on the urban commune characteristics should be adopted.

4.5.2 Waste Amount Forecast

The factors that will effect the increase in waste amount are as follows;

- increase in population
- expansion of service coverage
- increase in unit generation per capita as income levels increase
- increase in economic activities in line with increased income levels

Elsewhere in this report the forecast for the municipal urban waste in Morocco in general, and Safi and El Jadida in particular are discussed.

Each urban commune will set the first two factors as described earlier in this report. Concerning increase in unit generation a 1 - 2% annual increase is reasonable, adopting the higher figure in presently economically active communes (for Safi city an average of 1% was adopted based on the forecast economic growth rate in each of the three urban communes). The same applies for the other waste types which may be considered to increase from 6 to 8% annually (for Safi city a smaller value of 4% was adopted). An example for estimating the waste amount of one urban commune is as follows;

Table 4.5-1 Estimation of the Waste Amount of One Commune (Example)

Item	1996	annual growth rate (%)	2000
Population	100,000	3%	112,550
Service coverage	80%	target set by each urban commune	example 95%
Household waste unit generation	0.6 kg/cap/d	2%	0.65 kg/cap/d
Commercial & Institutional Waste	15 ton/d	7%	20 ton/d
Total waste amount	63 ton/d		89 ton/d

4.5.3 Waste Composition Forecast

A forecast of the change in waste composition is possible based on the examples of developed countries. As the living standards increase and the society becomes more consumer active (for products other than food) and competition amongst retailers increases more paper (wrapping), plastics, metal and glass are expected to be found in the waste stream. Therefore in broad terms the waste composition is expected to undergo the following changes;

- paper to increase
- plastic increase
- non-combustibles (metal and glass) increase
- garbage and wood decrease
- ashes decrease

The above changes in the waste composition will result in the following changes;

- density decrease
- moisture decrease
- lower calorific value increase
- recyclable constituents increase

If the waste in Morocco follows these trends than more activity in the recycling field may be encouraged. And in the not so distant future more consideration may be given to the potential for incineration.

CHAPTER 5 IMPROVEMENT PLAN FOR COLLECTION SERVICE COVERAGE

5.1 Citizens' Right to receive the Service

There was another choice for the title of this section; "SWM Operators' Obligation to Provide the Service". It was felt that that title would have put the burden completely on the operators. Rather this chapter stresses the right of citizens living in particular areas to receive the service and at the same time the need for their cooperation. Therefore community participation in selection and implementation of the collection system is very important.

As explained in Chapter 2, each urban commune should understand the extent of service coverage in the commune. For the non-served areas the urban commune should study the following;

- locations of non-served areas on maps
- under which collection section the area belongs
- population living in those areas in order to estimate the amounts of waste generated there

Under the principle of extending collection service to all the residents the municipal engineer should then, based on the targets set out as described in Chapter 3, develop specific targets by collection section. The next step would be to decide the appropriate technical system for the non-served areas. The following section makes some proposals based on the type of non-served area.

5.2 Countermeasures for Non-served Areas

From the visits made by the Study Team and interviews with officials it is considered that most of the non-served areas are located in the following areas;

1. newly developed areas on the urban fringe
2. slum areas (shanty towns)
3. rural areas on the urban fringe
4. areas with difficult vehicle access

Service shall be extended by the urban commune to these areas under the principle of strong community participation. This participation may take any of the following forms;

- waste discharge at collection stations (with or without communal containers) with walking distances of up to 100 meters
- acceptance of collection frequencies of 3 to 2 days per week
- maintenance of collection stations regulations and sanitary conditions
- provision of own primary collection as necessary
- participating in recycling schemes to decrease waste volume to be collected and provide some small revenue to cover some costs such as purchase of hand carts or brooms for street sweeping
- assistance in sweeping of branch streets

Comments and countermeasures for each area are discussed below.

5.2.1 Newly developed areas on the urban fringe

a) Description

Such areas include new housing areas developed either by the government or private developers on empty lands skirting the urban agglomeration. The reasons for not extending collection service to such areas may be any, or a combination of the following;

- No planning for SWM during the development planning stage
- Lack of equipment and manpower to extend the service to these areas
- Unclear under which cleansing section jurisdiction the area belongs to
- Urban commune's refusal to serve the area if the residents are unlicensed

b) Countermeasures

For any new formal development the basic utilities of electricity, water and sewage are considered. In a likely manner plans for SWM need to be drawn up at the development stage. Countermeasures for this problem are as follows;

- develop SWM plans (collection frequency, collection system, equipment required, associated costs, etc.) when submitting future development plans for the approval of the urban commune's city planning department or section
- developers responsible for maintaining building maintenance and landscaping after selling the plots, may be encouraged to collect and transport the waste to the disposal site (the problem with this countermeasure is the residents possible complaint that although they pay the "cleansing tax" they must also pay to the developer to collect their garbage)
- introduce collection frequency of 3 to 2 days/week and discharge at collection stations as a minimum where the development has already been completed and collection service is not provided

5.2.2 Slum areas (shanty towns)

a) Description

A literal translation from the Arabic name for such areas is "tin cities". Dwellings are constructed by low income people on land with unclear ownership rights. Such areas usually lack basic infrastructures such as water piped to the housing, sewage and paved streets. Public drinking fountains and toilets are mainly used. Electric power is usually provided through homemade connections to power lines. In many Moroccan cities such areas are located within the urban fabric, near the city center.

Obviously the residents in such areas have other priorities than SWM, such as water supply. During visits to such areas in some cities the clean conditions of the streets were noted. The residents pay much attention to sweeping in front of their homes, and cooperate together to keep their narrow, dense areas clean. Waste is usually taken out to open spaces were it is illegally discharged or collected by the cleansing authorities in cleansing campaigns. Reasons for not extending collection service to these areas include;

- Urban commune's desire to eliminate such areas
- Difficult access within the areas
- Illegal settlement of the residents
- Poverty of the residents and inability to pay "cleansing tax"
- Citizens demand for other services and low priority they place on SWM

b) Countermeasures

Such areas however cannot be ignored. The collection of solid waste and removal of public health threat should not be coupled with solving the social and legal problems related to such areas. The following countermeasures may be adopted to extend collection service;

- usually citizens living in such areas know each other and try to improve the poor conditions around them so it is necessary to address their community leaders with specific proposals such as those described herein
- provide communal containers at collection stations (a container of 3 to 5m^3 with multi-loader truck is a feasible solution)
- encourage citizens to bring their wastes to collection stations by themselves without primary collection
- encourage citizens to promote and operate simple recycling initiatives starting with one or two components such as paper and plastic
- if such areas are legalized or development plans are introduced then at the same time SWM component should be considered

5.2.3 Rural areas on the Urban Fringe

a) Description

Small villages in the outskirts of the urban areas are sometimes included in the urban commune. Such villages usually lack paved roads and basic public services such as piped water and sewage. These areas may be described as follows;

- Usually sparsely populated (low density) and distant so service may be expensive
- These areas are usually outside collection section boundaries
- Difficulty to access, and drive through such areas

b) Countermeasures

Urban communes have a responsibility to extend collection service to all inhabitants of the commune inclusive of the residents of any villages that may fall within the commune boundary. However because of the nature of such areas, suitable collection system should be selected. Excessive door-to-door, daily collections using compactors may not be cost efficient. The following countermeasures are recommended;

- provide collection service at least once a week in case of door-to-door collection or 2-3 days/week in the case of collection station equipped with community container (a container of 3 to 5m^3 with multi-loader truck is a feasible solution)
- door-to-door collection only applied where households are at great distances apart
- self treatment by burning under safe conditions may be promoted
- in rural communities organic content of the waste may be used as compost

5.2.4 Areas with difficult Truck Access

a) Description

With the development of the equipment used in waste collection and transport, it becomes more difficult to apply such equipment in the old parts of the city or areas with unique topographic features. In many Moroccan cities the Medina areas represent such areas. These areas may be described as follows;

- Medina areas; tourist attractions and concentration of traditional crafts industries
- Hilly areas; old development of the city
- Areas far from paved streets

b) Countermeasures

It is not possible to ignore such areas because of their traditional and sightseeing value. An adequate collection system to serve the narrow alleys in such areas should rely on a primary collection using small vehicles and a secondary collection system from a transfer station near the area. The collection system can be described as follows;

- Use of dumper (mechanized 1 m^3 vehicles) or pick-ups to collect the waste from collection stations within the area and bring to the transfer station. Hand carts may also be employed but animal driven carts should be avoided except for unique conditions such as many stepped alleys.
- Selection of an adequate primary collection method to bring the waste to the main streets or transfer station should be in consultation with the community leaders
- An empty site located near the area may serve as a transfer station using a container of 3 to 5m^3 with multi-loader truck.

CHAPTER 6 SELECTION OF SUITABLE COLLECTION AND TRANSPORT TECHNICAL SYSTEM

6.1 General

6.1.1 Waste Amount

The collection and transport service should cope with the generated waste amount. Therefore the most important starting point is to determine the necessary waste amount to be collected and transported. That has been discussed in Chapter 4. Most urban communes are divided into cleansing sections, based on the available equipment (e.g. one truck per section) or other considerations.

Based on the analysis described in the previous chapters, the urban commune municipal engineer will estimate the amount of waste generated daily at each cleansing section by type and the amount of waste that should be collected from each cleansing section using the targets set out by the commune and taking into consideration the expansion of the service coverage area as shown in Chapter 5.

The urban commune should then have a clear idea of the effort required at each cleansing section. Knowing the characteristics of each section the next step would be to decide the appropriateness of presently applied collection system; where it is applied, if it is sufficient or requires strengthening. This chapter may assist the commune municipal engineer in selecting an efficient system that is both implementable and cost efficient.

6.1.2 Flow of the Collection and Transport System

The typical collection and transport system flow is depicted in Fig. A.6.1-1.

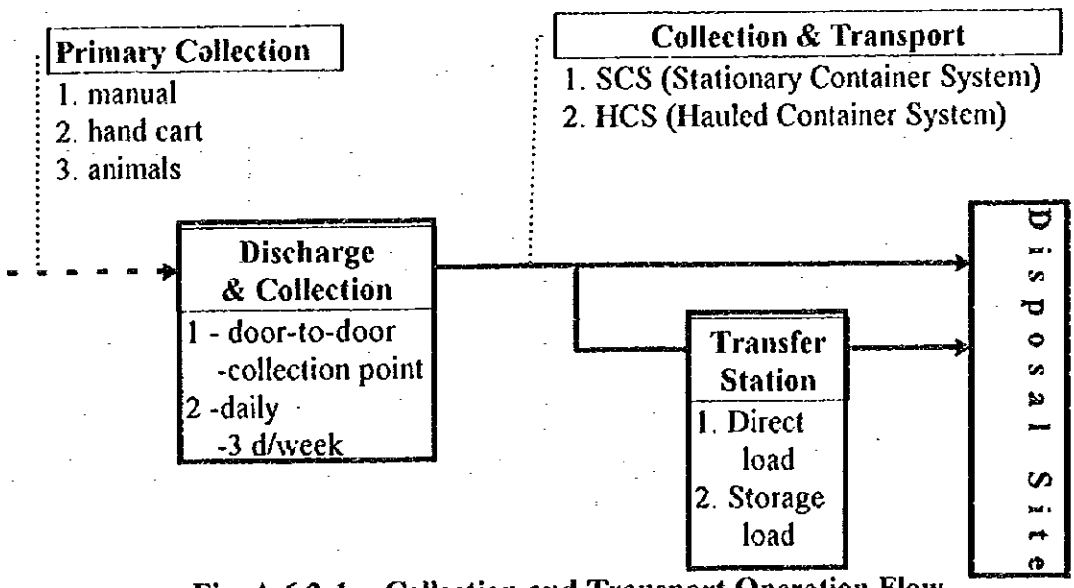


Fig. A.6.2-1 Collection and Transport Operation Flow

Each step of the collection and transport system shall be described in the following sections.

6.2 Primary Collection

6.2.1 Need for Primary Collection

Primary collection involves bringing the waste from the discharge location to the collection station. This service is provided in areas where truck access is difficult or where communal container is used. While residents within walking distances of about 100 meters can walk to the containers, those living farther away may require primary collection to bring their waste to the container.

In principle it is strongly suggested to apply this service only where it is very necessary. This service has three disadvantages;

- it increases waste collection costs (estimated at 50 to 80 DH/ton using hand cart)
- it is a difficult task for waste collection workers or involves using animals which may create unsanitary conditions
- it decreases citizens awareness of SWM and reduces any efforts they may exert in waste volume reduction by having them become accustomed to receiving door-to-door collection service

Citizens living within about 100 meters from collection stations should be encouraged to bring the waste to the collection stations by themselves. As shall be discussed in the following section, the collection station may be an open station type or may be a communal container. In the case of communal containers, sizes of 3, 6, 10 and 16 m^3 may be placed depending on size of collection station and density of the population to be served. For the collection stations a large amount of waste piled up at the point is not recommended. For such points 1 m^3 of waste should be considered with a maximum volume of 2 m^3. Under these conditions, as shown in Table A.6.2-1, for collection stations serving the following population densities it may not be necessary to provide primary collection.

Table A.6.2-1 Collection stations where Primary Collection is Unnecessary

Collection station	Population Served (capita)	Population Density (cap./ha.)
1. Collection station (open station)		
- waste amount 1 m^3 placed at station	500	160
- waste amount 2 m^3 placed at station	1,000	320
2. Collection station with Communal Container		
- container size 3 m^3 placed at station	1,600	510
- container size 6 m^3 placed at station	3,200	1,020
- container size 10 m^3 placed at station	5,300	1,700
- container size 16 m^3 placed at station	8,500	2,700

Estimates: - waste densities in open station and communal container assumed 0.3 and 0.32 t/m^3 resp.
- unit. generation rate 0.6 kg/cap/d

If an open station serves an area with population density of 160 to 320 persons/hectare there is no need for considering primary collection, as all the residents using the station will be within the 100 meter walking distance. In the same manner the areas served by communal containers and with densities as shown in the table do not require primary collection.

Where collection stations (based on waste volume expected or container sizes) serve lesser population densities, introduction of primary collection should be considered. This service would be only for citizens living far from the collection stations and not those close to it.

6.2.2 Types of Primary Collection

At present the three types of primary collection observed in the urban communes are;

- manual
- hand cart
- animal hauled

Manual and animal hauled types are used where the area contains many steps such as the Fez Medina and it is difficult to use hand carts.

Manual type, where the collection worker collects the waste using primitive tools and a basket should be avoided as much as possible because of the difficult working conditions involved. Animals for hauling waste should only be used to serve areas where there are many steps and are far from the collection stations.

Costs for hand cart can be decreased by utilizing one hand cart to serve a larger area on a rotating basis (instead of buying two carts and increasing workers); i.e. three days a week at location A and the other three days at location B. Locations A and B would be midway to the collection station and on opposite sides of it. This would avoid door-to-door collection by the hand cart which is time consuming. Citizens would be informed to bring their wastes to these locations within certain hours and the hand cart would make 3 to 4 trips from that location to the collection station a day. This system has been tested in Indonesia in low income areas with large success. However it requires a strong participation on the part of the community which can only materialize after conducting public education.

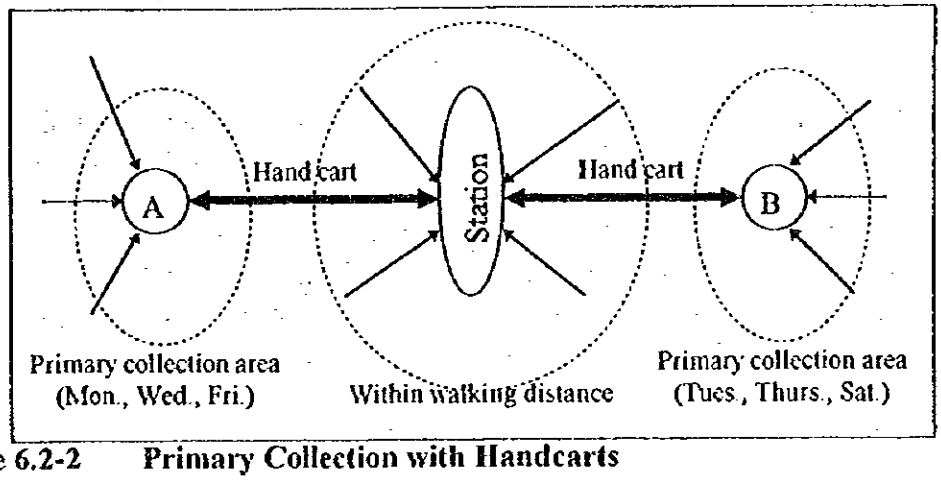


Figure 6.2-2 Primary Collection with Handcarts

6.3 Discharge and Collection

6.3.1 Definitions

Discharge is the activity in which citizens remove their solid wastes from their premises to a designated point where the wastes are to be collected. Factors that should be considered in this activity are;

- packing in which waste is discharged (plastic bag, individual bins, unpacked or loose)
- weight discharged waste
- time when waste is discharged
- point where waste is discharged

Collection is the activity in which the urban commune collects the waste from the places where it is discharged to transport it to the disposal facility. This activity is generally effected by the same factors as that of the discharge, and therefore both shall be discussed together in this section.

6.3.2 Discharge/Collection Location

The urban commune, based on the existing practice should consider two methods for discharge and collection; door-to-door (curbside) and collection station. In the door-to-door method the citizens discharge their wastes in front of their residences or commercial establishments. The collection station method calls for citizens to bring their wastes to a designated pick up point.

The collection station may either be an open space, a fenced-in space, or a communal container (with various sizes). The collection station method is more cost effective than the door-to-door method because it reduces the amount of time the collection truck spends on the collection route and therefore increases the number of trips the truck can operate in a day.

The collection station should be located along a main street in order to facilitate truck access and temporary stopping to load the waste without creating too much traffic disturbance. A signboard should be posted to identify the location and the discharge instructions. There may be difficulty in selecting the station locations because of the NIMBY theory (Not In My Back Yard) where residents refuse to have such a station in front of their properties. Locations in front of empty lots, offices or public buildings may be easier to select.

However this system demands of both citizens and urban communes the following;

- citizens cooperate in (i) walking to the collection stations, (ii) using plastic or paper bags to pack their wastes (in the case of no communal container), and (iii) not discharging wastes after collection truck pick up on the designated day
- urban communes must be (i) prompt in collecting the wastes at the designated times in order not to leave the wastes piled up at the collection stations, and (ii) properly clear the collection station at the time of pick-up

6.3.3 Discharge/Collection Time

In the context of discharge/collection time both the day of the week and the hour of the day should be considered.

In Japanese cities citizens are allowed to discharge their wastes only three or two days a week. Daily waste collection is too costly. Lower collection frequency can reduce the collection costs by 20 to 30%. In the case of Morocco daily collection is the common practice. Each urban commune should consider the steps required to introduce the 3 days/week system. This is expected to take time as the citizens must be educated before hand on the benefits of this system. The argument always put forward is that the Moroccan household waste is high on the water content side being mainly organic. This should be taken into consideration. The proper storage of 2 to 3 days waste in the household is possible although it may incur more costs on the citizens part in buying suitable bins. Therefore their cooperation and understanding is essential.

Experience of the Study team in Safi city indicates that there is strong opposition on the part of residents to store their waste inside their residences for more than one day. Therefore it may be too optimistic to consider introducing this system in the near future for all the urban commune. The urban commune is advised to select an area where community awareness is strong and introduce the 3 days/week system on a pilot project basis coupled with an educational campaign. Based on the evaluation of the pilot study the system may then be gradually expanded over a larger area.

Presently in Morocco there are no clear regulations on discharge time. In many urban communes the citizens generally know when the collection truck usually passes and discharge their waste before that time. But in many places served by morning collection, discharge of waste in the evening or at night is observed. Scavenging by man and animals is significant and keeping discharged waste in the streets for a long time leads to scattering of waste and poor aesthetic conditions.

In the case of door-to-door or collection stations (without communal container) discharge, and where the collection truck passes say between 08:00 to 11:00, citizens should be instructed to discharge their wastes during the early hours of 06:00 to 08:00. For door-to-door collection, discharged waste should be packed in disposable paper or plastic bags or suitable size individual bins. In case of collection stations, citizens may find it inconvenient to use individual bins because they would have to return to the collection station to pick up the emptied bin after the truck has left. Loose waste discharge should be strictly forbidden.

For collection stations having communal containers which permanently serve the area, the citizens can bring the waste to the container at any time. However the waste should of course be placed inside the container. If the container serves more than one area on a rotation system (say 3 days a week in area A and the other 4 days in area B) than citizens should be instructed on the week days in which to bring out the waste.

6.3.4 Source Separation

1) Considerations in Introducing Source Separation

Source separation means separating the waste components at the generation point (house, office, shop, etc.) and discharging the components separately. This system depends on two factors;

- provision and type of intermediate treatment facility
- recycling system

In Japan the majority of the waste is incinerated in an intermediate treatment facility and the ash is transported to the disposal site. To increase efficiency waste is separated at the source into combustible (kitchen waste, plastics, textiles, colored paper, etc.) and non-combustible components (glass, cans, some types of plastics, etc.) and collection days for each are designated.

In the city of Kawagoe the combustible waste is collected on Mondays and Thursdays and the non-combustible waste once or twice a month. Under the recycling system applied in the same city, newspapers and glass bottles are recycled. Again these are separated at the source and collected once a month on a designated day.

In Morocco, urban communes should consider source separation in the context of an overall plan for the separated materials. Introduction of incineration plants in Morocco is not likely in the near future because of the high costs of the facility, relative ease in finding land for landfill sites, and high moisture content of the waste. Likewise composting facilities have not been very successful so need to separately collect kitchen waste is not envisioned.

Separate collection of recoverable materials, on the other hand should be studied by the urban commune within an appropriate recycling program. This program should consider the market demand for the recyclable materials and the players involved in this activity. More discussion will be presented regarding this matter later in this report.

Source separation incurs separate collection of the separated items and the collection costs are likely to increase. Therefore application of source separation should only be under feasible conditions, such as gaining revenues from sales of recovered waste items, or applying incineration or composting as intermediate treatment processes, with the high costs of such processes offset by the savings in land purchase costs for the disposal site or revenues from compost sales or energy recovery. In Morocco conditions do not yet justify widespread source separation of the waste.

2) Separation of Hazardous Municipal Wastes

As the environmental consciousness of the Moroccans strengthens and operation of the disposal sites is gradually improved to sanitary landfill it will be necessary to separate the hazardous components in the municipal wastes (such as batteries, oils, some cleaning and polishing liquids, house insecticides, some medicines, etc.) and dispose of it separately taking special precautions.

The urban commune should consider introducing separate collection of hazardous household wastes after some public campaigns and based on the targets set out on the national level, and the available treatment and disposal facilities.

6.4 Collection & Transport System

6.4.1 General Description of Technical Systems

Transport systems can be broadly classified into two systems

- Stationary Collection System (SCS)
- Hauled Container System (HCS)

In the SCS waste collection trucks collect the waste from the door-to-door or collection stations and transport it to the disposal facility. A number of collection stations are covered during one trip of the collection truck.

In the case of HCS waste is discharged in large containers placed at the generation places, and the collection truck hauls the waste filled container to the disposal facility. Either the truck brings an empty container to the point at the time of collection or returns the emptied container to the point. In each trip the truck makes one pick up.

In Morocco the SCS is predominant, while the HCS can be observed at some hospitals and low income residential areas.

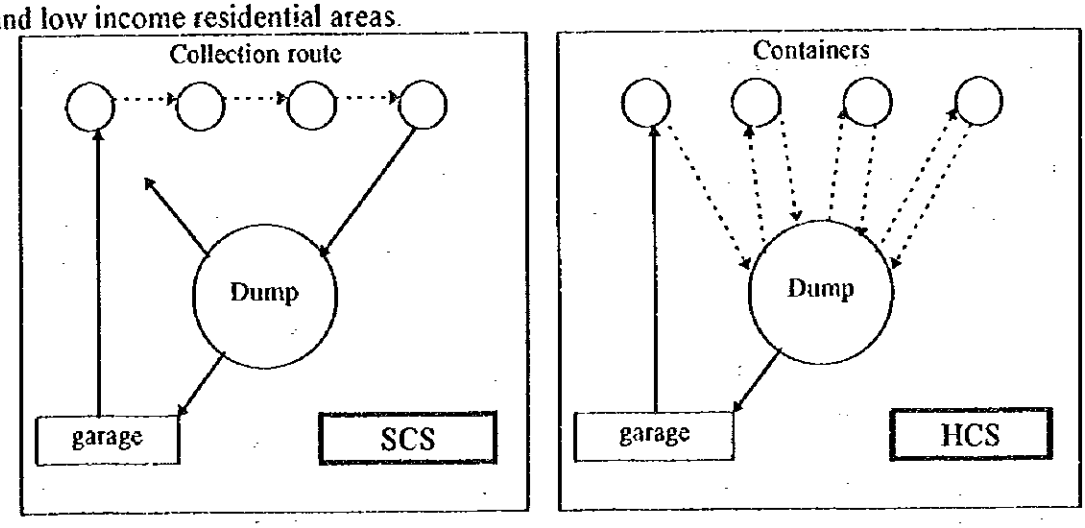


Figure 6.3-1 Stationary Container System (SCS) and Haul Container System (HCS)

6.4.2 Applicability of each System

1) General Applicability

In principle HCS is suitable for waste collection from large waste generators. On the other hand SCS is more suited for collection of small quantities of waste from a large number of generation points. The characteristics of each can be compared as follows (Table A.6.4-1);

Table A.6.4-1 General Applicability of the Transport Systems

Comparative Item	More suitable system SCS/HCS
a. Large waste generators	HCS; Collection of one large container serving the waste generator will mean a reduction in time spent on the collection route and collection crew number. Thus it may be possible to increase truck trips and lower collection costs. Examples are markets, department stores, block housing, etc. HCS will also facilitate in the case of making direct contracts with large generators and payment by number of containers trips over a specified period.
b. Detached low rise dwellings	SCS; Use of HCS in such places having low population densities would involve long walking distances to a large container or increased costs of introducing a primary collection system.
c. Aesthetic evaluation	SCS; This system, if properly operated through discharge of packed waste within given hours and prompt collection is more appealing than the placing of a large container, especially for such areas as touristic, city centers, high and medium residential areas and important institutional buildings. Indeed it is usually very difficult to find residents agreeing to place large communal containers near their properties.
d. Community participation	SCS; Based on the present practices in Morocco it seems easier to get the citizens cooperation in bringing down their waste at a given time in packed form, than to ask them to walk large distances to a communal container location or be responsible for maintaining the cleanliness of the container site.

2) Cost Comparison

In order to compare unit costs for both the HCS and SCS, costs of using different truck types at various distances to the disposal site were compared. The unit costs were estimated as explained in Chapter 10. The trucks and containers compared are shown in Table A.6.4-2 and costs are depicted graphically in Fig. A.6.4-1.

Table A.6.4-2 Equipment Cost Comparison

Truck Type	Capacity (m^3)	Container (m^3)	Collection System (SCS/HCS)	Abbreviation (in graphs)
Compactor	16	1&2	SCS	CL
	12	1&2		CM
	8	NA		CS
Dump Truck	6	NA	SCS	DM
	4	NA		DS
Flat Bed	6	NA	SCS	FM
	4	NA		FS
Multi-loader	6	6	HCS	AM
	3	3		AS

For distances less than 10 km, the small compactor (CS) operated with no containers shows the lowest unit costs followed by the large multi-loader (AM). Above 15 km, the medium size compactor (CM) shows the least unit costs. As the distance increases the smaller trucks of all types become very expensive to operate, while the compactor trucks become the most economical.

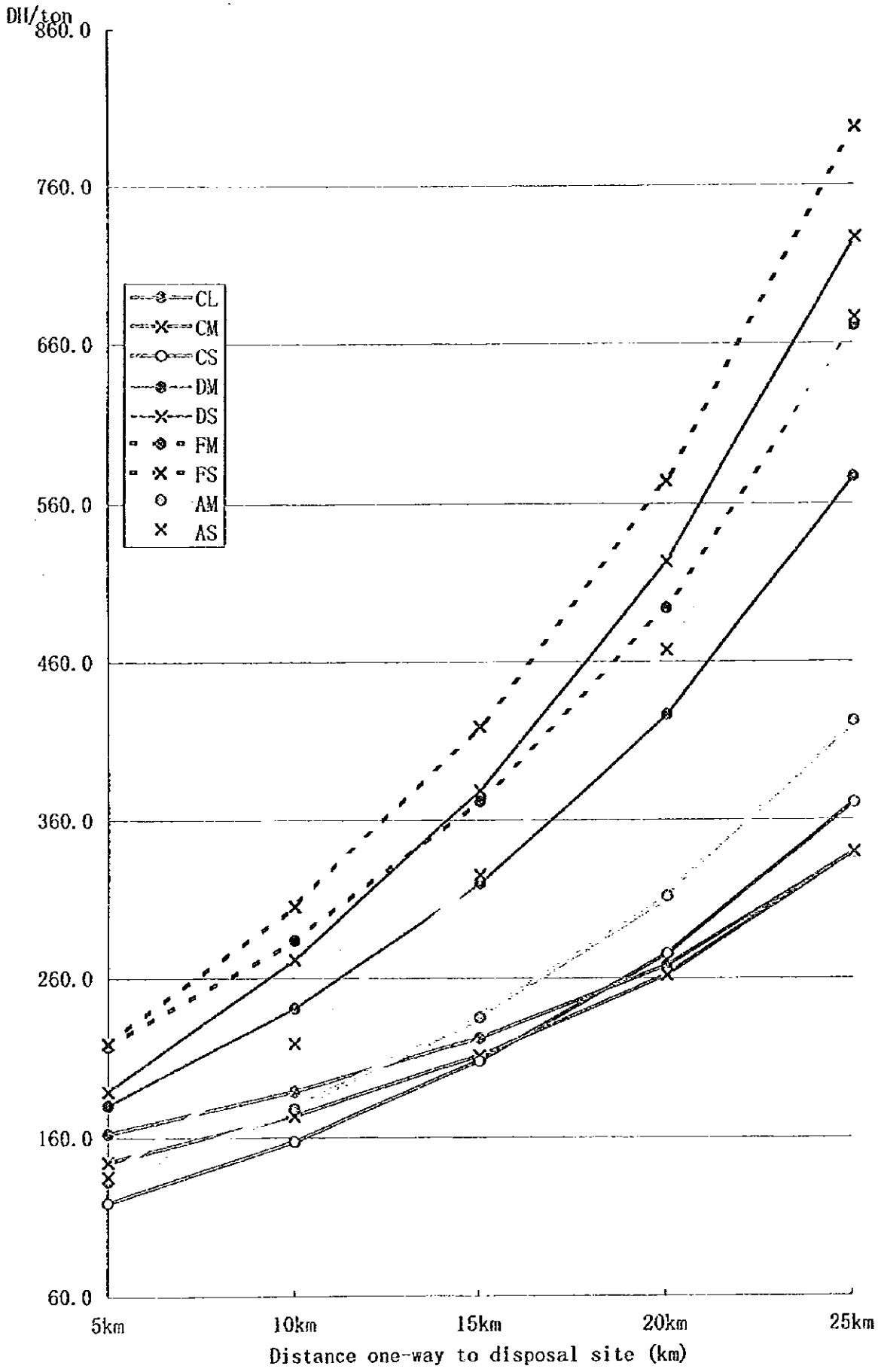


Figure A.6.4-1 Unit Cost Comparison of Collection Systems

In order to select two trucks representing both systems and being most suitable for the Moroccan conditions, the unlikely trucks were removed from the analysis. The medium compactor (CM; 12 m^3) and medium multi-loader (AM; 6 m^3) were selected to represent the SCS and HCS respectively. The results are shown in Table A.6.4-3.

Table A.6.4-3 Unit Cost Comparison for HCS and SCS

(unit: DH/ton)

Truck type	capacity (m^3)	One way distance to disposal site (km)				
		5	10	15	20	25
HCS: Multi-loader Medium (AM)	6	133	175	211	262	340
SCS: Compactor Medium (CM)	12	145	175	277	334	437

It is clear from the table, that HCS is more cost effective at the lower one-way distances below 10 km, while SCS is more cost effective at one-way distances longer than 10 km.

6.4.3 Equipment and Manpower

1) Types of Equipment

The types of trucks that may be considered under each transport system are as follows;

- Hauled Container System (HCS)
  1. Hook type (armroll) (6 and 10 m^3)
  2. Tilt frame (6 and 10 m^3)
  3. Multi-loader (3 and 6 m^3)
- Stationary Container System (SCS)
  4. Flat bed (4, 6 and 10 m^3)
  5. Dump truck (4, 6 and 10 m^3)
  6. Compactor (8, 12 and 16 m^3)

For the HCS the two types mostly used in Morocco are the hook type and multi-loader. The multi-loader is basically used with small containers. For SCS the flat bed is not recommended because of the time wasted in emptying the truck at the disposal facility. Based on the cost analysis described in the previous section, it is recommended to select the truck type from the following;

- Hauled Container System (HCS)
  1. Hook type (armroll) (3 and 6 m^3)
  2. Multi-loader (3 m^3)
- Stationary Container System (SCS)
  3. Dump truck (4 m^3)
  4. Compactor (8 and 12 m^3)

Table A.6.4-4 shows a guide for the selection of the suitable truck type based on some assumed conditions. Trucks of capacities less than 6 m^3 are generally not cost effective, especially when used without a transfer station. However they are necessary for certain areas of the Urban Commune with narrow roads and so a number of these trucks should be included in the fleet.

Table A.6.4-4 Truck Selection Criteria (other than costs)

Consideration Items	HCS			SCS		
	Armroll 3 m^3	Armroll 6 m^3	Multi-loader 3 m^3	Dump truck 4 m^3	Comp-actor 8 m^3	Comp-actor 12 m^3
1. Areas with narrow streets	A		A			
2. City Central Areas				B	A	
3. Lack of space for placing containers				A	A	
4. Separated waste collection	A	B	A			
5. Areas with poorly paved streets	A		A	A		
6. New urban development areas		B			A	A
7. Hospital and industry household waste	A		A			
8. Green parks			A	B		
9. Markets and department stores	A	A	B			
10. Multi-story block housing	A				B	A
11. Poor maintenance abilities			A	A		

Notes: A: Very suitable, B: Suitable

For areas where truck access is difficult (items 1, 5) it is more efficient to ask citizens to bring their waste to a communal container, than to operate a SCS whereby the truck would spend too much time on the route.

The HCS demands space for placing of container, and the continued physical presence of the container. Thus the SCS is more suited in places of tourist value, city commercial centers, and where no space exists for placing of container (items 2, 3). HCS is suitable in serving large waste generators (items 7, 9).

Maintenance of the hydraulic systems of compactors and armroll trucks may be difficult when there is poor workshop equipment and technical know-how. Multi-loader and dump trucks would be more suited in this case (item 11).

2) Equipment and Manpower by Cleansing Section

Knowing the amount of waste to be collected by collection section and after deciding the appropriate transport system and equipment the municipal engineer should then estimate how many trucks (by type) and workers are needed by section.

An example for estimating the required trucks and manpower for a population of say 20,000 (a small urban commune or cleansing section of a large urban commune) is shown in Table A.6.4-5.

It should be noted that all assumption are based on experience gained from time and motion surveys in cities in developing countries and in Safi city. To obtain realistic results the urban commune municipal engineer should conduct time and motion surveys in his own urban commune as shall be explained in Chapter 7.

This exercise is just to give an example for estimating required truck and manpower. Under actual conditions a combination of a number of trucks would be more cost efficient. Safi city collection and transport improvement plan was prepared using a number of truck

types and may be referred to.

Table A.6.4-5 Truck and Manpower Requirements Estimation

Truck	Hauled waste density (kg/m^3)	Hauled waste/ trip (ton)	Trip number/ shift	Driver + Crew	Reqd. truck number	Reqd. container number	Reqd. man-power
1. HCS							
(1) Armroll (6 m^3)	320	1.6	4.9	2	2	10	4
(2) Multi-loader (3 m^3)	320	0.9	4.9	2	3	15	6
2. SCS							
(1) Compactor (12 m^3)	550	5.6	1.7	4	2	88	8
(2) Compactor (8 m^3)	550	3.7	2.2	4	2	--	8
(3) Dump truck (4 m^3)	350	1.2	2.8	6	4	--	24

Assumptions: 1. Unit generation rate: 0.6 kg/cap/d
2. Truck haul rate: 85%
3. Distance one way to disposal site: 10 km
4. Travel speed to disposal site: 30 kph
5. Shift: 7 hours
6. Collection daily at collection station
7. Armroll: 1 container/trip, CM: 26 containers ($1m^3$)/trip

6.5 Transfer Station

6.5.1 Need for the Transfer Station

The transfer station is a facility to which the waste is transported by a smaller capacity means of transportation and transferred into a larger capacity transport means. The need to provide a transfer station becomes more urgent as the distance between the collection route and the disposal facility increases. Usually at distances larger than 20 km it becomes necessary to consider introduction of a transfer station.

The urban commune should decide on constructing a transfer station after conducting an economic evaluation. An example of such an evaluation is shown in Fig. A.6.5-1. The results of this evaluation show that for medium sized compactor (12 m^3) and multi-loader (3 m^3), it is more cost efficient to introduce a transfer station for distances of over 12 and 16 kilometers respectively.

In this example a transfer station of capacity 200 ton/shift was assumed and the secondary transport to the disposal facility was operated using trucks hauling 40 m^3 capacity containers with built in compactors. The distance from collection zone to the transfer station was assumed to be 5 km, and distances from the station to the disposal facility at 10, 15, 20, and 25 kilometers.

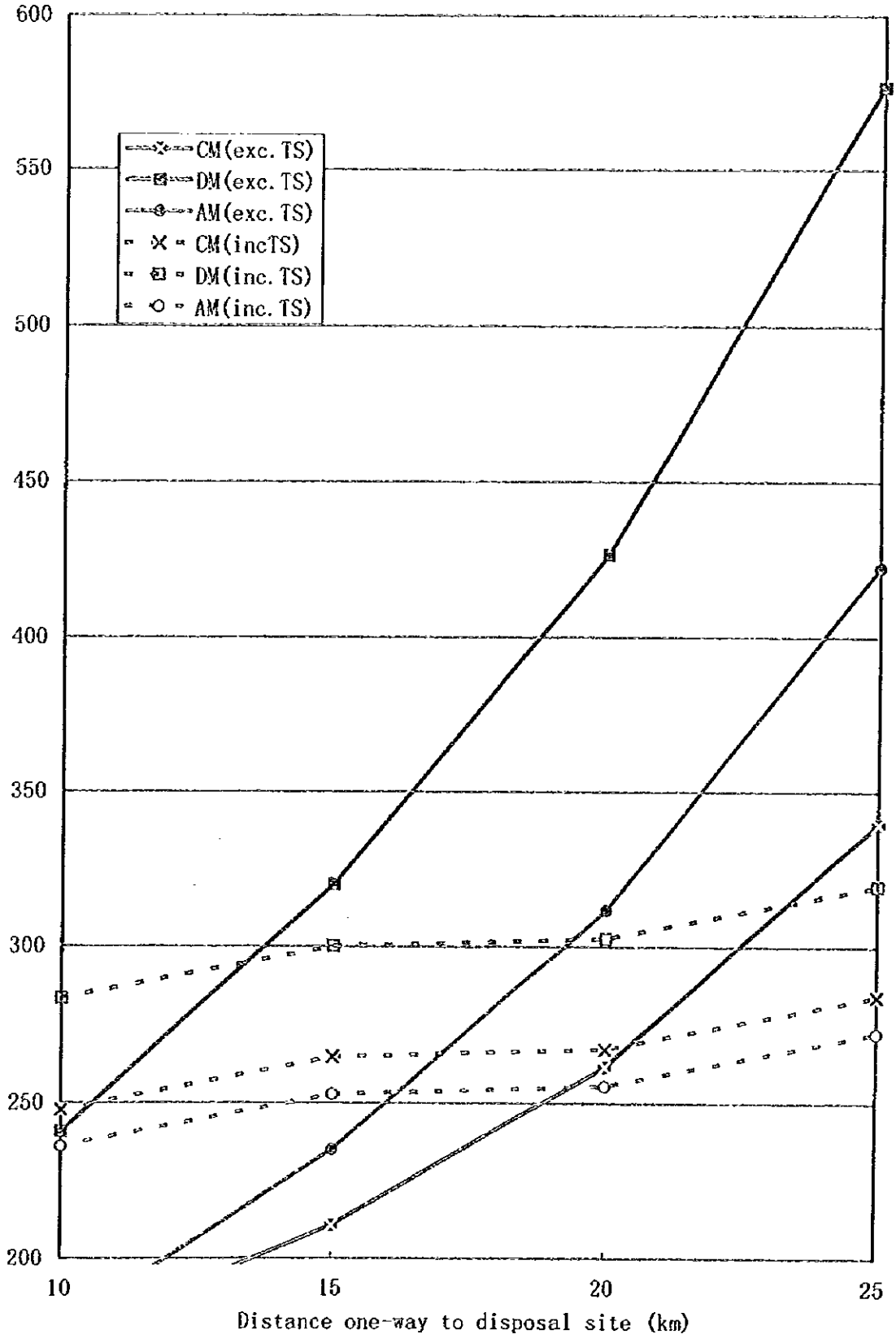


Figure A.6.5-1 Transfer Station Necessity Evaluation

6.5.2 Transfer Station Facilities

Transfer stations are basically operated by (a) direct loading, or (b) storage loading. In direct loading the waste is dumped into the secondary transport containers from an elevated platform. Under storage loading the primary transport trucks dump the waste in a storage pit. The waste is then loaded onto the containers of the secondary transport trucks by cranes or bulldozers.

The transfer station facilities vary depending on the size of the station, secondary transport to the disposal facility and use of the station for any other activity, such as sorting of waste. A general description follows.

Incoming collection trucks are weighed at a truck scale at the station entrance. The collection trucks then ascend a ramp to reach an unloading platform.

Depending on the station size the unloading practice differs. In the case of smaller stations, the trucks unload directly into waiting containers or large dump trucks for the secondary transport (direct loading type). In the case of larger stations, a storage pit may be available to provide capacity for 1 to 2 days storing of waste in case of emergency. In principle all waste arriving at the transfer station should be transported to the disposal site on the same day (storage loading). The unloaded waste is stored into the secondary transport truck using bulldozers or loading hoppers.

The secondary transport trucks may be large dump trucks, or trailers hauling containers. Naturally the larger the capacity the more cost efficient the secondary transport will be. Provision of compactors will also improve cost efficiency. Compactors may either be built into the container, or may be stationary to push the waste into the containers. In selecting the suitable secondary transport means it is necessary to consider the maximum allowable weights on the highways in Morocco. A 40 m^3 container hauling compacted waste of density 500 kg/ m^3 would have a weight of 20 tons which is acceptable in most countries.

The secondary transport facility will stand on a truck scale and when the container reaches the maximum allowable weight loading will stop. The collection truck will be re-weighed as it leaves the station and the unloaded waste weight shall be recorded.

6.5.3 Small Transfer Stations for Primary Collection

In areas where it is necessary to provide primary collection, the urban commune should consider the introduction of a small transfer station to unload the waste into collection trucks. Such stations are on a small scale and need not be so sophisticated because the expected waste amount transferred there is small. However they should be carefully designed and operated because they are always adjacent to the collection zones and residential areas. Examples are found serving the Fes Medina area where the waste is transferred from donkeys, mules and hand carts into collection trucks.

In the design of such stations the following should be considered;

- site enclosure to control access
- availability of collection trucks to transport the waste so as not to have the waste lin-

ger at the station
- slope of ramp leading up to unloading platform should be very gentle
- washing facilities at the site
- station distance to the collection zone and access to a main road

6.5.4 Considerations in Siting and Design of Transfer Stations

A transfer station is an important facility that is usually operated to serve more than one urban commune. Therefore in the siting and design, and indeed the operation of such a facility the urban community is expected to assume the lead role. So an urban commune, with a distance of more than 20 km from a disposal site should study construction of a transfer station together with the Urban Community, as it is expected that other neighboring urban communes will be facing the same need. Some of these considerations are addressed in this section.

1) Transfer Station Area Requirements

The transfer station area should be decided taking into consideration the following;
- design capacity
- collection trucks and secondary transport trailer sizes and maneuvering requirements within the station
- need for having a storage capacity of maximum 3 days (the station should not be allowed to serve as a small dumping site)
- implementing of waste recovery

2) Equipment Requirements

As explained earlier the following facilities should be considered in the design of the transfer station;
- site enclosure
- two truck scales, for the incoming collection trucks and for the outgoing secondary transport trailers/trucks
- facilities for loading the waste depending on station design
- stationary or container-installed compactors
- washing facilities for collection trucks
- emergency repairs workshop
- administrative and washroom facilities
- etc.

3) Environmental Considerations

On the one hand the transfer station is not a facility for permanent disposal of the waste, such as a disposal site but rather an intermediate processing point where the waste is compacted (in most cases) and loaded onto larger transport trucks for transport to the disposal site. On the other hand, from the cost effectiveness point of view the station should be located close to the collection routes in order to increase the utilization efficiency of the collection trucks by increasing the number of trips they can perform daily. This means that the station design should take measures to eliminate environmental haz-

ards to nearby residents such as scattering of wastes, attraction of animals and scavengers, generation of bad odors, leachate drainage and etc.

The site should be enclosed and access controlled. Waste should not be kept for a long time at the station. A buffer zone should be erected around the facility to act as a wind barrier and catching of wind-scattered paper and plastic bags. Depending upon the amount of generated leachate, pretreatment before discharging into the sewage system should be considered.

4) Siting of the Station

The site selected for the transfer station should take into consideration;

- area available and that required
- distance from residential areas
- transport costs incurred in both transporting the waste from the collection routes and the secondary transport of the waste to the disposal facility
- access to main roads for the large secondary transport trucks to go to the disposal facility without passing through residential areas
- other factors, such as ultimate land use (the station may be a temporary facility that would become redundant as the disposal facility location changes)

CHAPTER 7 WASTE COLLECTION AND TRANSPORT OPERATION PLAN AND TECHNICAL OPERATION CONTROL

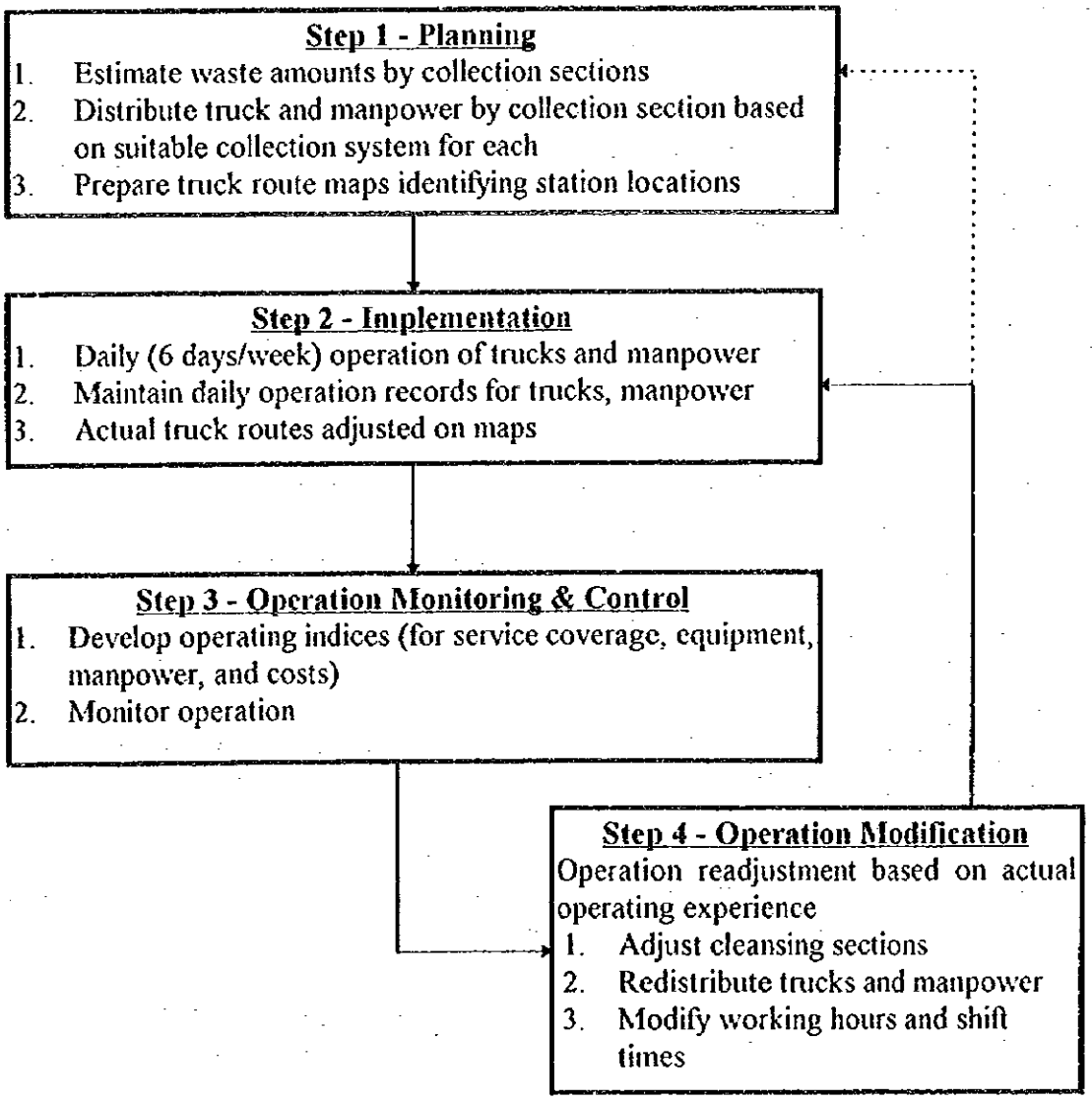
7.1 Operation Plan Formulation

7.1.1 Flow of the Operation Plan

In Chapter 1 the outline of the operation plan was described. In the preceding chapters the information necessary for formulating the operation plan were discussed. Basically the formulation should follow the four steps of (see Fig. A.7.1-1 below);

- Planning
- Implementation
- Operation Monitoring & Control
- Operation Modification

Fig. A.7.1-1 Operation Plan and Implementation Cycle



7.1.2 Determination of Cleansing Sections

It has been assumed so far that each urban commune is already divided into a number of cleansing sections to implement the collection work. In principle division of the urban commune into cleansing sections should take into consideration the following;

- in order to easily collect population and other necessary data the present administrative borders should be followed whenever possible
- each cleansing section should be of a size to be at least served by one collection truck (i.e. a population of around 10,000 persons)
- cleansing sections within the urban commune should be evenly divided as possible

In order to avoid abrupt changes, the urban commune should maintain the present cleansing sections divisions and modify them as necessary based on survey of operation condition (as shall be discussed in the following section).

In the case of expansion of collection service the urban commune municipal engineer should decide either to prepare a new cleansing section or expand the borders of adjacent existing sections in order to incorporate the new service areas.

7.1.3 Operation Plan

All urban communes are operating collection trucks at present so it is clear that no operation plan will be prepared from scratch. However it is doubtful whether the urban communes are operating based on a documented plan. The documented operation plan should be as follows;

(1) Identify the borders of the cleansing sections on a map (suitable scale of 1:10,000). Existing sections may be maintained or modified as suggested in the previous section.

(2) Prepare a table showing the population for each cleansing section and estimated waste amount generated by section. If population data are unavailable estimate populations based on the maps, or directly estimate waste amounts based on trucks trips made at present. In the case of the later estimation method some adjustment should be made if the collection coverage by the existing trip numbers does not reach 100%.

Cleansing section	Area (Ha)	Population	Waste amount

The waste amount may be estimated by multiplying the population by the waste unit generation rate of 0.5 kg/person/day.

(3) Prepare a list of the available trucks and containers. Prepare a table identifying the operation outputs that can be expected from each truck. Examples are shown in the following table;

Truck no.	Type	Age (years)	Capacity (m^3)	Trips/shift	Waste amount/shift (ton)
1234	Dump	8	4	2	3.0
5678	Compactor	4	12	2	13.2
4321	Multi-loader	1	3	6	6.3

Notes: haul waste density assumptions (Dump: 0.38 t/m3, Compactor: 0.55 t/m3, multi-loader: 0.35 t/m3) based on Safi survey

(4) Based on the above two tables distribute the trucks to the cleansing sections. According to truck distribution distribute the manpower.
(5) Prepare the preliminary truck routes on maps and identify locations for placing of stations
(6) Prepare new, or modify existing record sheets to be kept at the garage, disposal site and administration office for every truck (contents as explained in the following section)
(7) Identify person in charge of each cleansing section

7.2 Implementation

Collection service shall be implemented as set out in the plan. Any changes from the plan shall be recorded. These changes may include the following;

- Actual truck route may differ from that proposed in the plan, considering traffic congestion, traffic regulations such as one-way streets, roadside parked cars problems, etc.
- The same applies for the waste pick-up stations. Locations identified during the planning stage may have to be changed to accommodate requests of residents, improve on walking distances, or make use of more suitable locations found at the site.
- While using the various forms for collecting data on the operation, modifications to maintain better records will almost always appear.
- An ideal situation would be to computerize the data collection and analysis system, but that can only be introduced depending upon the budget and financial capability of each urban commune.

7.3 Operation Monitoring & Control

7.3.1 Tools for Operation Control

Step 3 of the operation flow requires development of operating indices and system for monitoring operation and making adjustments as necessary. The operating indices shall be developed to ensure that the available resources; collection trucks, communal containers and manpower are effectively utilized. On the other hand operation shall be monitored on a daily basis and analyzed daily, weekly and monthly to introduce any necessary adjustments to the operation. The requirements for each are described in Table A.7.3-1.

Table A.7.3-1 Developing Operation Indices and Monitoring System

Item	Tools
Operation Indices (by collection truck and by route)	(1) Number of trips per shift • The smaller the truck capacity the larger the number of trips required and vice-versa, in order to use the truck efficiently. • Long distances to the disposal site will decrease the number of trips possible (2) Haul per trip (ton/trip) • This indicator shall be divided by the truck design capacity to obtain the truck capacity utilization. • A low utilization means it is necessary to adjust the route in the case of SCS, or increase the time between collections in the case of HCS. (3) Working hours per shift • A 7-hour working shift and a set number of overtime working hours shall be defined. The actual working hours shall be compared with the set hours to ensure fair distribution of the works. • Actual time required for weight hauled (min./ton) is an indicator. (4) Crew number • In principle one driver and 3-4 crew members (SCS) and one driver and 1 crew member (HCS) shall be assigned per truck. On difficult routes where door-to-door collection is predominant it may be necessary to increase the crew number. • Actual weight hauled per worker (ton/worker) is an indicator. (5) Community Satisfaction • Complaints from the public shall be analyzed in terms of number and content in order to measure their satisfaction as to service coverage and quality of service.
Monitoring System	(1) Collection truck operation records • Daily operation records (start and finish times, collection routes, number of crew, number of trips and duration of each, waste hauled per trip, operation costs, etc.) • Maintenance and repairs by item, costs, and duration (including downtime) (2) Time and motion surveys • Periodic time and motion surveys to determine the operation indicators and evaluate the operation (3) Community participation • Extent of citizens cooperation in observing discharge rules shall be monitored and evaluated in coordination with the community leaders

The effort needed to monitor the operation and introduce modifications to the operation plan are described in the following section.

7.3.2 Monitoring System

1) Monitoring Staff

The urban commune municipal engineer should designate a foreman to head each cleansing section. This foreman should be aware of the characteristics of the cleansing section (population, land use, maps, streets, etc.), the daily activity required, some mechanical fundamentals concerning collection trucks maintenance and repairs, and knowledge of accounting and analysis of data.

The cleansing section head should immediately form a working relationship with the heads of the community within the cleansing section in order to monitor together the work as necessary.

2) Maintenance of Truck Records

Records for each collection truck should be maintained at various levels in order to be able to cross check the data. Depending on urban commune size and reliability of the personnel the following levels may be proposed.

a. Cleansing Section Head

The cleansing section head shall divide the cleansing section into collection routes and designate collection trucks, containers and personnel for each route (as set out in the planning stage). In cooperation with the garage dispatcher, he can maintain the following daily records for each truck;

- truck number
- route number (or other designation)
- driver name and crew number
- time departed from depot
- time finished work and returned to the depot
- number of trips (driver information)
- waste amount hauled per trip (disposal facility information)
- truck breakdowns; nature and downtime (driver information for simple repairs and workshop report for larger repairs)
- costs incurred for fuel and lubricants

b. Disposal facility operator

The records maintained at the disposal facilities are very important for the collection service in order to cross check the information provided by the driver and eliminate any illegal dumping of the waste. The records should cover the following items for each collection truck;

- collection truck arrival and departure times for each trip
- waste amount hauled each trip

c. Driver record

This is the most difficult record to maintain because of drivers general reluctance to record their activities and high rate of illiteracy amongst them. A simple form should be prepared by the cleansing section head and as much as possible data filled in should be in numerical figures. The record should contain the following;

- departure and arrival times from and to the depot
- arrival and departure times to and from the disposal facility
- hauled waste amount measured at the disposal site
- time stopped for any breakdowns, fueling or repairs
- number of crew
- any problems experienced during the collection work (e.g. damage to communal containers, change in traffic regulations, roadside car parking problems)
- condition of the truck at the start of the work day (a simple check sheet should be prepared for that purpose)

d. Workshop Record

Usually truck maintenance and repairs will be handled in the urban commune workshop or depot. Records should be maintained there for each collection truck, to include the following;

- maintenance works and dates
- repair works, dates and duration (including waiting time at the workshop)
- repair costs and spare parts procured

3) Time and Motion Surveys

This survey is very important both for setting operation indices and monitoring and evaluating operation. It has been discussed in detail in the report titled "Improvement of Solid Waste Management in Developing Countries", by Dr. K. Sakurai, and published by JICA in 1990. The contents of that report are briefly summarized hereafter.

a. Objectives of the Survey

- efficiency of collection equipment utilization (loading capacities, working hours)
- efficiency of collection crews (waste collected per crew member)
- appropriateness of collection route
- appropriateness of collection time schedule (effect of rush hours on collection times in certain routes)
- suitability of collection points, communal containers and individual bins used by the citizens
- crew behavior (crew internal cooperation, wasting time on other activities such as recycling)
- extent of community participation (respecting discharge regulations)

b. Requirements for the Survey

- a clear map of the collection routes surveyed
- population (or household number) served on the collection route
- digital watch
- truck scale (if there is no truck scale at the disposal facility then use of one belonging to another agency should be arranged)
- odometer in working condition (either that of the collection truck or the truck the surveyor is using)
- necessary form for recording the data

c. Execution of the Survey

In principle the surveyor will be given a form to fill out during the survey. The surveyor shall either ride in collection truck beside the driver (the truck odometer must be in working condition) or use his own vehicle and follow the truck. Using a form the surveyor will fill in the following information;

- Time (garage departure, collection zone arrival(s), collection points arrivals and departures, collection zone departure(s), disposal site arrival(s), disposal site departure(s), start and finish of rest breaks, start and finish of any breakdowns, etc.)
- Number of bins collected at each stopping point and judge average sizes based on average measurements
- Weight of waste hauled
- Odometer reading (garage departure, collection zone arrival(s), collection points arrivals and departures, collection zone departure(s), disposal site arrival(s), disposal site departure(s), etc.)
- Prepare a map of the route and plot on it locations of depot, disposal facility, collection route starting and finishing points and collection route itself

Some advice to the surveyors to facilitate their work may be as follows;

- not to disturb the collection crew during their work
- record actual time and odometer readings and all calculations to be made in the office later
- the survey should cover the total shift, i.e. from the departure from the depot at the start of the shift to the arrival to the depot at the end of the shift

d. Analysis of the Survey Results

- Working hours utilization analysis
  Analysis of the results may show such problems as delay in shift starting time due to large number of truck breakdowns, fueling, or simple repairs. Time may also be lost in loading of loose waste at collection points, and in traffic congestion. Finally some shifts may be finishing too early which would indicate unbalanced route distribution.

- Loading capacity utilization analysis
  Although the truck may be full in terms of volume the design truck haul weight may not be achieved because of the low waste density and vice versa. Therefore after a number of measurements it may be possible to determine the optimum haulage

amounts and then judge whether the waste collected on a route is enough to effectively use that optimum haulage amount.

- Individual containers study
  Extent of the waste discharged in loose form can be estimated. Also the various types of individual containers used can be understood and attempt to achieve standardization of bins studied.

- Route and Road study
  The route taken by the collection truck and plotted on the map should be analyzed to determine any unnecessary duplications, U-turns, etc. The road conditions such as pavement, excessive roadside parking, congestion, narrowness, etc. should be analyzed as to the resulting waste in time. The study may also show the appropriateness of the collection truck size or collection system used based on the route physical conditions.

- Crew behavior study
  Crew cooperation in collecting and loading the waste should be analyzed. Excessive time wasted in materials recovery on the collection route, a practice common in Morocco should be terminated. Crew poor handling of individual bins and damaging them may harm the desired community participation. On the other hand too large and heavily loaded individual bins may be difficult to handle by the crew and the community should be made aware of this. Tools and uniforms used by the collection crew should be noted as to their sufficiency. Any dangers as a result of poor working habits should be noted.

- User cooperation study
  Users cooperation in discharge of waste in suitable bins and inside communal containers and respect for discharge times should be studied. At times users may complain to the surveyors on such things as collection truck tardiness, or other problems with collection crew members. These complaints should be compiled for further study.

4) Monitoring of Community Participation

The analysis of the time and motion surveys will assist in monitoring and strengthening community participation. In addition each cleansing section head should instruct a number of supervisors to patrol the cleansing section at different hours of the day to monitor operation and be in a position to receive and verify any complaints from the citizens. The cleansing section head should immediately act on any serious complaints and consult with community leaders on countermeasures he proposes to take to resolve the problem.

7.4 Operation Modification

Based on the continuous monitoring and after confirmation of the problems, the operation plan should sometimes be readjusted. Adjustments can be in the following aspects;

(1) Minor adjustments
- redistribution of trucks and manpower
- rotation of communal container (one container to be rotated between two locations on different week days to improve container capacity efficiency)
- introduction of collection point instead of door-to-door collection in areas where the truck time on the collection route is too long
- improvement of collection truck routes in terms of route balancing (trips by the one truck should haul similar waste amounts in each trip, and the same truck types should haul similar waste amounts per shift) and micro routing (avoid delays by redesigning the route traveled by the collection truck)

(2) Major modifications
- redefining of cleansing sections and collection routes to improve truck haul efficiency
- introduction of 3 days per week collection in some areas where truck utilization efficiency is low

7.5 Feedback to Action Program

The data collected and analysis results should be reflected in the action program prepared as explained in Chapter 1 of this report. Modifications to the action program may be required as follows;
- revise the targets set up in the action program (e.g. speed up attaining a collection service coverage of 100%)
- adjustment of equipment and manpower requirements based on actual operation of the collection system
- finalize the equipment procurement plan for the following year

CHAPTER 8 WORKSHOP AND MAINTENANCE

8.1 Prevention is Better than Cure

Periodic and continuous preventive maintenance is the best way to protect collection vehicles and increase their lives. It is necessary for the urban commune municipal engineer to consult with the workshop engineers and prepare inspection and maintenance sheets.

In Japan daily and periodic inspection of collection vehicles are required by law. Periodic inspection items are classified into 6 and 12 months terms. In addition all collection vehicle manufacturers provide purchasers with handbooks showing maintenance and inspection lists and schedules. Table A.8.1-1 shows a sample of a daily inspection check list proposed by a Japanese truck manufacturer for reference and inspection items every 5,000 km (only some parts of the original list are shown here).

Table A.8.1-1 Daily and Periodic Inspection List

Item	Remarks
A. DAILY	
D-1 Engine oil level	
D-2 Coolant level and radiator cap function	
M-3 Brake and clutch fluid level	
M-4 Water separator	
D-5 V-belt tension and damage	
D-6 Indicator lamp defective	oil pressure, battery charging, parking brake, etc.
D-7 Fuel level	
D-8 Wheel nut tightness	
D-9 Instrument gauges and lamp functions	
D-10 Accel pedal operation and engine idling	
D-11 Brake pedal play and parking brake	
D-12 Engine condition	starting, noise and exhaust smoke
D-13 Wiper and window washer function	sufficient cleaning fluid and wiper rubber okay
D-14 Lamps and horn operation	
D-15 Tire pressure, wear and damage	
M-16 Leakage for oil, fuel, air and water	
M-17 Chassis spring breakage, U-bolt tightness, etc.	check for cracks and wear
M-18 Brake pipe or hose interference	
D-19 Drain cock of the air tank	to drain off the water
B. EVERY 5,000 KM	
M-1 Fuel injection pump	
D-2 Engine oil	
M-3 Full-flow oil filter	
M-4 Radiator cap function	Radiator cap fit to a tester, checked under pressure
M-5 Air cleaner oil	change
M-6 Clutch release sleeve and release shaft	
D-7 Transmission gear oil	
M-8 Propeller shaft	joint and center bearing
M-9 Clearance between drum and lining	service brake
M-10 Main and park brake	
D-11 Tire positioning	

Note: D: Driver, M: Mechanic

A more general example of a check list prepared based on a review of a number of Japanese truck manufacturers documents is shown in Table A.8.1-2

Table A.8.1-2 General Periodic Inspection List

Item	Inspection content	before operation	monthly	yearly
A. VEHICLE				
- Engine	noise, start, exhaust, oil flow	X	X	X
B. OIL				
- Oil pump	noise		X	X
	oil flow		X	X
	bolt tightening			X
- Oil cylinder	loading			X
	oil flow		X	X
	damage in the removable part			X
- Oil motor	noise		X	X
	oil flow		X	X
	bolt tightening			X
- Engine oil	oil level in the tank	X		X
	dirty (color)			X
	strainer in the tank			X
	filter change			X
- Rubber hose	damages (wear, tear) to the hose		X	X
	oil flow		X	X
- Oil pressure valve	bolt tightening			X
	operation			X
C. ELECTRICITY CONTROL				
- Loading switch	rubber water hose damage, proper placing		X	X
	rear switch operation	X		
- Loading control	remit switch, relay timer		X	X
- Unloading control	remit switch tightening			X
	lowering and raising switch tightening			X
	dump remit switch tightening			X
- Distributor	connectors, etc.			X
- Rotary slider	armwire tightening			X
D. SAFETY FUNCTIONS				
- Emergency stop switch, operation	operation, switch well installed	X	X	X
- Interlocking of lowered tailgate	operation	X	X	X

Note: (X) Check item

8.2 Driver Responsibility

Drivers should be made responsible for the collection vehicle they drive and as much as possible rotation of the vehicles among the drivers should be avoided in order to reinforce that responsibility. In Safi city each driver is assigned a specific truck, so this approach is acceptable to Moroccan urban communes.

The one very noticeable preventive maintenance countermeasure that is lacking in most of the urban communes visited was the washing of collection vehicles after each shift. This is

a simple procedure and a necessary one at the same time, in order to prevent damage to the truck metallic body by rust. Water supply should be installed at all the depots and drivers instructed to wash their vehicles daily, including inside the box hauling the waste.

A promising observation was made during the Safi study. Drivers of the new compactors daily washed their trucks at the completion of the work shift using the truck's built-in washing pump. On the other hand most of the older dump trucks were washed only once or twice a week.

8.3 Public and Private Workshop

The urban commune municipal engineer and workshop engineer should ensure that the maintenance and repair facilities available to them can meet the required work. The workshop assigned for these works should have a sufficient number of bays, in addition to the tools and equipment.

The space requirements for a workshop and garage facility for an urban commune operating 10 collection trucks is as follows;

- Parking space: 12 bays
- Truck repair bays: 4 bays
- Maintenance and tires: 6 bays
- Container maintenance
- Car washing area
- Fuel pump station
- Office
- Passenger car parking space
- Handcart storage
- Guardsman

The workshop engineer should research the potential and advantage of using private workshops for large repair and maintenance works, within the framework discussed elsewhere in this report on privatization.

CHAPTER 9 RECYCLING

9.1 Understanding Recycling

On the official levels of the local authorities in Morocco, recycling is relegated to a very minor role, if any. It is left completely in the hands of private contractors who act as a go between the scavengers at the disposal sites and on the streets, on the ones side and the users of the salvaged items from the waste stream on the other hand. These private contractors are of varying scales. Some have transport trucks and processing equipment (plastic shredders, balers, crushers), as observed in Safi.

At the official level no records are maintained as to private sector extent of involvement in recycling. However unofficially, most collection crews are involved in separating plastics, glass and paper during the collection work and selling the separated items to the private contractor.

This chapter provides general information to introduce the local authorities to the recycling activity and proposes methods in which they can actively participate in this sector.

9.1.1 Definition of Recycling

The green banner of recycling has been raised in most of the developed countries and many recycling marks such as the three sided triangle, and the green dot have become familiar fixtures on merchandise sold to the consumers. It may be about time for the Moroccan urban communes to come on board and actively participate in recycling.

Recycling can be defined as a process incorporating the following steps (refer to "Integrated Solid Waste Management", published by McGraw-Hill);

- separation and collection of waste recoverable materials,
- preparation of the recovered materials for reuse, reprocessing, and re-manufacture, and
- reuse, reprocessing, and re-manufacture of these materials

The recoverable materials may either be reused in the manufacture of the same product type (eg. newsprint to newsprint) or reused in the manufacture of a different product (eg. newsprint into tissue paper, plastic bottles into fiberfill). The recoverable materials may also be used as they are, such as discarded furniture, some electric appliances, books, etc. which are repaired and cleaned and reused without any processing or manufacturing.

9.1.2 Importance of Recycling

Recycling provides a means to conserve natural resources by reusing recoverable waste materials and reduces the amount of solid waste required to be transported and disposed of at the disposal site. This in turn prolongs the life of the sanitary landfill site.

These are the "touchable" or "quantifiable" reasons for recycling. However there is another reason for strongly promoting recycling and that is to increase the awareness of the citizens about the problems of solid waste management and gain their participation. The

drive to recycling took a launch forward in the United States as the citizens there resisted the increased construction of incineration plants and the difficulty in securing sites for these facilities and also for new disposal sites. It was a "bottom up" approach with the community taking the initiative and the political and administrative organs following. In Morocco it may be necessary for the urban communes to take the lead in recycling, a "top down" approach, as the community awareness of SWM is very limited here.

9.1.3 Preconditions for Success of Recycling

For a recycling program to succeed there should be a strong demand for the recoverable materials and the market value of these materials should be sufficient to pay for the collection and transport costs involved. So far in many instances recycling programs have been subsidized economically but it is difficult to consider such a situation for Morocco where the priorities for the limited SWM financial resources are correctly directed towards improving landfill operation at the disposal sites and expanding collection service.

Urban communes should therefore closely look into recycling programs that are self supportive. This will differ from one commune to the other primarily considering the distance from the commune to the end users and the related transport costs. However it is significant that a recycling industry does exist at present with the recoverable materials transported to Casablanca, Mohammedia and Marrakech. Materials were being sent to these cities from as far as the northern cities of Tangier and Tetouan and the southern city of Safi. This industry is entirely operated by the private sector and any urban commune participation is on an unofficial basis (e.g. separation of recoverable materials during collection by the urban commune workers). Therefore a self supporting program is conceivable.

Active community participation in the program is another important factor for its success. Community cooperation in separating recoverable materials at their homes, shops and offices will reduce the effort required to separate these materials from the collected waste. Another community involvement would be in the drive to purchase products manufactured in part by recycled materials. However this factor may be a long term consideration.

9.1.4 Current Recycling Quantity

Judging from the study in Safi city, it is estimated that 3 - 5 % of generated municipal waste is recyclable materials such as paper and metals, of which roughly a half may be extracted at sources, one quarter may be extracted at disposal site, and the remaining one quarter may stay at disposal site.

9.2 Identification and Reuse of Recoverable Materials

9.2.1 Identification of Recoverable Materials

Analysis of the solid waste composition will assist the urban commune in deciding which materials may be targeted for recovery. In general the materials shown in Table A.9.2-1 may be considered.

Table A.9.2-1 Recoverable Materials from Municipal Solid Waste

Recyclable Material	Active in Morocco	Types of materials or uses
Aluminum	X	Beverages cans
Paper		
Old newspaper	X	Newspapers
Corrugated cardboard	X	Packaging
High-grade paper	X	Stationary paper, trim cuttings
Mixed paper	X	Mix of newspapers, magazines, stationary paper, etc.
Plastics		
Polyethylene terephthalate (PETE)	X	Soft drink bottles, food oil bottles, photographic film
High-density polyethylene (HDPE)	X	Milk containers, detergent and cooking oil bottles
Polyvinyl chloride (PVC)		Pipes, some food packaging and bottles
Low-density polyethylene (LDPE)		Thin film packaging, bags and wraps
Polypropylene (PP)		Battery casings, food box liners
Polystyrene (PS)		Electronic products packaging, fast food containers, plates
Multilayer and other		Multilayered packaging, ketchup and mustard bottles
Mixed plastics		Various combinations of the above
Glass	X	Clear, green and brown glass containers and bottles
Ferrous metal	X	Tin cans, and other types
Nonferrous metals	X	Aluminum, copper, lead, etc.

Note: (X) High potential in Morocco
Source: "Integrated Solid Waste Management", Publisher: McGraw-Hill

9.2.2 Potential Reuse of Recovered Materials

Urban communes can, based on the above Table, determine the recycling potential of the their municipal solid waste. It is also necessary for them to determine whether there are any end users in or nearby the commune. The following Table A.9.2-2 shows some of the potential reuses of the recovered materials.

Table A.9.2-2 Potential Reuse of Recovered Materials

Recovered materials	Potential reuse examples
1. Aluminum	cans are re-melted after processing, formed into ingots and rolled into sheets which are cut to produce new cans
2. Paper and card-board	as pulp substitutes, to produce container-board, liners for cartoon boxes, some building products, etc.
3. Plastics	• PETE; polyester fibers used in making clothes, pillows, carpets • HDPE; detergent bottles and motor oil containers • PVC; non-food containers, truck bed liners, hoses, toys, floor tiles, etc. • LDPE; making new film bags and packaging • PS; foam foundation insulation boards, office accessories, food service trays, toys, trash receptacles, etc.
4. Glass	generally used to produce new glass containers and bottles
5. Ferrous metal	generally used to produce new steel

9.3 Collection and Processing of Recoverable Materials

There are two ways to salvage the recoverable materials;

1. at the source, i.e. source separation
2. from the collected mixed waste

At present the second way is commonly applied in Morocco and it is not clear to what extent, if any source separation exists. In this section both systems will be discussed in order for the urban commune to determine which is appropriate for the commune.

Methods for processing of the recoverable materials shall be introduced in section 9.3.3. However it is suggested that in future recycling projects set up by the urban communes, processing activity be the responsibility of the private sector because of the related equipment and space requirements.

9.3.1 Source Separation

Source separation is the common practice in developed countries. Citizens are requested to separate recoverable materials from their wastes. The recovered materials are then left by the citizens at collection points on designated days or taken to "drop-off centers".

Obviously source separation requires the community's cooperation and as the number of items to separate increases, the more effort is required. Operation of a drop-off center would eliminate the need to provide special collection of the recoverable materials from the source. However if these centers are not in sufficient number the citizens may find it bothersome to bring their separated items. The centers may also accept hazardous household wastes and sell reusable old furniture and other items after repairing or renewing them. Centers may be equipped with equipment to process the recovered materials.

It is anticipated that it will be difficult to operate such centers soon in Morocco, because of the burden on the citizens to bring their wastes. So urban communes should consider collection of separated recoverable materials from the source.

9.3.2 Salvaging from Collected Mixed Solid Waste

The present practice in Morocco is to salvage waste materials from solid waste after it is discharged or collected. This is done mostly manually and under poor conditions, either at the discharge points or at the dumping sites.

In some developed countries materials recovery facilities (MRF) have been set up to further separate the source separated waste as well as to separate the mixed solid waste. At these facilities, in addition to manual separation, magnetic separators are used for aluminum and tin cans separation. The MRF may also contain some processing equipment such as shredders and balers.

This system may be introduced where the sale of recovered materials justifies the costs and the community participation is not strongly anticipated.

9.3.3 Processing of Recoverable Materials

Processing of the recoverable materials has three objectives;

- to modify the physical features in order to facilitate storage and transport
- to remove undesirable materials and contaminants
- to process and prepare the materials for subsequent use

It is clear from these objectives that the end users requirements in terms of transport, storage, and reutilization of the recovered materials play an important part in considering the suitable processing method to be applied. It is therefore recommended that the urban commune not get involved in this activity but confine itself to the collection and primary transport phase.

The processing methods most commonly applied are;

- Shredders (plastic, paper)
- Glass crushers (glass)
- Wood grinders (wood, garden wastes)
- Screening
- Density separator (removal of light combustible materials)
- Magnetic separator (removal of ferrous metals)
- Densification (baling of paper, cardboard, plastics, and crushing and flattening of aluminum and tin cans)

9.4 Adoption of Recycling by the Urban Commune

The urban commune, based on its analysis of the waste composition and market demand should determine when and to what extent to introduce recycling. The question of "whether or not to introduce?" should not be posed because recycling is an integral component of SWM and is vital for its success. It is suggested that the urban commune put the following steps into implementation, after elaborating upon them as necessary;

Step 1: Understanding present conditions

- waste composition and amount of recoverable materials in the waste
- suitable targets for recovery of some materials, e.g. paper, plastic and glass
- identify possible end users by studying the current private system in place
- discuss with these end users on their demand and purchase costs

Step 2: Implementation of a pilot project

- prepare a pilot project plan for source separation (e.g. material to be recovered, trucks and containers to be used for collection, collection frequency per week, end user of the material, duration, cost and financing of the pilot project etc.)
- select a suitable cleansing section in which to implement the project (medium to high income area, community structure in place, social associations available, etc.)
- prepare a public campaign designating the material to be separated (advisable to start with one or two materials), collection points, special containers, collection time, etc.
- eliminate activity of scavengers in the cleansing section so as not to disturb the project
- implement the pilot project for a period of 3 to 6 months

- urban commune shall be responsible for collection of the separated waste items and their transport
  i. in order to minimize costs the regular collection dump trucks can make one trip after completion of their regular shift, therefore paying overtime only
  ii. during the pilot project the collection shall be door-to-door, 2 days per week (e.g. one day for paper and the other day for plastic and glass) and if the project is successful than placing of specific containers can be considered as a next phase
  iii. processing of the separated waste (crushing, shredding, washing, baling, etc.) shall be the responsibility of the present private firms or end users
- monitor the project throughout the implementation duration

Step 3: Expansion of the pilot project

- at the end of the pilot project analyze its results (was the targeted recoverable material amount collected, how did the citizens cooperate, was the cost paid by the end user sufficient, was the collection system suitable, etc.)
- based on the analysis and discussion with the end users and community leaders expand the pilot project scope possibly both in area and recoverable items