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Japan International Cooperation Agency (JICA)
The Ministry of Public Works and Regional Planning
The Municipality of Bucharest
Romania

The Study on the Solid Waste Management System for Bucharest Municipality in Romania

Final Report

Volume 2

Principles and Master Plan

December 1995

EX Corporation
Yachiyo Engineering Co., Ltd.

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PREFACE

In response to a request from the Government of Romania, the Government of Japan decided to conduct the Study on the Solid Waste Management System for Bucharest Municipality in Romania and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Romania a study team headed by Mr. Masato Ohno, EX Corporation from August 1994 to October 1995.

The team held discussions with the officials concerned of the Government of Romania, and conducted four field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Romania for their close cooperation extended to the team.

December 1995

Kimio Fujita
President
Japan International Cooperation Agency

Table of Contents

INTRODUCTION

1. Study Objectives and Scope

The prime objective of the "Study on the Waste Management System for Bucharest Municipality in Romania" is to prepare plans for improvements of solid waste management of the Bucharest Municipality.

The study consists of the following 3 phases:

Phase 1: Formulation of principles

Phase 2: Formulation of master plan for period 1996 - 2010

Phase 3: Feasibility study on priority projects

During the phase 3, the following studies were carried out:

1) Feasibility study on the development of the 3 sanitary landfill sites in Balaceanca, Cretuleasca and Glina

2) Study on technical assistance

3) Study on waste education

4) Study on waste bin supply

The study covered the following aspects:

1) Operational and technical aspects

   a. waste collection and haulage
   b. street sweeping
   c. treatment and disposal
   d. recycling
   e. industrial demolition and hospital waste management

2) Institutional aspects

f. privatization (institutional options)
g. contract management
h. organization and management

3) Financial and economic aspects

i. financing plan
j. waste tax and citizens' affordability

4) Legal aspect

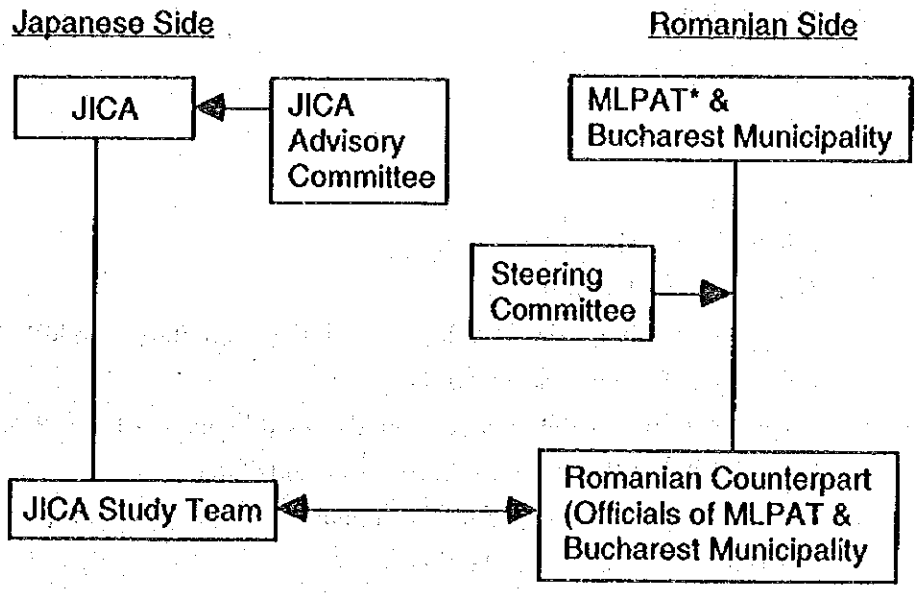
k. Bucharest Sanitation Norm
l. Laws, regulations and guidelines

The study activities included field observation, diagnosis of the current situation, discussion with the Romanian counterparts, meetings with relevant authorities and other agencies including World Bank office in Bucharest, field surveys (topographic, geological and environmental surveys), and environmental impact assessment (EIA).

2. Study Organization

The study was carried out jointly by the JICA Study Team headed by Mr. Masato Ohno and the Romanian Counterparts led by Mr. Ursu Tirla of the Bucharest Municipality. In the Romanian side, a Steering Committee for the Study headed by Mr. Radu Dumitrescu of the Bucharest Municipality was organized. The committee includes representatives from Ministry of Public Works and Regional Planning (MLPAT) represented by Mr. Aurelia Dumitrescu, Ministry of Environment, and Ministry of Industry. In Japanese Side, an Advisory Committee headed by Dr. Sachiho Naito was organized to provide advises to the Study Team.

The study organization is shown in the figure below:



* MLPAT: Ministry of Public Works and Regional Planning

Fig. 1 Study Organization

3. Reports

Through the Study, the following reports were produced:

1) Inception report
2) Progress report (1)
3) Progress report (2)
4) Interim report (1)
5) Progress report (3)
6) Interim report (2)
7) Draft final report
8) Final report

The final reports comprises of 9 English reports, 5 Romanian reports and 1 Japanese summary as listed below:

English Reports

1. Summary
2. Principles and Master Plan
3. Appendices to the Master Plan
4. Feasibility Study on the Development of the 3 Sanitary Landfill Sites in Balaceanca, Cretuleasca and Glina
5. Appendices to Feasibility Study on the Development of the 3 Sanitary Landfill Sites in Balanceanca, Cretuleasca and Glina
6. Basic Design Drawings for the Planned Sanitary Landfill Sites in Balaceanca, Cretuleasca and Glina
7. Studies on Technical Assistance, Waste Education and Waste Bins Supply
8. Guidelines for Formulation and Implementation of Master Plan for Improvement of Municipal Solid Waste Management and for Feasibility Study on Solid Waste Management Improvement Projects

Romanian Reports

9. Summary
10. Guidelines for Formulation and Implementation of Master Plan for Improvement of Municipal Solid Waste Management and for Feasibility Study on Solid Waste Management Improvement Projects

Japanese Report

11. Summary

Part A
Principles

Proposed Principles of Solid Waste Management for Bucharest

INTRODUCTION

The formulated principles cover the following important subjects:

1. Objectives of solid waste management
2. Environmental waste policy
3. Definition of municipal waste
4. Responsibility of Central/Local Government, Business Waste Generators, and Citizens
5. Technical Standards and Choice of Appropriate Technology
6. Private sector involvement
7. Effective organization and management
8. Financing and cost recovery
9. Legal arrangements
10. Waste utilization
11. Toxic and hazardous waste management
12. Public relation and waste education

The principles were formulated by, 1) taking into account solid waste management principles used in Japan and European countries, and 2) assessing the applicability of those principles to Bucharest.

The principles formulated are for the Bucharest solid waste management. And, where appropriate, the roles of central government has been considered in this context.

1. Objectives of Solid Waste Management

1.1 Overriding Objectives

The major objectives of solid waste management are to:

1. protect public health;
2. protect the environment; and
3. maintain public cleanliness in order to keep public places aesthetically acceptable;

by means of proper storage, collection and safe treatment and disposal of municipal waste.

In addition a further objective, could be to conserve natural resources through waste reduction polices and recycling. This would depend on government environmental policy.

1.2 Service Objectives

Additionally local government will set the important service objectives of:

1. improving the quality of the service. This would include:
    a. collection frequency
    b. reliability
    c. collection method;
2. enhancing efficiency and reducing costs
3. extending service coverage to areas which may not be served or are inadequately served; and
4. upgrading environmental disposal standards and enforcement procedures.

In short, a key concept for the improvement of municipal solid waste management is "do more (better services) with less (money)".

2. Environmental Waste Policy

Proper waste disposal is very important. However, to reduce the quantity of waste to be disposed of is even more desirable from the environmental and economic point of view. There are two ways to achieve this; waste prevention (to reduce generation of waste) and waste utilization (reuse, recycling and resource recovery) The preferred priority between waste prevention, utilization and disposal is generally as follows:

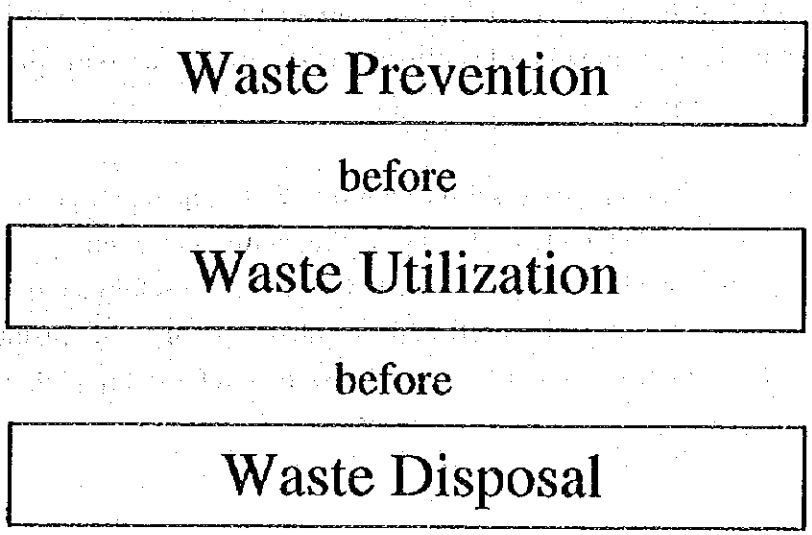


Fig. 2-1 Priority of Waste Prevention, Utilization and Disposal

The above preference is commonly shared in Japan and many European Union (EU) member countries.

Waste Prevention

The purpose of waste prevention is reduce generation of waste materials by making producers change their production processes and consumers change their consumption patterns. Methods of waste prevention include the following:

1. Changes in product design and types of materials, e.g. by increasing the number of components in products that can be recycled.
2. Greater use of recyclable packaging and containers
3. Changes in products design, materials and composition to reduce their toxicity.

Effective waste prevention requires the establishment of national laws and enforcement systems. Waste prevention policies should be promoted firstly at central government level and then at municipal level. EU countries have been recently preparing laws and regulations concerning waste prevention.

Waste Utilization

Waste utilization is promoted through reuse, recycling, and recovery of resources (material or energy) from waste. Laws and regulations should be passed and issued by central government to promote waste utilization, especially the recycling of packaging and energy recovery.

Reuse and recycling can best be promoted through the waste separation at source. Municipal government should take the lead in promoting waste separation at source. Waste separation at source contributes not only to the recovery of useful material but also to the reduction of waste to be collected and disposed of, with resultant reductions in cost. For further discussion on waste utilization, refer to Principle Item 10.

Waste Disposal

Waste that can't be utilized has to be collected and properly disposed of to minimize environmental impacts. In order to dispose of waste in a sanitary manner, disposal facilities must be constructed to comply with disposal standards. The level of sanitary tariffs should be high enough to cover the construction and operation of these facilities.

3. Definition of Municipal Waste

3.1 Municipal Waste

The municipality of Bucharest (MB) is responsible for management of municipal waste. Municipal waste is defined as solid waste that may be collected and disposed of by ordinary methods and which is the responsibility of the municipality. Types of municipal wastes are as follows:

1. Household waste
2. Commercial waste
3. Waste generated from public institutes such as schools
4. Market waste
5. Hospital waste that does not require any treatment
6. Dead animals excluding domesticated animals (cows and pigs)
7. Street waste excluding demolition waste dumped on street
8. Other waste accepted by the municipality as municipal waste

3.2 Non-Municipal Waste

Non municipal waste i.e. designated waste is not MB's responsibility but is the responsibility of waste generators. Waste categories are summarized in Table 3-1 below:

Table 3-1 Waste Category and Management Responsibility

Kinds of Waste	Management Responsibility	Remarks
1. Municipal waste	Municipality of Bucharest (MB)	The MB collects bulky waste upon receipt of requests from citizens by charging special tariff.
2. Non-municipal waste	Generators of waste	
2-1 Non-hazardous industrial waste & commercial waste of large amount	(The municipality should monitor generators' management of non-municipal waste until they establish a proper management system for these waste.)	The municipality may accept waste 2-1 & 2-2 at its disposal site on full cost recovery base.
2-2 Demolition waste		
2-3 Discarded vehicles		
2-4 Hazardous waste including infectious hospital waste		The central government should establish hazardous waste management (treatment) facilities.

4. Responsibilities of Central/Local Government, Business Waste Generators, and Citizens

The Bucharest Municipal Government must have the power and responsibility for organizing solid waste management. As shown below, there are other organizations involved in the solid waste management.

1. Central government
2. Bucharest Municipal government
3. Contractors
4. Business (Industrial & Commercial) Waste Generators
5. Citizens

The proposed principle responsibilities of respective organizations are given in Table 4-1 below:

Table 4-1 Parties Involved in Solid Waste Management and Their Responsibilities

Involved Parties	Responsibilities
1. Central government	1) to formulate national policy with respect to waste reduction, recycling and solid waste management 2) to formulate and pass national SWM laws 3) to set technical standards 4) to research solid waste management 5) to ensure that the laws and regulations are applied 6) to provide guidance to local government

2. Municipal Government	1) to formulate local policy and prepare local strategies and plans (short and long term) 2) to finance SWM 3) to levy waste tax 4) to formulate regulations 5) to formulate guidelines with respect to : a) methods of discharging waste (types of containers to be used), and b) the waste reporting requirements of business waste generators c) recycling (types of waste to be recycled) 6) to provide waste collection, haulage and street sweeping services through the use of contractors 7) to plan, construct, operate and provide waste disposal services 8) to monitor service provision in accordance with the local norms 9) to enforce service standards 10) to administrate the contracting and licensing of SWM services 11) to monitor contractor' s performance 12) to train SWM personnel
3. Contractors	1) to provide waste collection, haulage and street sweeping services under contractual arrangements
4. Business (industrial & commercial) waste generators	1) to manage (collection, treatment and disposal) their waste except for that accepted by the municipality as municipal waste 2) to submit reports on their waste (types, quantity, pre treatment and other information) as required by the municipal regulations
5. Citizens	1) to reduce generation of waste 2) to recycle 3) to comply with the Municipality's waste collection procedure 4) not to litter waste 5) to dispose of discarded vehicles by using commercial enterprises

5. Technical Standards and Choice of Appropriate Technology

5.1 Why are Technical Standards Necessary ?

The provision of solid waste management services, even if imperfectly provided, directly contributes to securing the sanitation and comfort to those who receive them. However the provision of these services may cause secondary pollution in medium and long term. Technical and environmental standards are therefore necessary.

The nature of environmental problems is such that they are often too late or too costly to take restorative measures. It is generally more economical to take preventative measures than restorative actions after environmental damage has occurred

The appropriate degree and types of preventative measures are selected using environmental and technical standards. Currently adequate technical standards for SWM in Romania have not been established. EC directives which were recently established could be used as basis for formulating and setting Romanian standards.

5.2 Possible Environmental Risks Arising from the Provision of SWM Services and Preventative Measures

Possible environmental risks and preventative measures are summarized in Table 5-1 below:.

Table 5-1 Possible Environmental Risks Arising from Provision of SWM Services and Preventative Measures

Types of SWM Services	Possible Environmental Risks	Preventative Measures
1. Precollection	1) Public health risks associated with vermin and insects because of low frequency of collection	Precollection with a frequency of once in every 8 days or more
2. Collection and haulage	1) Pollution of streets and buildings with garbage and waste water discharged from containers or vehicles.	Use appropriate equipment or handling procedures.

3. Disposal	1) Pollution of surface or ground water with leachate generated from waste deposits in landfill sites	Selection of appropriate sites Non-acceptance of hazardous waste at municipal disposal sites Compliance with Agreements of the Bazel Convention Installation of sanitary landfill facilities which include leachate control facilities such as rain water ditch, leachate collection pipes, oxidation ponds, treatment facilities, lining, etc.
	2) Waste scattering	Installation of embankments and fences
	3) Generation of vermin	Application of chemicals
4. Treatment (incineration)	1) Air pollution with ashes and hazardous materials emitted from incineration	Installation of anti-pollution facilities

5.3 Choice of Appropriate Technology

Technology to be selected for SWM should:

1. satisfy the environmental and technical standards, and
2. be cost-effective and appropriate.

More specifically, it is desirable that the technology selected should satisfy the following criteria:

1. Effective for environmental pollution control.
2. Affordable in terms of both investments and operation and maintenance costs.
3. Expertise and spare parts for operation and maintenance is locally or easily available.
4. Socially acceptable.

It is advisable that a relevant authority in Romania will execute a pilot study for formulating technical standards for waste disposal.

Lastly, it is worthwhile to note that the selection of appropriate sites for SWM facilities, especially landfill sites, is as important as the choice of appropriate technology in view of public health and environment protection.

6. Private Sector Involvement

6.1 The Privatization Decision

Why should local government privatize solid waste management ? What *activities* can it privatize ? How can it *decide* whether to privatize or not ? If it decides to involve the private sector what *method* of privatization is most suitable ? These are questions that local governments must ask when they are considering privatization.

6.1.1 Why and What to Privatize ?

Private sector involvement may provide a solution to improving the solid waste management (SWM) service which is either too costly and/or has low levels of service. In this context privatization should be considered as a means to:

1. improve the quality of the service;
2. enhance efficiency and reduce costs ; and
3. mobilize private investment, thus expanding the resources available for capital investment.

The extent to which the private sector can bring these benefits will depend on the sector' s capabilities. If the market for provision of SWM services is just emerging we would expect the benefits to be considerably less than those of a matured market.

Theoretically any of the component activities of SWM can be privatized, partially or wholly. In practice collection and haulage and also street cleansing are usually the first to be considered, rather than disposal (including treatment). This is because the former are much less risky to privatize than which is much more risky. Disposal is more risky because:

Firstly, local government may have insufficient management and technical knowledge of disposal. In this case they should not divest them until they have demonstrated competent management and technical capabilities in providing these services themselves.

Secondly, the private sector is largely motivated by market forces and profit making, rather than public or environmental values, for which local government is responsible. Privatization should only be considered if local government can effectively regulate the private sector to ensure that these values are maintained.

Thirdly, disposal facilities have high capital costs.

Fourthly, in the early stages of the privatization process the private sector may not have the technical and management capabilities.

Experience in Japan, Europe and the United States strongly supports these arguments. In Japan and the US only 10% and 7% of landfills, respectively, are privately managed. In Japan all waste incineration facilities are operated by local government.

6.1.2 How Do We Decide Whether to Privatize or Not ?

A number of contextual issues have to be considered when evaluating the case for privatization. The following criteria should be considered when deciding whether to privatize or not.

1) Legal Sufficiency and Enforcement

Are laws and regulations sufficient to:

1. enable and empower local government to contract/license and effectively regulate SWM services;
2. allow private companies to compete fairly and with minimal risk; and
3. set appropriate environmental and disposal standards; and
4. to enable local government to effectively monitor and enforce laws and regulations ?

2) Government Capability and Public Accountability

Does government have the capability and expertise to:

1. manage the contracting process, including contract design, definition of performance measures, tendering and bid evaluation;
2. manage concessions and franchising of services;
3. monitor performance and enforce contracts/licenses/franchises; and
4. regulate the private sector, e.g. where there is tariff regulation ?

Local government must ensure that its responsibilities towards SWM are met and that public accountability is maintained. If it lacks the above capabilities, then it may not be able to carry on its responsibilities.

3) Private Sector Capabilities

Does the private sector have the necessary technical and management capabilities, and financial resources ? Secondly, can it mobilize financing for capital investment more efficiently than the public sector ?

Private sector management practices should bring a number of benefits, e.g.:

1. management that has more freedom, commitment and innovation;
2. improved management skills and more effective decision making;
3. better planning and financial management; and
4. improved resource management e.g. asset management and worker supervision.

Government should carefully assess whether the private sector has these capabilities.

4) Efficiency and Costs

Local government should consider whether the private sector can improve efficiency and reduce costs through:

1. better financial discipline;
2. higher labor productivity;
3. more efficient operational procedures;
4. freer labor practices of hiring and firing;
5. more effective management; and
6. organizational efficiencies and rationalization.

Local government should also consider how likely competitive market forces will stimulate the private sector to be more efficient.

At the same time it should identify what impedes it from providing an efficient service itself, e.g. inefficient work arrangements, restrictive labor practices, bureaucratic management ? Can these constraints be removed or is private sector participation a better solution ?

5) Competition

Is the private market sufficiently developed so that there are enough companies to provide effective competition ? Are there barriers to entry ? If the market is still undeveloped are economic incentives required to stimulate private participation ?

6) Costs of Privatization

Will privatization reduce overall costs ? Local government should determine whether the administrative costs of contract management and regulating the private sector will be less than the savings generated from private sector involvement ? In practice this may be difficult to prove.

6.1.3 What is the Appropriate Method of Privatization to Use ?

Once it is decided to involve the private sector, the appropriate method of privatization has to be selected. There are numerous methods but in general they will fall under one of the following:

1) Contracting

Local government awards a finite term contract to a private company for the provision of a service after a competitive tendering process. The private company is then paid for the services it provides under the terms of the contract which it may competitively retendered every 1 or 2 or more years. Examples are: collection and street sweeping, operation of recycling or disposal facilities.

2) Concessions

The local government awards a concession to a company to set up and operate a facility under a long term contract. Ownership and financing of the facility can be the responsibility of either local government or the company's, but building and operation are the company's. The facility can be operated indefinitely by the company or transferred to local government at a predetermined date. Examples could include, an incinerator, a recycling facility, a landfill. The major difference to contracting is that the selected company is required to build a facility rather than utilizing local government's existing infrastructure.

3) Franchising

The local government awards a franchise for the delivery of a service to a designated area after competitive procurement. Under the licensing agreement the company has monopoly rights to provide the service in the designated area and assumes full financial responsibility, i.e. collects revenues from the households and enterprises it serves, and recovers its costs. Similarly any capital investment is its own

responsibility. Local government exercises control through the licensing agreement and might also exercise price regulation. Assets and service responsibility are not usually transferred back to government. There may be periodic refranchisement over the medium or long term.

4) Full Privatization

Local government allows the private sector to freely provide services to whom and wherever it wants to. Consumers are likewise given the choice of who they want to contract with. There is free competition between private sector companies who are fully financially responsible for revenue collection and investment.

The role of local government is reduced to licensing and regulation including enforcement of sanctions. Regulatory arrangements may be quite sophisticated, requiring an independent regulatory body at regional or national level, and the development of complex regulatory methodologies.

However, full privatization is not a recommended solution if private sector participation is not already well developed through contracting, concessions or franchising, and regulatory arrangements are weak. There are large risks for both local government and private sector providers if this method is prematurely adopted, particularly if regulation is poor. Regulatory arrangements need to be sufficiently developed to:

Firstly, ensure that local government can monitor and enforce service quality and standards. Although competition may increase the quality of the service as companies compete for business, service quality may fall if contractors are not subject to appropriate independent monitoring arrangements, e.g. there would be a increased risk of environmental pollution if disposal standards were not adhered to and not monitored.

Secondly, regulate new entrants and prevent cartels from forming. Similarly if there are too many entrants, who are not properly screened by a regulator, and there is too much competition, companies may be forced to reduce costs with possible impacts on service delivery. If company bankruptcies increase because of over supply, there will also be an increase in service discontinuity. Conversely cartels with fewer providers may form, in which case the benefits of private sector efficiencies will be lost and the citizens will pay more for their services.

The total cost of service delivery across the area provided may also increase as the benefits of economies of scale are lost, e.g. companies may have extra transport costs if their customers are scattered across a large area rather focused in one sector of the area provided. This will be offset by increased competition. But it will be difficult to assess what the overall economic benefits or costs really are.

Lastly providers may lack a sense of area responsibility if they are geographically free to provide services. This may mean that service levels may decline e.g. the contractor will not collect from non payers resulting in accumulation of wastes. From this point of view it may be preferable to use franchisees.

7. Effective Organization and Management

7.1 Why is Effective Management Necessary ?

Solid Waste Management may be appear technically, economically and financially sound but may be poorly delivered because of organizational and management deficiencies. These aspects are often overlooked but are nevertheless crucial for an efficient and high quality service to be provided, and for innovative capacities to be developed.

7.2 What is Effective Organization and Management ?

There are two broad institutional alternatives to provide SWM services:

1. Local government manages it through a department; or
2. Local government contracts the service, wholly or partially, to a private sector company who administrates it.

In each case there is a different institutional structure. In the first case this is the internal department in local government and also the other management responsibilities above the department itself, i.e. other departments, the Mayor and the Council.

In the second case there are two components, the first is the private company itself and the second is the institutional arrangements that the Municipality has to organize to manage private sector contracting. This will include managing the contracting process (contract design, setting performance measures, tendering and bid evaluation), monitoring performance and enforcing contracts.

Whatever the institutional arrangements, the provider of SWM services needs to develop the same organizational and management capabilities. These capabilities should include:

1. An efficient organizational structure with clear reporting lines, rational departmentation, reasonable spans of control and numbers of levels of managers/supervisors, and appropriate senior management structure.
2. A clear assignment and delegation of responsibilities and adequate authority to managers and supervisors with accountability for individual performance.

3. Procedures to clearly set and monitor objectives from the strategic level down to middle management and supervisors. Managers must have a clear understanding of their objectives.
4. Effective planning and policy formulation. These should include preparation of medium/long term strategic plans as well as annual operational plans.
5. Effective financial management. This should include integration of financial planning into the planning process, implementing budgetary planning and control and appropriate accounting systems.
6. Effective decision making by managers. (the right decisions made in the shortest time)
7. Appropriate systems. These will include management information systems and other procedures e.g. work flows and communication patterns. Managers will need appropriate and regular information to enable them to make effective decisions and to efficiently carry out their responsibilities.
8. Periodic assessment of managers performance against agreed performance targets and criteria.
9. Well trained and committed managers.

8. Financing and Cost Recovery

8.1 Financing and Costs

Local governments are very often constrained in their ability to generate revenues and often rely on central government for their capital investment financing needs. Access to non governmental financing may be limited. Additionally it is not uncommon for deficits on operating expenditures to be subsidized by central government.

In principle it is preferable that operating costs are recovered wherever possible through user tariffs or charges rather than through general taxation, because cost recovery encourages financial discipline and cost efficiencies. However this may depend on the type of service provided. For instance street cleaning is almost entirely a public good since everyone benefits equally from it. As a result we might expect it to be provided out of general taxation rather than user tariffs. In principle the costs of financing capital investment, e.g. in landfill sites, should also be recovered, where possible, through tariffs or a waste tax.

The cost of administrating the levying of tariffs also needs to be considered, i.e. billing and collection. Levying user tariffs may be financially unjustifiable if these costs are too high.

8.2 Cost Recovery and SWM

In the context of SWM there is some scope for levying user tariffs or a waste tax depending on the service provided.

8.2.1. Collection and Disposal

Tariffs can be levied to recover the costs of both waste collection and disposal, as RASUB does. In addition revenue can be generated by levying tipping fees at landfill sites on commercial and industrial enterprises, or on private sector waste collectors.

Increases in Disposal Costs and Financing

Capital and operating costs of disposal will increase if the municipality builds and operates a sanitary landfill which has to comply with higher environmental and public health standards. In addition increases in land prices will add further costs. The

municipality should improve its financing arrangements to cover these cost increases, and recover them from tariffs or a waste tax where possible. Where they cannot be recovered, loans should be considered. However, all financing costs should be fully recovered from tariffs or a waste tax.

These increased costs should not be thought of as onerous if the benefits of reduced environmental and public health costs over the long term are considered.

8.2.2 Recycling and Resource Recovery

In practice these activities are often uneconomic and may require government subsidization. Cost recovery is generally low. Recycling is covered in more detail in Principle Item 10.

8.3 Financial Incentives to Reduce Waste

An advantage of levying user tariffs is that service users can be given financial incentives to reduce waste if the level of the tariff is determined by the quantity of waste generated. This is an important mechanism to support the implementation of central and local government policies of waste prevention and utilization.

9. Legal Arrangements

Central government should formulate a national solid waste management law that include the following conditions:

1. Local governments have power and responsibility for municipal solid waste management.
2. Local governments have power and responsibility for setting by-laws, regulations and norms with respect to municipal solid waste management.
3. The central government has a responsibility to set environmental and technical standards with respect to solid waste management.
4. Local governments may use SWM contractors or franchisees.
5. Non-municipal waste generators are responsible for managing their waste.
6. Toxic and hazardous waste management.

1) Local Government's Power and Responsibility for Solid Waste Management

The citizens entrust the provision of solid waste management services with local governments. National law should state that local government is solely responsible for municipal solid waste management (SWM), since SWM is a public good. No other entities should assume this responsibility.

It is also necessary that the national law clearly defines the scope of the responsibility of the local governments.

2) Local Governments' Power and Responsibility for Legislating By-laws, Regulations and Norms

The national law should state that local government has the power to make by-laws and regulations with respect to solid waste management.

In the by-laws, the local governments may define the responsibilities of involved parties such as citizens, business waste generators, SWM companies, sector governments, and municipal government itself.

The formulation of regulations and guidelines and norms is necessary to implement the by-laws. Efforts must be made to inform the public of these by-laws, regulations and guidelines.

3) Central Government's Responsibility to Set Environmental and Technical Standards with respect to SWM

Central' government' s responsibility to set environmental and technical standards should be stated in the national law. The following EU Directives may be used as basis to set environmental and technical standards with respect to SWM.

1. EU Directive on Waste (Revised in 1991)
2. EU Directive on Toxic and Dangerous Waste & Hazardous Waste (Revised in 1991)
3. EU Directive on Containers of Liquids for Human Consumption (85/330/EEC)
4. EU Directive on Transboundary Transportation of Hazardous & Toxic Waste (1984)
5. EU Directive on Battery Containing Hazardous Materials

4) Local Governments' Use of SWM Contractors or Franchisees

National law should be supported by national regulations and guidelines specifying how contracts and agreements are to be tendered and enforced. This would include:

1. definition of performance measures;
2. contract design;
3. principles and procedures for the contracting process including bid evaluations and selections;
4. monitoring and enforcement procedures.

5) Non-municipal Waste Generators' Responsibilities

National law should state that non-municipal waste generators are responsible for their waste according to Polluters Pay Principle (PPP).

6) Toxic and Hazardous Waste Management

Central government should establish a national law and facilities for management of toxic and hazardous waste. For further discussions, refer to Principle 11.

10. Waste Utilization

10.1 Ways and Benefits of carrying out Waste Utilization

There are two major ways to utilize waste; recycling and resource recovery. Waste recycling includes reuse of materials through physical separation. Some materials such as metals and glasses are recycled through a recovery process. Resource recovery includes generation of heat or energy through incineration of waste and waste transformation, e.g. composting.

The waste utilization brings economic benefits in two ways: 1) revenues generated from recycling and 2) the reduction of waste management costs because the quantity of waste decreases.

10.2 Feasibility of Waste Utilization and Justifiable Government Subsidy

The following cases assume service provision is by a private contractor:

1) Case where Recycling is Commercially Feasible without Government Subsidies

A necessary condition for feasible recycling is:

$x > z$

where,
x: Direct benefits (market value of recycled materials)
z: Costs of waste recycling including costs of source separation, processing, distribution and marketing

If the above conditions are met, recycling might be commercially viable without any government subsidy.

2) Case Where Government Subsidies are Needed and Justified for Promotion of Recycling

Waste recycling is not financially feasible, but economically (from view point of Bucharest citizens) feasible if:

$x < z$ but $x + y > z$

y: Indirect benefits (saving of costs of solid waste management gained through recycling and resulting reduction of waste to be managed)

In this situation, the waste recycling business will not be profitable to waste recycling operators because the costs required for recycling are greater than the revenue obtained from recycling.

However, from the view point of Bucharest citizens, the recycling is profitable because gross benefits of recycling (sum of direct and indirect benefits) are greater than the costs. In this situation, the government subsidies to the recycling operators may be needed and justified to promote recycling. In this case, justifiable level of subsidy (expressed as "s") is:

$$y > s > (z - x)$$

i.e., the appropriate subsidy is more than the difference between the costs and revenue (z - x), but less than the saving of costs of solid waste management gained through reduction of waste to be managed (y).

3) Case where Recycling is not Feasible

Waste recycling is not feasible from either the commercial (financial) or economic view points if:

$$x + y < z$$

In this case, no government subsidies will be justified.

The above discussion is summarized in the following table:

Table 10-1 Feasibility of Waste Recycling and Justification of Government Subsidies

Conditions of Benefits and Costs of Recycling	Feasibility of Recycling	Necessity of Government Subsidies
1. Direct benefit (revenue) is greater than the cost of recycling (x > z)	May be commercially feasible	Government subsidies may not be necessary because recycling is commercially profitable.
2. Sum of both direct benefit and indirect benefit (saving in SWM costs made through recycling and resulting reduction of waste to be managed) is greater than the recycling costs x + y > z	Commercially (financially) not feasible, but economically (from view point of Bucharest citizens) is feasible.	Government subsidies (s) [y > s > z - x] are justifiable, and useful to promote recycling.
3. Sum of both direct benefit and indirect benefit is smaller than the recycling costs x + y < z	Neither commercially (financially) nor economically (from view point of Bucharest citizens) feasible.	Government subsidies cannot be justified.

Financial costs of recycling largely depend on 1) degree of peoples' efforts for separation at source, and 2) production costs (labor and equipment costs). Prices of recycled materials largely depend on the demand for recycled materials which are significantly influenced by prices of new (non-recycled) materials.

10.3 Feasibility of Resource Recovery

1) Recovery of Energy (Heat and Electricity) from Incineration

Although "Waste to Energy" is ideal, it is usually uneconomic. Generally the following conditions have to be met for the recovery of energy from incineration to be economically viable:

1. Cost of production of energy
   1) Waste of reasonable high calorific value is constantly available. (Waste has to be dry enough to self-incinerate without using much fuel)
   2) Costs of installation, operation and maintenance of energy generating facilities (boilers and generators) have to be reasonably low
   3) Utilization of the incinerator' s capacity must be above an optimal level.

2. Price
   1) There are buyers of energy who purchase energy at reasonably high prices.
   2) There is adequate and constant demand for energy generated.

It took 10 years or more for many Japanese cities to develop the incineration technologies that are suitable to the conditions of Japanese municipal waste. "Waste to Energy" is feasible only after development of reliable incineration technology. In Japan and some other countries, "Waste to Energy", particularly generation of electricity through incineration is generally not financially feasible . Economic feasibility (from the view point of citizens of Bucharest) has not been achieved yet in many cities either.

2) Composting

Like "Waste to Energy", composting is good. However, it is very rare that the production of compost from waste proves to be financially viable. The composting may be feasible with the following conditions:

1. Market conditions:

   There are users who have a constant demand for compost at location reasonably near to the compost plant.

   Notes:

   a. The price of compost is very sensitive to the costs of transportation.
   b. Demand for compost is generally low and infrequent, e.g. consumers may apply compost once in a 3 to 5 year period.

2. Production conditions:

   The experience of Bangkok city that has over 30 years of composting experience showed that composting business would be feasible if 1) simpler and low-cost technology is used, and 2) old waste (collected from disposal site) instead of new waste is used. Use of sophisticated and expensive facilities makes the composting business unfeasible.

11. Toxic and Hazardous Waste Management

11.1 Necessity for Defining of Hazardous and Toxic Waste

In Japan and many other countries, hazardous and toxic waste is generally defined as follows:

1. Materials that contains mercury (Hg), cadmium (Cd), lead (Pb), PCB, etc. at levels higher than specified in the standards;
2. Materials that have dangerous nature such as explosives and corrosives
3. Materials generated from processes or facilities which are designated as hazardous waste generators.

Specific items designated as toxic and hazardous waste differ from country to country. It is advisable that the Romanian government should specify toxic and hazardous waste in the national law.

11.2 Necessity for Establishing National Management System for Toxic and Hazardous Waste

Good management of toxic and hazardous waste requires special attention and systems in the following aspects:

1. Laws and regulation:
   The manifest system with respect to collection, haulage and treatment is indispensable.
2. Special systems for collection, haulage, treatment and disposal:
   Separate collection systems and special treatment facilities (special incinerator and other treatment facilities) are required.
3. Research and development:
   Treatment and disposal of toxic and hazardous waste require high level expertise.

To establish a national management system for toxic and hazardous waste is required not only from view point of the protection of public health and the environment but also from an economic view point. There is a possibility that foreign investments in the manufacturing sector in Romania may be frustrated if foreign investors are made responsible for management of their own wastes because there are no treatment

facilities in Romania. The situation where there is no enforcement of laws concerning these waste may also affect the nation' s export business.

11.3 Role of Bucharest Municipal Government

Although the municipality is not responsible for management of toxic and hazardous waste, it is advisable that the municipality should:

1. establish a system of registering toxic and hazardous waste generators and management contractors, and to identify them through the application of the system.
2. make it obligatory for toxic and hazardous waste generators and contractors to separate these waste from municipal waste.
3. prohibit toxic and hazardous waste being brought into the municipal disposal sites.
4. request Central government to pass laws and regulations concerning toxic and hazardous waste, and establish special facilities for treatment and disposal of these waste.

Until facilities for treatment and disposal of toxic and hazardous waste are provided, temporary measures could be such as using a designated part of the landfill for such waste, and controlling the waste and its leachate with special attention.

12. Public Relations and Waste Education

The citizens' cooperation is indispensable for establishing a good SWM system. The municipal government should prepare and carry out campaign program aimed at promoting of waste reduction, utilization and compliance informing citizens of the regulations concerning storage and discharge of solid waste.

At the central government level, the inclusion of waste and environment education in school curriculum should be considered.

Part B
Master Plan

Chapter 1
Waste Quantity and Quality

CHAPTER 1 WASTE QUANTITY AND QUALITY

1.1 Current Waste Quantity

1.1.1 Type of Waste Studied

Waste generated in Bucharest can be actually categorized as follows:

A. Municipal waste
(Collected under the responsibility of the Bucharest municipality)
1. Household waste
2. Business waste which should be collected by the municipality
This includes the following sub-components
2-1. Commercial waste
2-2. Market waste
2-3. Waste from public institutes such as schools
2-4. Waste from small industry
2-5. Non-infectious hospital waste
3. Street waste

B. Non-municipal waste (Collected by generators)
4. Waste from large offices
5. Industrial waste
6. Demolition waste

All municipal waste is collected under the responsibility of the municipality, whereas non-municipal waste is collected by generators.

Currently, household waste is collected by RASUB and RGR, and commercial waste is collected together with household waste by RASUB, RGR and ADP. Majority of market waste is collected by 4 m^3 containers placed in markets, and the remaining market waste is collected by rotary compactors together with household waste. Industrial waste of major industries is collected and hauled by generators, while that of small factories is collected by RASUB. Demolition waste is hauled by RASUB. ADP, which is responsible for street sweeping, sometimes collects demolition waste when it is dumped on streets.

1.1.2 Waste Quantity Estimation Method Used

In order to estimate quantity of waste generation, collection, disposal and recycling, the Study Team conducted field surveys, and used information and assumptions shown below.

A. Surveys Conducted
   1. Household waste generation quantity survey
B. Information Used
   1. Waste quantity data obtained by the truck scale at Glina disposal site
   2. Statistics and Information of Bucharest
   3. Information on recycling by National Commission of Material Recycling
   4. RADET's information on hauled quantity to an incinerator

Major Assumptions Used

1. Seasonal Fluctuation of Waste Quantity

1.1 Seasonal fluctuation in non-recycled quantity (Waste generation quantity excluding recycling)

Annual average of non-recycled household waste generation quantity is assumed to be 96.6 % of the quantity estimated directly by the household waste generation quantity survey carried out in July 1995. This assumption was made according to the RASUB's information that the relative generation rates in summer, autumn, winter and spring are 1.1: 1.1: 1: 1.05.

1.2 Seasonal fluctuation in waste collection quantity

Based on the monthly waste collection quantity data shown in the RASUB's activity report in 1994, no seasonal fluctuation is considered for the collection quantity of household, business and street waste, while the annual averages of construction and demolition waste are assumed to be 91 % of those estimated in this summer period .

2. Collection rate

Collection rate means the ratio of collection quantity to non-recycled quantity that needs to be collected and disposed of. The collection rate of household waste is 84.8 % as a result of the waste generation quantity survey and the collection quantity data by the truck scale. For all other waste categories shown in table 1.1-2, collection rates are assumed to be 90 %.

3. Hauled Quantity on Saturday and Sunday

It is assumed that quantities of waste hauled to Glina landfill site on Saturday and Sunday are 10 % and 3 % of average weekday quantity respectively.

1.1.3 Estimated Waste Quantity and Waste Flow

It is estimated that average waste generation in Bucharest is 1,622 tons/day, of which 1,034 tons/day is household waste. Daily average household waste generation per capita is 473 grams/day. Average per capita generation including recyclable material sold to REMAT is 504 grams/day. Daily average collection is 1,339 tons/day, of which 822 tons/day is household waste. This means that 85% of household waste is collected after recyclable material is separated. Table 1.1-1 and Table 1.1-2 show average daily waste quantity by waste type. Waste generation by type and sources, collection and recycling, and collection by haulers are shown in Fig. 1.1-1 to 1.1-4. Estimated waste flow is presented in Fig. 1.1-5.

Table 1.1-1 Daily Average Waste Generation, Collection, Disposal and Recycling of Municipal and Non-municipal Waste in Bucharest 1995

(unit: tons/day)

Waste Type	Generation (a)	Recycled (Only household waste) (b)	Non-Recycled (a-b) (c)	Collected and Disposed at Glina site (d)	Not Collected (c-d) (e)
Municipal Waste	1,317	79	1,238	1,065	173
Non-municipal Waste	305	-	305	274	31
Total	1,622	79	1,543	1,339	204

Note: This table does not indicate recycling quantity of non-municipal waste.

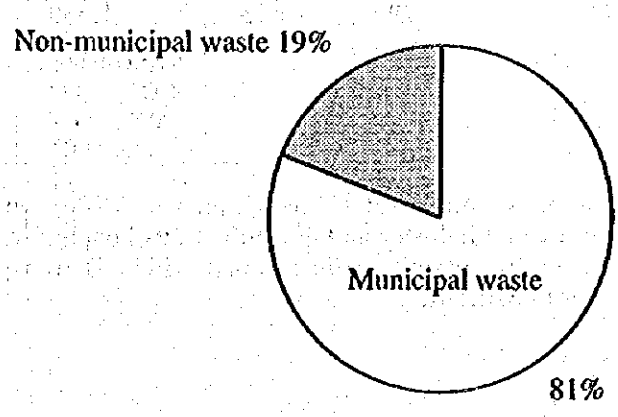


Fig. 1.1-1 Generation of Municipal and Non-municipal Waste

Table 1.1-2 Daily Average Waste Generation, Collection, Disposal and Recycling by Waste Type in Bucharest 1995

(unit: tons/day)

Waste Type	Generation (a)	Recycled (b)	Non-Recycled (a-b) (c)	Collected and Disposed at Glina site (d)	Not Collected (c-d) (e)
A. Municipal Waste					
Household Waste	1,034 (63.8 %)	65	969	822 RASUB: 718 RGR: 104	147
Business Waste[a)]	226[b)] (13.9 %)	14	212[b)]	192[b)] RASUB: 115 RGR: 30 ADP: 47	20
Street Waste	57 (3.5 %)	-	57	51 ADP: 51	6
Total Municipal Waste	**1,317**	**79**	**1,238**	**1,065[b)]**	**173**
B. Non-municipal Waste(hauled by Generators)					
Waste from Large Office	9 (0.6 %)	-	9	8 Generators: 8	1
Industrial Waste	191 (11.8 %)	-	191	172 RASUB: 60 Generators: 112	19
Demolition Waste	105 (6.5 %)	-	105	94 ADP: 92 RASUB: 2	11
Total Non-municipal Waste	**305**	**-**	**305**	**274**	**31**
Total	**1,622** (100.0 %)	**79**	**1,543**	**1,339** RASUB: 895 RGR: 134 ADP: 190 Generators: 120	**204**

Note: a) Business waste includes commercial waste, market waste, waste from institutes, waste from small industry and non-infectious hospital waste.
b) 6 tons of business waste, mainly from airport, which is transported to RADET's incinerator in Miritari.

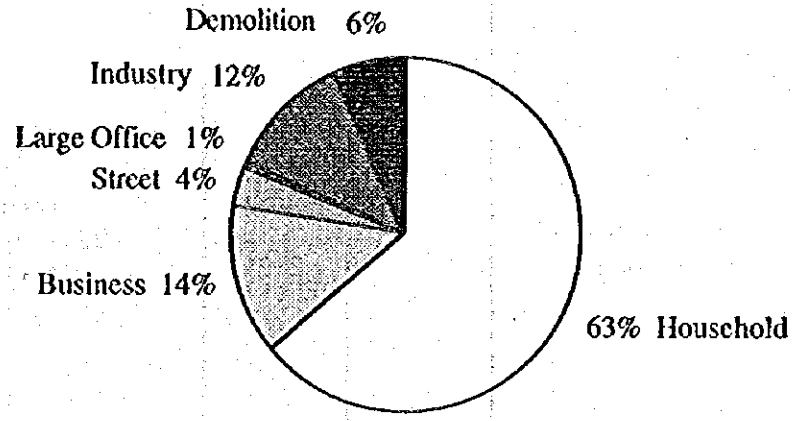


Fig. 1.1-2 Waste Generation by Sources

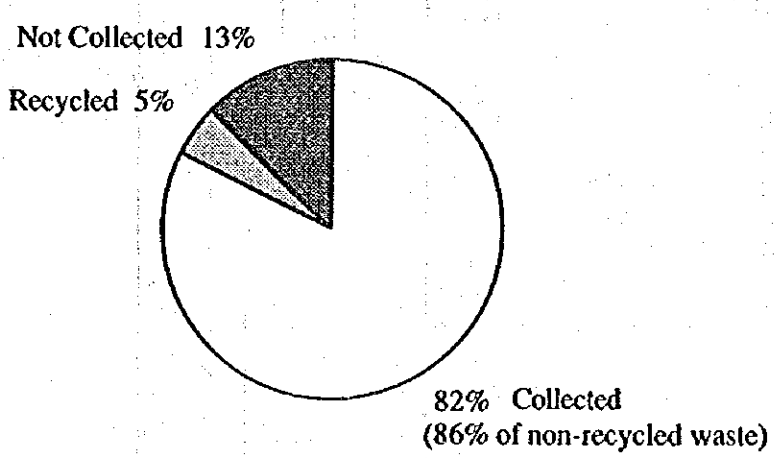


Fig. 1.1-3 Waste Collection and Recycling

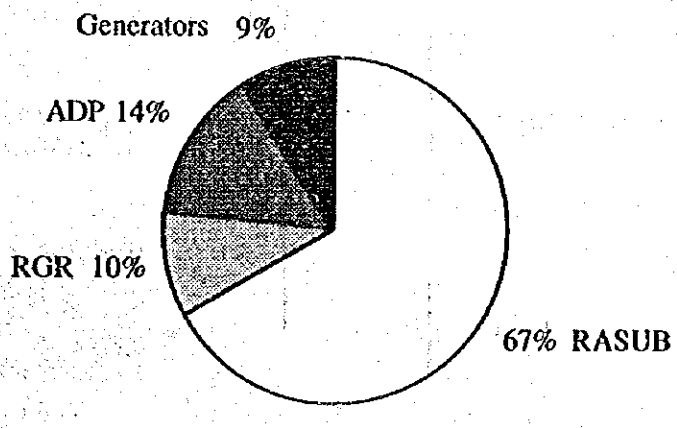
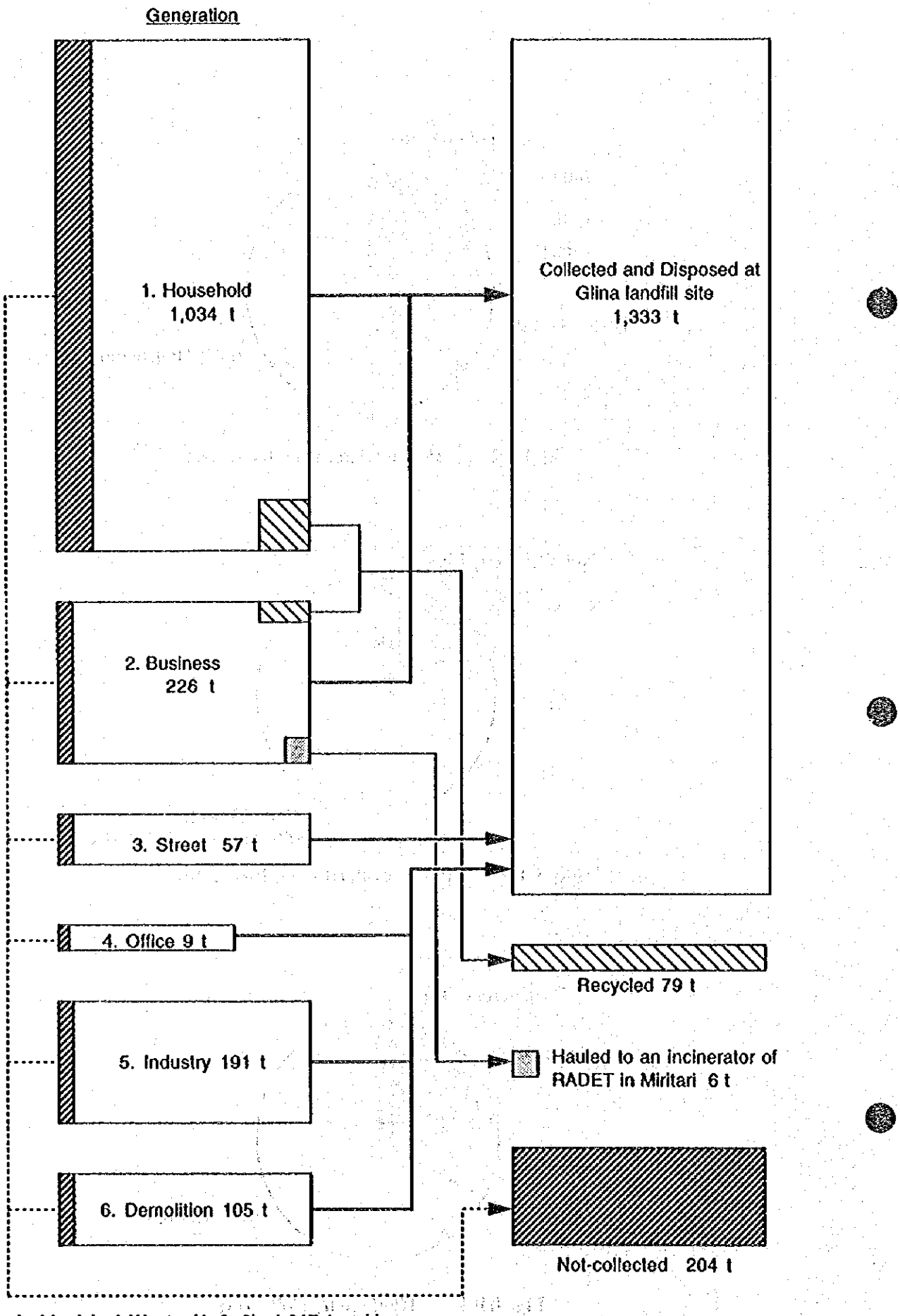


Fig. 1.1-4 Haulage by Collectors



A. Municipal Waste (1+2+3): 1,317 tons/day
B. Non-municipal Waste(4+5+6) : 305 tons/day
Total : 1,622 tons/day

Fig. 1.1-5 Waste Flow in Bucharest 1995

1.1.4 Waste Generation by Sources

1) Municipal Waste

a. Household Waste

Estimated quantity of household waste generation is as follows:

Average daily household waste generation in Bucharest city =1,034 tons per day

This quantity consists of non-recycling quantity (969 tons/day) and recycling quantity (65 tons/day).

(1) Non-recycling Quantity

The Study Team chose a total of 150 households of different family size throughout Bucharest city. Family size ranged from 1 person to 5 persons. 30 households of each size were chosen initially, and the family size was confirmed at the end of survey period. A survey team collected waste by plastic bags and weighed them for consecutive 8 days. Based on these data, per capita house hold waste generation quantity excluding recycling was estimated to be 473 gram/capita/day. Multiplying by 2,050,000, Bucharest population in 1995, household waste non-recycling quantity is estimated to be 969 tons/day (473 gram/capita/day x 2,050,000 person = 969 tons/day).

(2) Collected Quantity

Collected quantity is estimated from waste quantity data obtained by a truck scale installed at Glina landfill site. Since RASUB and RGR collect household waste and business waste in mixture, collected household waste quantity is estimated by dividing total quantity of household and business waste (1,014 tons) into each components proportionally according to the number of contracts for collection services and total capacity of waste bins.

(3) Recycling Quantity

According to information obtained from REMAT, average quantity of recycling of household and business waste excluding industrial or demolition waste is 79 tons/day. Recycling quantity of household waste is estimated to be 65 tons/day according to the following calculation:

- Recycling quantity of household waste

$$a \times b/(b+c) = 65 \text{ tons/day}$$

where,

a: Average daily quantity of household and business waste excluding industrial or demolition waste =79 tons/day

b: Average daily quantity of non-recycled household waste = 969 tons/day

c: Average daily quantity of non-recycled business waste collected by the municipality excluding airport waste =212 tons/day

b. Business Waste

Estimated quantity of business waste generation is as follows:

Average daily business waste generation in Bucharest city =226 tons per day

This quantity consists of non-recycling quantity (212 tons/day) and recycling quantity (14 tons/day).

(1) Non-recycling Quantity

Because of the wide variety in size and type of the generation sources, waste generation survey as conducted for household waste is not suitable method. Non-recycling quantity is estimated from collected quantity on assuming that 90 % of non-recycling quantity is collected and hauled to Glina landfill site.

Average daily quantity of non-recycled business waste

$$= 192 \times 100/90 = 212 \text{ (tons/day)}$$

(2) Collected Quantity

As mentioned in the previous section, collected quantity of business waste is estimated from waste quantity data obtained by a truck scale installed at Glina landfill site, by dividing total quantity of household and business waste (1,014 tons) into each components proportionally according to the number of contracts for collection services and total capacity of waste bins. The estimated collected quantity is 212 tons/day.

(3) Recycling Quantity

By the same proportional division method applied for recycling quantity of household waste, recycling quantity of business waste is estimated as follows:

- Recycling quantity of business waste = 14 tons/day

c. Street Waste

Generation quantity of street waste is estimated from collected quantity on assuming that 90 % of generation quantity is collected and hauled to Glina landfill site by ADP.

Average daily generation quantity in Bucharest city = 51 x 100/90 = 57 (tons/day)

2) Non-municipal Waste

Non-municipal waste is composed of waste from large offices, industrial waste and demolition waste. Generation quantity of each waste is estimated on assumption that about 90 % of non-recycled waste is collected and hauled to Glina landfill site. Recycling quantity of these waste is excluded from these estimation. Estimated generation quantities of these waste are as follows:

Average daily generation (=non-recycled) quantity of waste from large office
= 8 x 100/90 = 9 (tons/day)

Average daily generation (=non-recycled) quantity of industrial waste
= 172 x 100/90 = 191 (tons/day)

Average daily generation (=non-recycled) quantity of demolition waste
= 94 x 100/90 = 105 (tons/day)

1.2 Current Waste Quality

1.2.1 Introduction

Waste quality of household waste, market waste, business (office) waste and street waste were analyzed. Analysis was conducted in November 1994 and July 1995. Household waste samples were obtained by plastic bags from 50 households of various family size. Samples from market and office were obtained at Glina site

when collection vehicles dump the waste (in November 1994), and from waste container at the market and a waste yard at the office (in July 1995). Street waste samples were collected from ADP's carts during street sweeping.

Items analyzed are the following:

1) Bulk Density
2) Water Content
3) Ash content
4) Physical Composition
5) Calorific Value
6) Elemental Composition for C, H, N, Cl, S and O

1.2.2 Results of Analysis

The results of analysis are summarized in Table 1.2-1 to Table 1.2-4. Composition of household waste is exhibited in Fig. 1.2-1.

Paper and plastics are contained little in household waste. Market waste contains a lot of vegetable waste and this might make its calorific value low. Calorific value of office waste is fairly high. This is due to high content of paper and low content of water in samples analyzed.

Table 1.2-1 Bulk Density and Three Major Components in November 1994

	Household	Market	Office	Street
Bulk density (t/m^3)	0.32	0.26	0.27	0.99
Water content (%)	49.52	56.82	13.16	16.25
Ash content (%)	21.42	23.24	32.40	not analyzed
Combustible (%)	29.06	19.94	54.44	not analyzed

Note; Figures in household and in street are averages of five and two samples, respectively.

Table 1.2-2 Bulk Density and Three Major Components in July 1995

	Household	Market	Office	Street
Bulk density (t/m^3)	0.23	0.18	0.17	0.36
Water content (%)	54.8	57.4	6.7	24.1
Ash content (%)	19.5	17.7	48.7	63.2
Combustible (%)	25.7	25.0	44.6	not analyzed

Note; Figure in household is an average of five samples.

Table 1.2-3 Physical Composition in November 1994

(unit; % in dry base)

	Household	Market	Office	Street
Paper	11.3	1.8	54.6	5.1
Textile	5.4	7.6	3.0	0.0
Garbage	35.8	58.2	0.0	0.0
Plastics	3.9	6.3	3.6	0.7
Leather	0.0	0.0	0.0	0.0
Wood	0.0	0.0	0.0	1.2
Other combustibles	15.3	25.0	6.7	3.3
Sub Total	71.7	98.9	67.9	10.3
Glass	7.1	1.1	12.1	0.0
Metal	7.2	0.0	17.3	0.0
Sand and stone	0.0	0.0	0.0	89.7
Other incombustible	14.0	0.0	2.7	0.0
Sub Total	28.3	1.1	32.1	0.0
Total	100.0	100.0	100.0	100.0

Note; Figures in household and in street are averages of five and two samples, respectively.

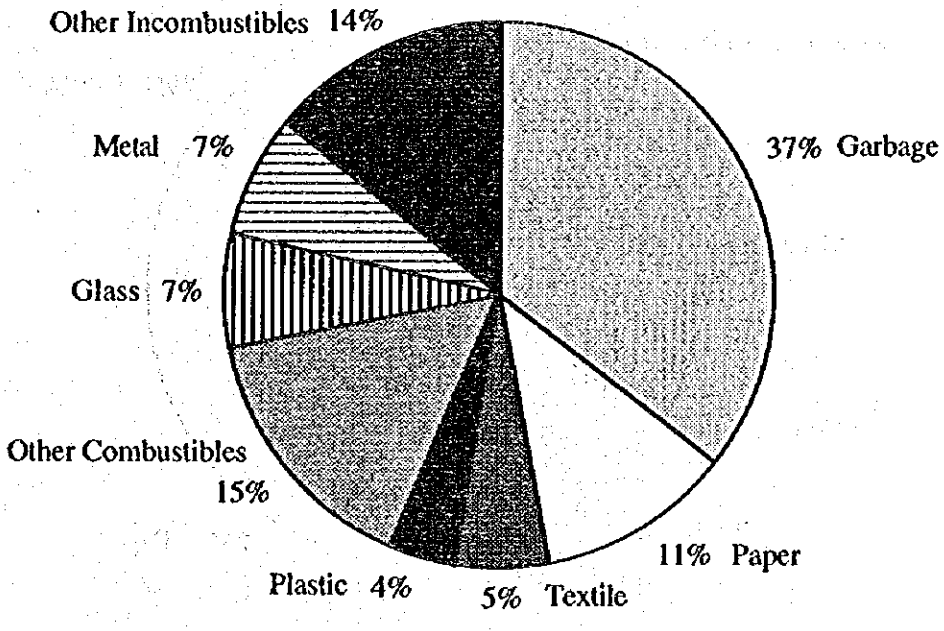


Fig. 1.2-1 Composition of Household waste Sampled in November 1994

Table 1.2-4 Physical Composition in July 1995

(unit; % in dry base)

	Household	Market	Office	Street
Paper	24.8	4.1	17.9	6.0
Textile	4.0	0.0	16.9	1.1
Garbage	28.2	61.0	2.9	1.1
Plastics	8.1	6.5	14.3	5.1
Leather	0.0	0.0	0.0	0.0
Wood and leaves	0.0	0.0	0.0	4.7
Other combustibles	1.3	0.5	0.7	0.0
Sub Total	66.4	71.6	52.7	18.0
Glass	9.0	14.5	14.8	12.3
Metal	4.4	3.1	25.2	1.3
Sand and stone	0.0	0.0	0.0	1.7
Other incombustible	20.2	10.3	7.3	66.7
Sub Total	33.6	27.9	47.3	82.0
Total	100.0	100.0	100.0	100.0

Note; Figure in household is an average of five samples.

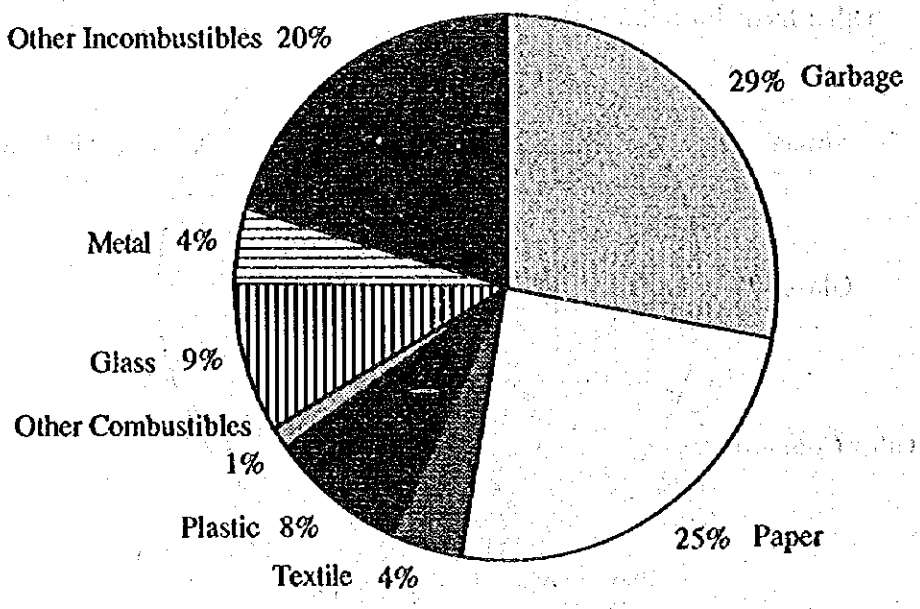


Fig. 1.2-2 Composition of Household waste Sampled in July 1995

Table 1.2-5 Calorific Value in November 1994 and July 1995

(unit; kcal/kg)

Elements	Household	Market	Office
November 1994	1,578	566	3,529
July 1995	844	757	2,628

Note; Figure in household is an average of five samples.

Table 1.2-6 Elemental Composition in November 1994

(unit; % in wet base)

Elements	Household	Market	Office
C	13.59	4.44	26.06
H	3.03	0.89	4.72
N	0.68	0.10	0.13
S	0.61	0.10	0.40
Cl	1.00	0.44	0.40
O	10.15	13.97	22.73
Total Combustible	29.06	19.94	54.44

Note; Figures in household is an average of five samples.

Table 1.2-7 Elemental Composition in July 1995

(unit; % in wet base)

Elements	Household	Market	Office
C	12.35	10.87	24.78
H	1.96	1.73	3.87
N	0.67	0.84	1.10
S	0.00	0.00	0.00
Cl	0.13	0.00	0.00
O	10.68	9.31	13.97
Total Combustible	25.60	24.97	44.63

Note; Figures in household is an average of five samples.

Chapter 2
Waste Quantity Projection

CHAPTER 2 PROJECTION OF WASTE GENERATION

2.1 Projection

In 1995, it is estimated that the waste generation amount was 1,622 ton/day, and per capita generation was 504 grams/capita/day as shown in Table 2.1-1. The corresponding quantities in 2010 are estimated to be 2,388 tons/day, and 667 gram/capita/day based on growth projection of economy and population. Waste generation growth rate differs by year. During 1995 - 2010, average annual growth of waste generation is 2.5 %. Section 2.2 shows assumptions used for the projection.

Table 2.1-1 Waste Generation Projection during 1995 - 2010

Year	Per capita Household waste generation rate (gram/day) (a)	Population (1,000) (b)	Household waste (ton/day) (a x b /1,000,000) (c)	Other municipal waste (ton/day) (d)	Total municipal waste (c+d) (ton/day) (e)	Non municipal waste (hauled by generators) (ton/day) (f)	Total waste generation (e+f) (ton/day) (g)
1995	504	2,050	1034	283	1317	305	1622
1996	506	2,065	1045	286	1331	308	1639
1997	511	2,080	1063	291	1354	314	1668
1998	522	2,095	1093	299	1392	322	1714
1999	532	2,110	1124	307	1431	331	1762
2000	543	2,125	1155	316	1471	341	1812
2001	555	2,141	1187	325	1512	350	1862
2002	566	2,156	1221	334	1555	360	1915
2003	578	2,172	1255	343	1598	370	1968
2004	590	2,188	1290	353	1643	380	2023
2005	602	2,203	1326	363	1689	391	2080
2006	614	2,219	1363	373	1736	402	2138
2007	627	2,235	1401	384	1785	413	2198
2008	640	2,251	1441	394	1835	425	2260
2009	653	2,268	1481	405	1886	437	2323
2010	667	2,284	1522	417	1939	449	2388

2.2 Assumptions Used for Projection

The major assumptions used for the projection of future municipal waste generation quantities are as follows:

1. Generation amount will increase with the Romanian GDP growth which may be decomposed into 2 factors; per capita growth and population growth. Assumed correlation between annual waste increase rate (a) and annual GDP growth rate (b) is as follows: $a = 0.7\ b$. It is assumed that the same correlation (0.7) will hold for per capita waste generation rate and per capita GDP growth.

   Remarks:

   The above assumption is used based on the Japanese experience during the period 1965 - 1980. During this period, average annual waste increase rate was 4.7 %, while average annual GDP growth rate was 6.6 % over the same period.

2. Population of Bucharest in 1995 is estimated to be 2,050 thousand, and the population growth will be 0.722 %/year until 2010.

3. The Romanian GDP growth rates projected in the World Bank report *ROMANIA An Economic Update, April 1994* are used for the waste projection. The projected annual GDP growth rates are as follows: 1.2 % in 1995, 1.5 % in 1996, 2.5 % in 1997, and 4.0 % from 1998 to 2002. No projection is shown for 2003 and thereafter. The Study Team assumes that GDP growth rate for period 2003 - 2010 would be 4 %. It is assumed that annual per capita economic growth (a) is: $b + c$, where b is annual GDP growth and c is annual population growth. (Eg. per capita economic growth rate in 1995 = 1.012 ÷ 1.00722 = 1.0047, i.e. 0.47 %.)

Chapter 3
Objectives and Targets

CHAPTER 3 OBJECTIVES AND TARGETS

3.1 Objectives of Solid Waste Management

3.1.1 Overriding Objectives

The major objectives of solid waste management are to:

1. protect public health;
2. protect the environment; and
3. maintain public cleanliness in order to keep public places aesthetically acceptable;

3.1.2 Service Objectives

The service objectives are to provide proper storage, collection and safe treatment and disposal of municipal waste.

3.1.3 Management Objectives

A key concept for the improvement of municipal solid waste management is "do more (better services) with less (money)". The management objectives include the following:

1. improving the quality of the service. This would include:
   a. collection frequency
   b. reliability
   c. collection method;
2. extending service coverage to areas which may not be served or are inadequately served; and
3. upgrading environmental disposal standards and enforcement procedures.
4. enhancing efficiency and reducing costs

3.2 Service Level Targets

3.2.1 Recycling

In principle, all recyclable waste should be recycled. It is estimated that the current household waste of Bucharest include metals (4 %), glass (9 %), plastic (8 %) and

paper (25 %) based on the waste composition analysis (dry base) conducted by the JICA Study Team in 1995. Most of paper and plastic contained in the household waste are not recyclable. Therefore, main target recycling objects would be metals and glass. In view of the waste composition shown above, recycling target for household waste is proposed to be 10 - 15 % in the year 2000 and thereafter. Recycling target should be reviewed periodically based on the socio economic conditions of Bucharest and changes in the future recycling systems.

At present, the recycling rate of household waste is estimated to be 6 %. Needless to mention, the proposed targets would not be achieved without the citizens' full cooperation, which however is not necessarily guaranteed. Therefore, recycling rate of 8 % in 2000 and thereafter is used for the purpose of planning waste collection and disposal on the safe side.

3.2.2 Collection and Haulage

It is estimated that 13 % of the citizens in Bucharest are not covered with waste collection contracts based on the information given by RASUB and RGR. According to the citizens' opinion survey conducted by the JICA Study Team, 26 % of the interviewees answered that they receive waste collection service once in 10 days or less frequently, while 93 % of the interviewees wished to receive the service at least once a week.

Waste Collection Service Targets

A. Targets to be Achieved by 2000
   1. The municipality should provide collection service to all (100 %) citizens of Bucharest by the year 2000.
   2. The municipality should collect 100 % of waste generated.
   3. The collection frequency should be at least once a week by 2000.
      After the year 2001, collection frequency should be a twice weekly for summer season.
   4. Collection and haulage services for each of the 6 sectors should be contracted out for improvement of service quality and efficiency.

B. Targets to be Achieved by 2005
   5. The collection frequency should be twice a week for all households, and twice a week or more for all business waste.

C. Targets to be Achieved by 2010
   6. Bucharest will become the cleanest city in Eastern Europe.

Collection frequency should be determined according to needs which depend on seasons and waste generation quantity. A once weekly collection is a minimum frequency in any case.

3.2.3 Street Sweeping

Sweeping costs should be reduced through the following arrangements:

1. contracting out of the street sweeping service. (Initially, the sweeping service will be contracted out together with collection and haulage services, but later, street sweeping should be contracted out separately from the collection and haulage service to achieve further cost reduction of street sweeping.)
2. use of patrol system (explained in the chapter of street sweeping.)
3. control of illegal dumping of demolition waste in the open spaces and streets

3.2.4 Disposal

The existing Glina landfill sites is not environmentally sound, and generates smoke, smell, and rodents. There is contamination of water by leachate. Public nuisance and health risks to the local residents are increasing. In view of this situation, the following is proposed:

1. The municipality will directly manage municipal waste disposal.
2. Introduction of sanitary landfill for all new landfill sites to be constructed in the future.
   (It is proposed that the first new landfill site of sanitary landfill will be constructed in 1998.)
3. Improvement of Glina site in order to reduce public health risks of the local residents living nearby the site.
4. Acquisition of land necessary for landfill.
   (It is estimated that landfill sites with a total waste receiving capacity of about 12 million m^3 (equivalent to area of 167 ha) will be required by 2010. The Study Team identified 5 sites at Balaceanca, Cretuleasca, Berceni, Afumati and Jilava. Total area of these sites will be equivalent to the required area.)
5. At present, incineration is not feasible from both technical and economic view points. However, possibility of a pilot incinerator may be considered after 2000 due to changes in socio economic conditions.

3.2.5 Management Targets

1. MB will contract out of the collection/haulage service and street sweeping for all the sectors by 2000 at the latest. MB will immediately establish a good contract management system.
2. MB will establish a municipal disposal organization in 1996.
3. MB will establish a system for monitoring the SWM services performance.
4. MB will introduce the waste tax in 1996. 100 % cost recovery will be achieved by 2000.
5. Through the contracting out of the collection/haulage services and resulting reduction of the costs, the future total unit cost ($/ton) of solid waste management should remain at the same level as the current one though the unit disposal cost will increase remarkably due to the introduction of sanitary landfill. See Fig. 3.2-1.

3.3 Waste Quantity Projection

Table 3.3-1 and Fig. 3.3-1 show projection of quantity of waste generation and recycling, and target waste collection rate and quantity.

Waste Generation

See Chapter 3 Section 2.

Recycling

The current recycling rate of household waste is 6 %. Target rate should be 10 - 15 % in 2000 and thereafter. However, for planning of waste collection and disposal systems on the safe side, minimum target of 8 % is assumed in 2000 and thereafter.

Collection and haulage

The current collection rates are 85 % for household waste, and 90 % for other waste. The target rate is 100 % for both waste in 2000 and thereafter. As a result, collection amount will increase from the current 1,339 ton/day in 1995 to 2,233 ton/day in 2010.

Incineration

The current waste amount incinerated at the RADET's incinerator in Militari is estimated to be 6 ton/day. It is not considered that the further continuation of the operation would be feasible due to the extremely poor conditions of the operation. Therefore, it is assumed that the RADET' incinerator would stop its operation in 2000.

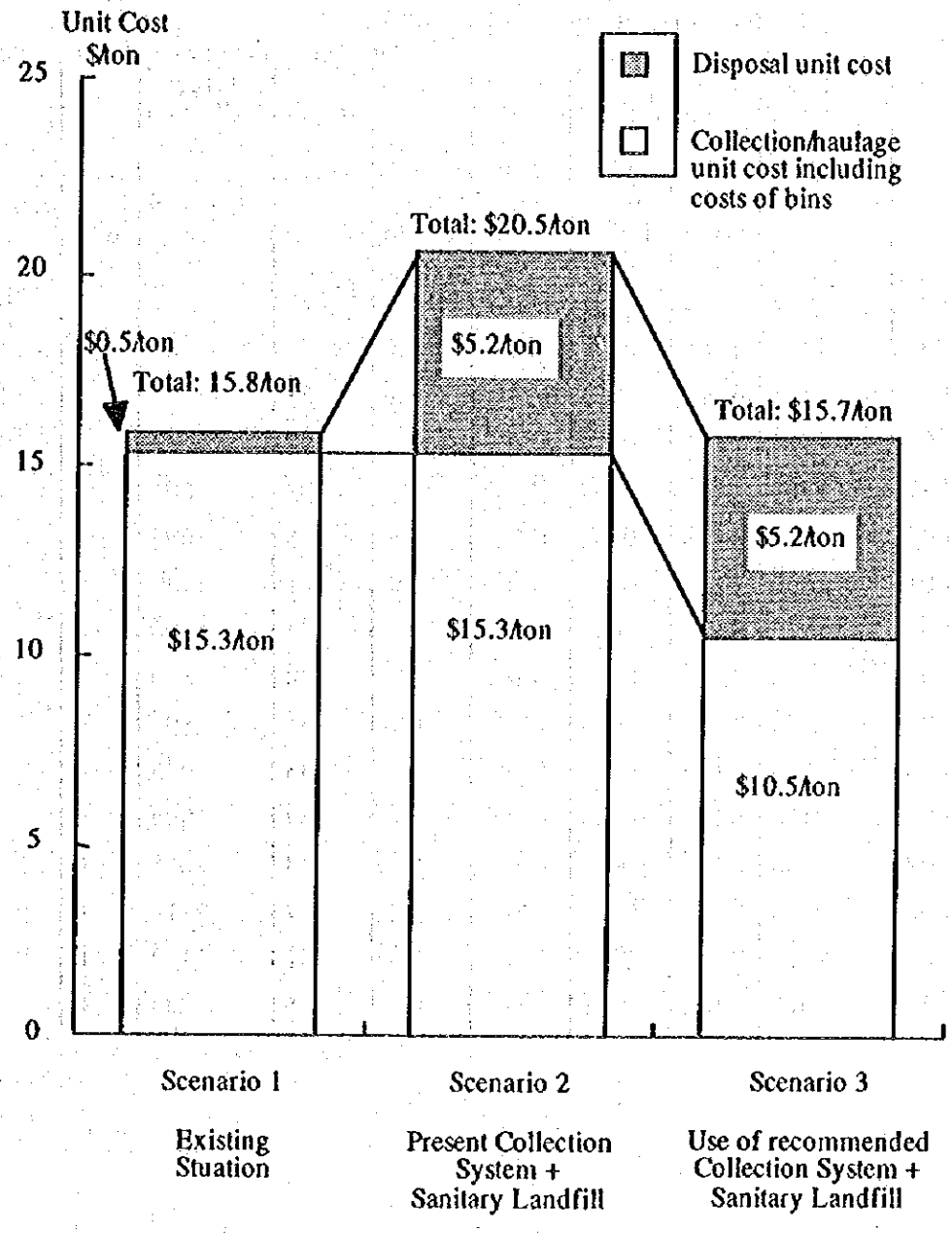


Fig. 3.2-1 Comparison of Unit Costs of the Existing Solid Waste Management System and Recommended System

Table 3.3-1 Projection of Waste Generation and Targets of Recycling & Collection during 1995 - 2000

Unit: ton/day unless otherwise indicated

Year	Generation including non-municipal waste (a)	Recycling of Municipal Waste (b)	Collection Rate (Household) (c)	Collection Rate (All other waste) (d)	Average Non-Collection Rate (e)	Recycled Municipal Waste (f)	Target Collection including non-municipal waste (g)	Incineration (h)	Non-collection (i)
1995	1622	6.0%	85%	90%	13%	79	1339	6	204
1996	1639	6.0%	86%	92%	11%	80	1384	6	175
1997	1668	6.5%	89%	94%	9%	88	1435	6	144
1998	1714	7.0%	92%	96%	7%	97	1512	6	105
1999	1762	7.5%	96%	98%	3%	107	1601	6	54
2000	1812	8.0%	100%	100%	0%	118	1694	0	0
2001	1862	8.0%	100%	100%	0%	121	1742	0	0
2002	1915	8.0%	100%	100%	0%	124	1790	0	0
2003	1968	8.0%	100%	100%	0%	128	1840	0	0
2004	2023	8.0%	100%	100%	0%	131	1892	0	0
2005	2080	8.0%	100%	100%	0%	135	1945	0	0
2006	2138	8.0%	100%	100%	0%	139	1999	0	0
2007	2198	8.0%	100%	100%	0%	143	2055	0	0
2008	2260	8.0%	100%	100%	0%	147	2113	0	0
2009	2323	8.0%	100%	100%	0%	151	2172	0	0
2010	2388	8.0%	100%	100%	0%	155	2233	0	0

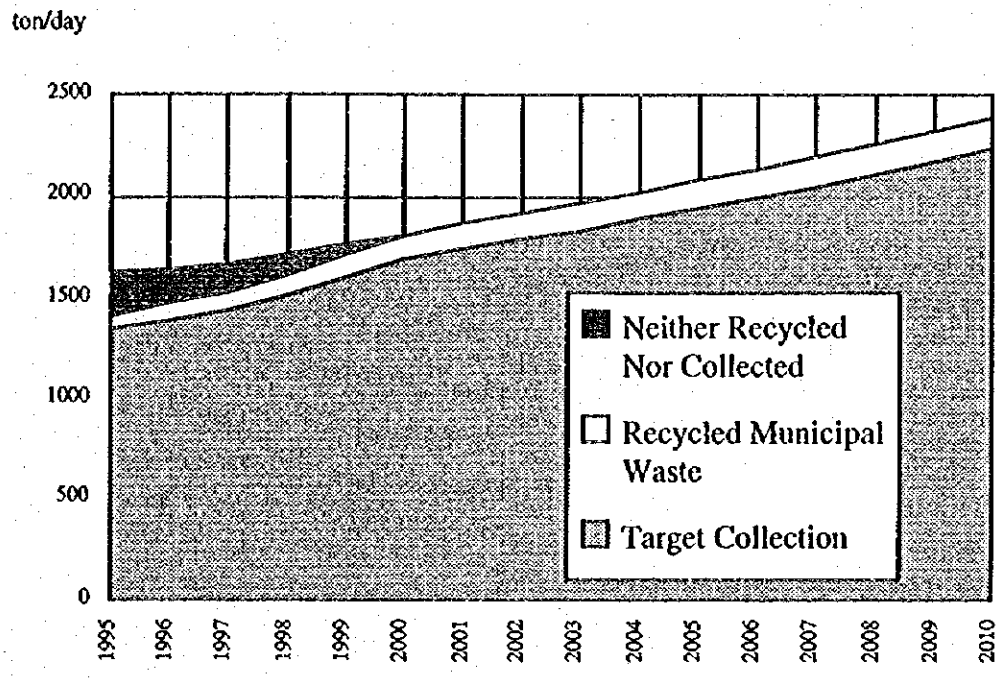


Fig. 3.3-1 Projected Waste Generation, Recycling, Collection and Non-Collection during 1995 - 2000

Chapter 4
Waste Prevention and Utilization

CHAPTER 4 WASTE PREVENTION AND UTILIZATION

4.1 Current Situation

4.1.1 Rate of Reuse and Recycling

1) Reuse of Household Waste

Glass bottles and PET (Polyethylene Terephthalate) bottles are two major items that are reused. Approximately 60% of glass bottles of mineral water or refreshment drinks with major brand are returned to shops through a deposit system and reused. This rate is considered fairly high and should be maintained. However, in recent years, some private shops have not accepted these bottles because these shops are not part of the recycling chain. This is an obstacle in deposit system. Other types of glass bottle such as wine bottles are not directly reused but recycled as glass material through REMAT because they are not standardized in their size and shape.

PET bottles entered the market place in Romania only four years ago (1991). At present 80% of PET bottles are reused as containers within households; but it is likely that PET bottles will be disposed of as general waste in near future.

2) Recycling of Household Waste through REMAT

REMAT, which was established as a state-owned company under the National Commission of Material Recycling in Ministry of Industry, is a major organization involved in material recycling. REMAT buys recyclable materials such as iron, non-ferrous metal, paper, glass, plastics, tires and batteries from citizens through their collection points. In Bucharest, REMAT has 60 collection points. 20 to 40 % of household recyclable waste has been collected through these collection points, but amount of collected materials from citizens seems to be decreasing in these years. Citizens' cooperation also seems to be decreasing. Probable reasons are;

- Decreases in prices of recyclable waste due to falls in demand
- Limited accessibility to the collection points, because of they open for short hours

Each collection point is allowed, by law, to set buying price of their own, but these prices are too low to have citizens' attention. The collection points open only two or three hours a day and mostly in weekdays. The short open hour of collection points discourages citizens' cooperation. According to the Study Team's survey on citizens' opinion, 85% of citizens do not go to collection points of REMAT.

3) Business Waste Recycling

Some materials are recycled by business enterprises such as offices, hotels and restaurants. Major recycled items are glass bottles, paper, plastic bottles and metal cans. Some of iron, wood and metal caps of bottles are also recycled, but their recycling rates are low. Recycling of business waste may increase as it contains greater recyclable components than household waste does.

According to the Study Team's survey, 32% of business enterprises recycle some kind of waste mentioned above. The participation rate is considered high, but the total recycled quantity is estimated to be low because of insufficient routes for recycling these business waste. It is noteworthy that some private buyers of business waste have already begun recycling business in Bucharest.

4.1.2 Institutional and Legal Condition at National Level

1) National Scheme of Waste Utilization

In Romania, Ministry of Industry (MoI) is responsible for recycling at central government level. National Commission for Material Recycling (NCMR), a commission in the MoI, is responsible for preparing strategy of secondary material recycling at national level. Actual recycling is operated by REMAT.

There are 44 REMAT throughout the country. Principally one county has one REMAT, but in Bucharest there are two REMAT, REMAT sud (south) and REMAT nord (north). REMAT was established in 1949 as a state-owned company with independent finance, but currently majority of them are in process of privatization. REMAT collects recyclable materials from industry or household, and process it to secondary material. It collects iron, copper, brass, lead, aluminum, glass, textile and waste paper from industry by its own cars. REMAT collects ferrous and non-ferrous metal, glass, waste paper from citizens through collection points. The structure of this collection organizations is shown in Fig. 4.1-1.

In Bucharest, there are 60 collection points under two REMAT. There are two types of collection points, one is fixed points like shops and the other is mobile point like camping trailers. Management of the collection point is entrusted to independent business enterprises, while assets of collection points belong to REMAT. Land of collection points is provided by the municipality. Recyclable materials collected through these points are transported to the responsible REMAT.

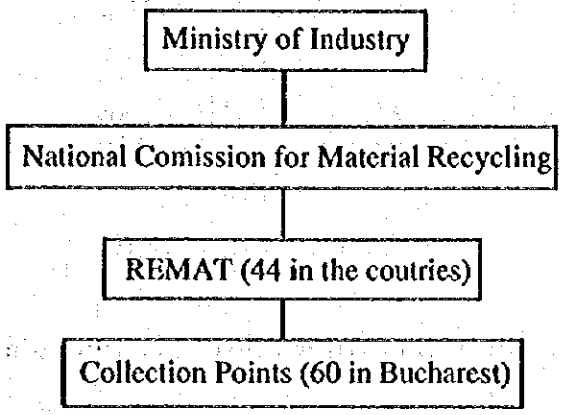


Fig. 4.1-1 Organizations for Material Recycling

2) New Law for Material Recycling

Ministry of Industry recently proposes a new law for material recycling, titled "Recyclable Materials Law" that replaces old law. Concerning municipality's authority, the law says the following:

- National Commission for Material Recycling (NCMR) cooperates with the local public administration authorities (Article 10).
- Local public administration authorities can apply the provision of the law to their territory (Article 12).
- Local public administration authorities have authority to issue norms for separate collection with approval by the NCMR, to organize economic enterprises for recycling of household waste, to authorize legal and natural persons who carry out separate collection (Article 13).
- Economic enterprises for recycling can have privileges such as reduction of rental fee for space or an exemption of profit tax (Article 18).

According to these provisions, the municipality will acquire authority to promote recycling activity in their own territory.

4.2 Methods of Waste Prevention and Utilization

4.2.1 Priority of Waste Prevention and Utilization

"Waste Prevention" and Waste Utilization" are two major ways for waste reduction, which are desirable from economical and environmental point of view. Priority of waste prevention utilization and disposal should be as follows:

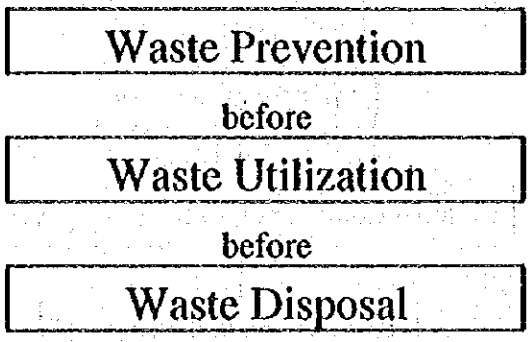


Fig. 4.2-1 Priority of Waste Prevention, Utilization and Disposal

4.2.2 Methods of Waste Prevention

Manufacturers and dealers should share the responsibility of waste prevention as well as consumers, because all the process of production, distribution and consumption generate waste. Measures to be taken by manufacturers and dealers include the following.:

1) Simple packages of their products
2) Use of reusable containers or those of recyclable material
3) Development of the route for reuse.

These measures by manufacturers and dealers are required to answer consumers' effort for waste prevention. Instruction and guidance to manufacturers and dealers are not local issue. Nation wide instruction and guidance by the National Government according to the national law is desirable.

4.2.3 Method of Waste Utilization

Waste utilization is achieved either of these way shown below.

1) Reuse; this means secondary use as it is
2) Recycling: this means material recovery
3) Heat recovery; this means use of waste as fuel

Among them, Reuse and recycling are discussed in this chapter, while heat recovery is discussed in Section 7.1.

A waste utilization plan should be economically feasible, otherwise it cannot be workable. Economic consideration of recycling is described as an attachment of this chapter.

4.3 Future Projection and a Target

Physical potentiality of recycling depends on the quantity of recyclable material contained in waste. According to the results of waste quality analysis conducted by the Study Team in 1995, paper, glass and metal occupy 25%, 9% and 4% of household waste respectively. They are expressed in dry-base and the percentages will be almost half if they are expressed in wet base. Thus, recyclable material is not so much at present, but waste quantity is increasing and waste composition will be changing along with economic growth. It is reported both in Japan and Germany that package waste occupies 50 to 60 % of urban waste in volume. Promotion of package waste collection and recycling is now common issue among the developed countries.

At present, recycling rate of household waste is estimated to be 6 % based on the quantity of recyclable material collected by REMAT in 1995. Package waste including paper, plastics and metal cans are increasing, which means that recyclable portion in waste will increase. Including recycling of paper, glass and metal, 10 -15 % is a desirable target rate of recycling of household waste. However, this 10 -15 % can not be easily achieved. The municipality should strongly promote citizens' cooperation to recycling. It is also necessary to develop collection system of recyclable material to facilitate it, and the municipality should also support it. Ideas of the collection system is discussed in the following section.

4.4 Measures for Collection of Recyclable Material

4.4.1 Proposed Measures

Current situation of Bucharest considered, proposed measures are summarized below. These measures are not mutually exclusive, but closely related.

Function of these systems and their advantages and disadvantages are described in the next section.

Table 4.4-1 Features of Proposed Measures

Options	Cost	Remark
1) Separate collection of waste	Require additional costs	Citizens' cooperation is necessary.
2) Separation by sorting facility	Very high costs for investment and operation of sorting facilities are required.	Preliminary separation at source is needed.
3) Installation of collection boxes	Least cost among the 4 options	Citizens' cooperation is necessary. The municipality gives permission to interested collectors
4) Subsidy for collection points	Cost depends on market price of collected material.	Demand, supply and prices have to be closely monitored.

1) Separate Collection of Waste

Citizens separate recyclable materials such as glass and metals from other waste in their home when they discharge waste. Collectors collect these materials separately and haul them to REMAT or other recycling plants.

Advantages

Separate collection of recyclable material at generation source contributes efficient material recovery.

Disadvantages

Separate collection is more costly than non-separate collection. Citizens will have to pay higher waste tariff to cover additional cost for material collection. Besides, citizens' close cooperation is indispensable to separate recyclable material by its kind.

2) Separation by Sorting Facility

The municipality provides sorting facilities. Municipal waste roughly separated is transported to the facility, and there recyclable material such as glass and metal are separated from waste.

Advantages

This is easier for citizen than the separate collection shown in the above section, because complete separation is not required but rough separation of incombustible matters from combustible ones is necessary.

Disadvantages

Investments and operation of the sorting facilities require high costs.

3) Installation of Collection Boxes

By installing many collection boxes throughout the city, the citizen can easily bring recyclable material to the collection boxes. Glass bottles, metal cans and plastic bottles are considered appropriate type of waste to be collected by this collection box. Although the citizens are not paid for their activity, easy accessibility to the collection boxes helps induce their voluntary cooperation. The material in the collection boxes are collected by private collectors with approval of the municipality.

Advantages

For the municipality, this system requires the least cost among the options. If private collectors can run their business in a good economic condition, additional collection boxes may be installed by the collectors themselves. This system may lead to establishment of system similar to German Dual System or French Eco-emballage System.

Disadvantages

Success of this system depends on the citizens' cooperation. Public relation is needed. Market of collected material affects the collectors' business. If there is no demand for collected material, the collector can not sell them and can not continue their business.

4) Subsidy for Collection Point

At present REMAT collection point gives little incentives to citizens to bring recyclable materials due to its low purchase price. The collection points even reject the materials or sometimes they are closed. This is due to the low market prices of these material. The municipality provides subsidy for collection points to be able to purchase the materials at appropriate prices from the citizens.

Advantages

Appropriate prices for waste material purchase gives direct incentive to the citizens. This will again activate collecting activities of the collection points.

Disadvantages

Fair management of the subsidy is not easy task. The municipality must inspect and evaluate each collection point's management situation. Secondly, amount of subsidy depends on market prices of recycled materials. If the market price of the material falls down, the amount of subsidy must increase. Adjustment of subsidy amount require constant monitoring of prices.

4.4.2 Selection of Measure

1) separate collection of waste, shown in the previous section, requires additional vehicles specialized for collection of material collection, because it is technically proved that compactors and rotary compactors are not suitable for material collection. Besides, collection by such special vehicles is not efficient. It takes longer time and the quantity is not so much, because the unit quantity discharged by a household is small. Thus, collection cost is estimated to be 2 or 3 times higher than that of ordinary waste collection. If the material is collected by kind, the cost will be much higher.

2) separation by sorting facility needs to develop the facility. Generally, development and operation of the sorting facility can be more efficiently managed by a collector of recyclable material than by the municipality. It is not efficient in cost to separate recyclable material which is only 10 % of whole waste.

3) installation of collection boxes is adopted in Many European cities. In Bucharest, there are 60 collection points , but it is not sufficient for citizen's easy access. It is necessary to increase the collection points. Participation of private collector to this system is more expectable, because this system is more efficient than measure 1) in the collection cost.

4) subsidy of collection point is too difficult to be managed by the municipality, because the municipality always must monitor the economic condition of recyclable material market.

Thus, considering the cost efficiency and possibility of participation of private collector, **3) installation of collection boxes** with collection by private collectors

seems most suitable for current situation of Bucharest. Detailed structure of this system will be discussed in the following section.

4.5 Proposed System for Collection of Recyclable Materiel

1) Material to be Collected

Successful recycling depends on marketability of collected material. If recyclable material is demanded in the market, collectors can sell it at enough high price. However, if the demand decreases, the collector cannot run their business in a good economic condition. At present, as market values of glass and steel seems not so high, recycling of them can not be handled only by private collectors and the support by the municipality may be necessary to support them. Though aluminum has high value as recyclable material, its current quantity in waste is still small. Collection of aluminum can not yet be successful. Collection of paper can be continued by REMAT because of its stable large quantity.

Therefore, glass and steel which mainly come from waste glass bottle and steel cans are proposed as recyclable material to be collected by the collection boxes.

2) Economic Condition of Subsidy by the Municipality

As shown in the principle 10., the following is the condition in which collection of recycled material is commercially feasible without the subsidy:

$x>z$ where,

x: Direct benefit (market value of recycled material)

z: Costs of collection

If $x<z$, subsidy is necessary to cover the collection cost, that is:

$x+s>z$

s: Subsidy to make the collection financially feasible

In this case, s should be smaller than the cost to manage the material as waste, otherwise it is better not to collect but to dispose them.

$s<c$

c: Management cost for the material when disposed as waste

Therefore: $z<x+s<x+c$ (A)

The (A) is the condition in which the subsidy by the municipality is justified

3) Demand for Collected Material

The x, the market value of collected material, depends on the demand in the market. At present it is difficult to predict the feasibility of recycling from the commercial point of view, since in Romania the production decreases and the demand seems small after the market economy started. When Romanian economy grows and is opened to the world, the demand for waste steel and glass grows and the market condition will be favorable for the collection.

4) Scheme of the Collection System

Basic scheme of the collection box system is shown in Fig. 4.5-1. An introduction of private collectors is a feature of this system. Two ways can be considered to use private collectors. One is contracting out and the other is license system. The license system is better because it stimulates ambitious activity of the private collectors. The municipality should prepare the license system in which responsibility of private collectors is defined in written form.

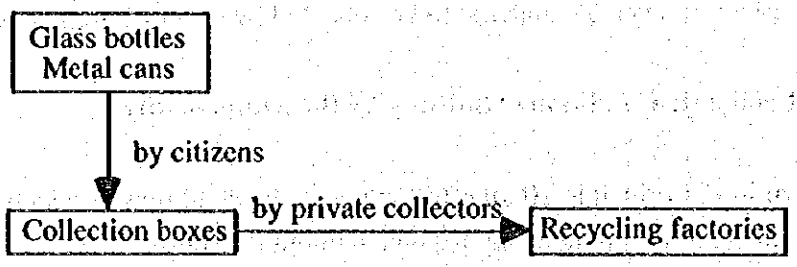


Fig. 4.5-1 Scheme of collection system by the collection boxes

In future when a new collection system similar to German Dual System or French Eco-emballage System is introduced in Romania, this collection box system using private contractors can be a component of the new system.

If $2m^3$ of collection box with two sections is used, necessary units of the collection boxes which are installed all over the city is estimated as follows:

- The collection boxes necessary : 1,540 units

This estimation is made according to the following assumptions.

Assumption:

1) The capacity of the collection boxes to be introduced is $2m^3$. A box is divided into two sections, each of which is for glass bottles and steel cans.
2) Frequency of collection by collectors is once a week.
3) Total recycled quantity in the year 2010 will be 228 tons/day which is 15 % of total household waste. 110 tons (about 48 %) of them is collected by the collection boxes.
4) Bulk density of these waste to be collected is 0.25 tons/ m^3.

Based on these assumptions, the volume of collected bottles and cans is estimated to be 440 m^3/day = 3,080 m^3/week. To cover this volume, 1,540 units of 2 m^3 box with two section is necessary.

5) Estimated Cost of Collection

Annual quantity of glass bottles and steel cans collected by the collection boxes is estimated to be 40,150 tons/year (= 110 tons x 365 days), while annual cost required to collect the glass bottles and steel cans from the collection boxes is 430,250 US$/year as shown in the table 4.5-1. Unit cost of collection is 10.7 US$/ton.

Table 4.5-1 Estimated Cost of Collection by the Collection Box System

1.	Annual Depreciation		
	Collection Truck	34 cars	106,250 US$/year
	Collection Box	1,540 units	77,000 US$/year
2.	Operation and Maintenance		
	Salary of Collection Workers	82 persons	147,600 US$/year
	Salary of Administrative Workers	8 persons	14,400 US$/year
	Fuel		85,000 US$/year
	Total		430,250 US$/year

This estimation is made according to the following assumptions.

Assumption:

1) The capacity of the collection truck is $6m^3$ corresponding 1.5 tons of the collected material in weight.
2) Average number of daily trip of the collection trucks is three. 34 trucks is necessary in this assumption.

3) Two persons are crews for one truck as collection workers. Working rate is 1/1.2. Total number of necessary crews is 82 persons.
4) 10 % of the number of crews is necessary for administrative work to manage this collection.
5) 5 days are working days per week.
6) One truck costs 25,000 US$. One collection box costs 400 US$.
7) Duration of depreciation of the trucks and the collection box is 8 years.
8) Annual cost of fuel of one truck is 2,500 US$.
9) Monthly salary of the workers is 150 US$.

4.6 Recommendation

As collection cost of recyclable material is increasing, only private collectors will not be able to manage it in near future. As mentioned in the section 4.2, not only consumers but also manufacturers and dealers must share the responsibility of recycling. In Germany and France, for example, law concerning package waste is promulgated in which responsibility of manufacturers and dealers is defined. Manufacturers and dealers are obliged to establish collection system for recyclable packages and share the cost of collection and recycling of waste package by their sales amount, while collection cost is put on prices of the products. In Romania also, it is desirable to formulate national policy for nation wide promotion of recycling, to establish the law concerning package waste based on the policy, and to define the responsibility of manufacturers and dealers. Such legal basis defining the manufacturers' and dealers' responsibility and collection and recycling system will be required to be a member country of European Union.

On the other hand, it is recommendable that Bucharest Municipality should prepare a plan to promote such recycling activity before a problem emerges, although the promotion of package waste recycling requires firstly formulation of a national policy as mentioned above.

Chapter 5
Collection and Haulage

CHAPTER 5 COLLECTION AND HAULAGE

5.1 Current Condition

5.1.1 Manpower and Equipment

There are two major organizations providing waste collection and haulage services in Bucharest; RASUB and RGR. RASUB is the major provider of waste collection and haulage services in Bucharest. It had 1,638 staff and workers, 204 trucks and 8 tractors in 1994. Its total expenditures was 6.1 billion Lei in 1994. RGR is a private firm established in 1994. It has 72 personnel and 15 trucks for collection and haulage. RGR's total expenditures was 1.19 billion Lei (including 0.54 billion Lei for repayments) in 1994.

The following table shows outline of the service capacity of RASUB and RGR.

Table 5.1-1a Existing Manpower and Container Used for Collection and Haulage, 1994

	RASUB		RGR	
No of Workers		1,523		55
No of Staff		115		17
No of Bins	(110 l metal bin)	170,000	(240 l plastic bin)	15,000
No of Container	(4 m^3)	761	4 m^3	5
			7 m^3	1
			1 m^3	6

Table 5.1-1b Existing Collection Vehicles Used by RASUB and RGR in 1994

Type of Vehicle	Maximum Load (ton)	Numbers	
		RASUB	RGR
1. Compactor (Manual loading)	3.2	79	–
2. Rotary Compactor (Manual loading	4.3	26	–
3. Rotary Compactor (Mechanical loading)	4.0	45	–
4. Container Trunk	1.1	27	–
5. Container Compactor (Arm roll)	4.4	14	–
6. Dump Truck	6.4	13	–
Total (1-6)	–	204	–
7. Tractor	2.0	8	–
8. Compactor (Mechanical loading)	5.1	–	5
9. Compactor (Mechanical loading)	6.4	–	4
10. Container (Mechanical loading)	5.0	–	2
11. Dump Truck	3.0	–	4
Total (7-11)	–	–	15

5.1.2 Service System

RASUB provides waste collection service mainly for 5 sectors (sectors 1, 2, 3, 4 & 5). RGR collects house household waste in Sector 6, and business waste from some business enterprises in the whole Bucharest.

RASUB provides collection service on weekdays. It provides a limited service on Saturday and Sunday. RGR provides collection service on weekdays and Saturday, and a limited service on Sunday.

The following table summarizes collection and haulage system of RASUB and RGR.

Table 5.1-2 Existing Collection and Haulage Service System of RASUB and RGR.

Provider	Waste Generator	Container for Discharge	Types of Collection Equipment	Daily Trip	Frequency per Week
RASUB	Household	-Metal bin (110 l)	-Compactor (Man. Loading)	2	Highest: 3
		-Plastic bag (70 l)	-R-Compactor (Man. Loading)	2	
			-R-Compactor (Mec. Loading)	2	Dominant: 1
		-Container (4 m^3)	-Container Truck	3	Lowest: 0.5
			-Ctn. Compactor (Arm Roll)	2	
	Business	-Metal bin (110 l)	-Compactor (Man. Loading)	2	
		-Generator's Ctn.	-R-Compactor (Man. Loading)	2	
			-R-Compactor (Mec. Loading)	2	
			-Dump Truck	1	
			-Tractor	1	
		-Container (4 m^3)	-Compactor (Arm Roll	2	
			-Container Truck	3	
RGR	Household	-Plastic Bin (240l)	-Compactor (Mec. Loading)	3	Highest: 7
		-Container (4 m^3)	-Container (Mec. Loading)	3	Higher: 3
	Business	-Plastic Bin (240l)	-Compactor (Mec. Loading)	3	Dominant: 2
		(120 l)			Lowest: 1
		-Container	-Container (Mec. Loading)	3	
		-Generator's Ctn.	-Dump Truck	2	

Source : RASUB, RGR

Abbreviation: R: Rotary
Ctn: Container
Man: Manual
Mec: Mechanical

5.1.3 Collection Coverage and Citizens' Satisfaction

1) Contract Coverage

Based on the information given by RASUB and RGR, it is estimated that 87 % of the citizens of Bucharest are covered by collection service contracts either with RASUB or RGR. 13 % of the citizens are not covered by the contract as shown in the following table:

Table 5.1-3 Household Waste Collection Contract Coverage in 1995

Collection Service Provider	Population Covered by Collection service Contract	
1. RASUB	1,404,754	69 %
2. RGR	370,800	18 %
3. Total (1 + 2)	1,775,554	87 %
4. Not-Covered	274,803	13 %
5. Total	2,050,357	100 %

Source: RASUB and RGR

2) Citizens' Satisfaction

According to the citizens' opinion survey conducted by the Study Team, only 34 % of the citizens answered that they are satisfied with the current waste collection service. 66 % are not satisfied.

The citizens' answers differ by sectors. Majority of the citizens living in Sector 6 which is served by RGR are satisfied with the service, while the majority of the citizens in other sectors served by RASUB expressed dissatisfaction.

Major reasons for the dissatisfaction are:

1) Irregularity of the collection service
2) Low collection frequency

5.1.4 Major Problems

1) Lack of discharge-container

It is estimated that approximately 270,000 waste bins would be required for Bucharest if 120 liter bins are used. However, it is roughly estimated that the bin shortage is gabout 40 % of the demand. The bin shortage causes the illegal dumping to increase, and also make the wastes the illegal dumping to increase, and also make the waste collection efficiency to decrease as inapproprite bins are used.

2) Bin is heavy and not easy to handle

All the bins provided by RASUB are made of steel and are not equipped with casters. Weights of an empty bin and of a waste-filled bin are 15 kg and 50 kg respectively. It is too heavy for one worker or even for two workers to handle. A bin provided by RGR is made of plastic and has two casters. So it is easy for a worker to handle even though the weight of waste filled bin is more than 80 kg. (Sometimes a worker carries two bins at the same time.)

According to the result of the Time and Motion Study conducted in November 1994, the collection and loading efficiency by type of truck is as follows.

1. Compactor (Manual loading)	2 workers	43-44 sec/bin (110 ℓ)	RASUB
2. Rotary Compactor (Manual loading)	3 workers	47-49 sec/bin (110 ℓ)	RASUB
3. Rotary Compactor (Mechanical loading)	2 workers	43-46 sec/bin (110 ℓ)	RASUB
4. Compactor (Mechanical loading)	2 workers	27-32 sec/bin (240 ℓ)	RGR

From the above data, time required for loading 1 ton of waste is estimated as follows.

1. RASUB's Compactor (Manual loading)	2 workers	20.4 min./ton	(346)
2. RASUB's Rotary Compactor (Manual loading)	3 workers	22.3 min./ton	(378)
3. RASUB's Rotary Compactor (Mechanical loading)	2 workers	20.4 min./ton	(346)
4. RGR's Compactor (Mechanical loading)	2 workers	5.9 min./ton	(100)

Note: figures in parentheses are index with RGR's compactor being 100.

Definitely RGR's system is much superior to RASUB's system. RGR's system is 3.4-5.6 times more efficient than RASUB's one.

Besides, cost of RGR's plastic bin (estimated to be 55 Lei per capita per month) is much lower than the cost of RASUB's steel bin (estimated to be 92 Lei per capita per month) assuming that both types of containers have 4 years durability.

3) Complicated Collection System of RASUB

As shown in Tables 5.1-1 and 5.1-2 RASUB's collection system is quite complicated. RASUB uses 7 different types of collection trucks though there exists only 3 major types of containers; 110 litre steel bin, 4m^3 steel container and plastic bag. This creates demand for enormous variety of parts-inventory, which are not interchangeably used. When a truck is broken, it is difficult for RASUB to dispatch a substitute truck. Beside, this complicated system would require higher operation costs than a simpler system.

Since there is no rational reasons to use seven types of system, types of collection equipment should be simplified in the near future.

4) Old equipment of RASUB

RASUB uses 204 collection equipment (trucks), of which 33 trucks are 8 years old or more, 93 are 6-7 years old, and 78 are 5 years old or less. Generally, collection equipment tends to be overused and usually cannot be used beyond 5 years. In fact, at RASUB's 4 workshops there were dozens of trucks under long or short term repair in November 1994. According to the study team's survey, 67 trucks (compactor, container truck) were under repair, out of a total of 243 trucks registered as workable.

Based on the above facts, rate of RASUB's usable collection trucks are assumed to be 80% at maximum. Procurement of new trucks is necessary.

5) Poor productivity at workshop

RASUB uses 4 workshops as maintenance workshop, operation control office, and garage. RGR has 1 garage, and has no repair workshop.

It is estimated that in 1994 RASUB spent 12.25 million Lei/truck on average for maintenance, which is more than 4 times larger than the corresponding expenditure of RGR. However, RASUB's maintenance is very inadequate. It would be necessary to consider a radical change including privatization of the workshops or use of private

maintenance services. See Table 5.1-5 and note below for estimation of the maintenance costs.

Table 5.1-4 Manpower and Expenditures of RASUB's 4 Workshops (for collection & haulage only)

(unit: Million Lei)

Nos. of Worker and Mechanic					Total Emoluments in 1994 (a)	Total Repair Cost in 1994 (b)	Repair Cost per Truck (a+b)/204
Berzei	Timisoara	Fintinica	Serban Voda	Total			
299	231	132	157	819	1,930	570	12.25

Note: 204 is a total number of RASUB's workable trunks.

Note on RGR's Maintenance Costs

RGR contracts with one contractor for equipment repairs, and spent 18 million Lei for maintenance for 5 months from June to October, 1994. Based on this expenditure it is assumed that RGR would spend 43.2 million Lei per year or 2.88 million Lei per truck per year. Moreover the contractor has a sufficient stock of spare parts and can repair damages in a few days in most cases.

6) Long haulage distance

Because there is only one disposal site (Glina site) in the eastern outside of Bucharest, trucks that collect waste from the western part of Bucharest have to travel long distance to the disposal site.

One more landfill site at least is necessary in the west part of Bucharest in order to reduce cost of haulage.

7) Other problems

Other problems include haphazard daily instruction as to places of collection, spilling out of waste from container, low number of trips, a large number of workers, and so on. These problems are corollary of the major problems as explained above, and may be solved in accordance with the solution of the major problem. Thus, the effort of relevant bodies should concentrate on the solution of the major problems at first.

Current condition of collection and haulage includes major problems above stated will be summarized as below.

1. Quantitative problems : – Discharge-container and its size
   – Collection equipment

2. Qualitative problems : – Material of discharge-container
   – Age of collection equipment

3. System/Management problems : – Types of collection equipment
   – Supporting function such as workshop
   – Management of contractors

5.1.5 Comparison of Cost Efficiency by Collection System

Cost efficiency of collection system is shown by the following indicator.

Net collection system cost / ton (including container)

Basis of estimation of cost efficiency are the following unit cost.

Table 5.1-5 Unit Costs by Collection System

Type of Truck	(1) Depreciation of Truck//yr [US$]	(2) Maintenance & Fuel cost/yr [US$]	(3) Crew & Mechanic Salary/yr [US$)	(4) Container cost/yr [US$]	(5) Overhead & Indirect cost/yr [US$]	(6) Total Unit cost [US$]
1 Compactor RGR-16 +240ℓ p-bin	24,047	6,110	3,790	6,750*	1,853	38,910
2 Compactor PELICAN +110ℓ s-bin	10,237	3,960	10,730	5,060	1,499	31,486
3 Compactor LIAZ +110ℓ s-bin	14,437	3,810	9,430	4,660	1,617	33,954
4 Compactor MEDIAS +110ℓ s-bin	9,489	5,150	9,430	3,800	1,393	29,262
5 Container-compactor PELICAN-C +4m^3 cont.	10,786	6,150	8,140	4,220	1,465	30,761
6 Container SRDAC +4m^3 cont.	5,592	3,960	6,840	1,630	901	18,923

Note Annual salary of the whole mechanics of RASUB/204 trucks is US$5,260/truck.
For RGR-16, corresponding salary is US$430/truck.
*: 240 ℓ plastic bin's cost is on a used bin.

Table 5.1-6 Cost Efficiency by Collection System

System	Waste Collected/Year (ton) (1)	Collection Cost/Year (US$) (2)	Unit Cost/ton (US$) (2)/(1)=(3)	Cost Index	Ranking
A. Bin System					
1) Compactor RGR-16	3,838	38,910	10.1	100	1
2) R-Compactor PELICAN	2,376	31,486	13.3	132	3
3) R-Compactor LIAZ	2,187	33,954	15.5	153	4
4) Compactor MEDIAS	1,782	29,262	16.4	162	5
B. Container System					
5) Con. Compactor PELC-CON.	2,403	30,761	12.8	127	2
6) Container SRDAC	945	18,923	20.0	198	6

Source : RASUB

The result of estimation cost efficiency by collection system shows that "Compactor RGR-16" has overwhelmingly the best efficiency. The second best is "Container Compactor PELICAN-Container". The worst one is "Container SRDAC".

Therefore the above two systems are recommended on the basis of cost efficiency.

5.1.6 Other Indices on Efficiency

Net time needed for loading / ton (loading efficiency) and Net time needed for collection & haulage / ton (operation efficiency) are supplementary information to judge efficiency of collection system. The results of the survey conducted by the Study Team are as follows.

Table 5.1-7 Loading Efficiency and Operation Efficiency of Collection System

System	Collected Waste/trip (ton) (1)	Trip (2)	Net Loading Time (minutes) (3)	Net Loading & Hauling Time (minutes) (4)	Loading Efficiency (minutes/ ton) (3)/(1)	Efficiency (minutes/ ton) (4)/(1)
1) Compactor MEDIAS	6.6	2	247	465	37.4	70.5
2) R-Compactor PELICAN	8.8	2	244	398	27.7	45.2
3) R-Compactor LIAZ	8.1	2	249	374	30.7	46.2
4) Container SRDAC	3.5	3	44	359	12.5	102.6
5) Con. Compactor PELC-Con.	8.9	2	273	456	30.6	51.2
6) Compactor RGR-16	12.3	3	123	314	10.0	25.5
Average	8.0	–	197	394	24.8	56.9

According to Table 5.1-7, "Compactor RGR-16" also shows the highest efficiency, while "Container SRDAC" is at the least efficient in terms of time spent for collection and haulage of 1 ton waste.

As a whole, it is judged that "Compactor RGR-16" has the highest efficiency. The second is "R-Compactor PELICAN". "Container Compactor PELICAN-Container" has the lower efficiency in speed. "R-Compactor LIAZ" does not show good performance. The worst systems are "Container SRDAC" and "Compactor MEDIAS", which should be abandoned in the near future. "R-Compactor PELICAN" and "R-Compactor LIAZ" should not be used.

5.2 Target Service Level

5.2.1 Principle

Collection and haulage service should be provided based on the Governmental Law and MB's Sanitation Norm. In principle, all the municipal wastes generated and discharged by citizens should be collected and disposed of at appropriate hygienic level under MB's responsibility.

5.2.2 Target Service Level

The following situation is considered in setting proposed target service level:

1. Contract Coverage of household waste is 87% in terms of number of persons with collection contract relative to the total population of Bucharest.

2. According to the citizens' Opinion Survey Conducted by the Study Team, 93% of the interviewees wish to receive at least once a week waste collection service, while 74% of the interviewees actually received at least once a week waste collection.

In view of the above situation, the following targets are proposed:

1. Collection Coverage	:	100% interms of both served population and collection amount by the year 2000
2. Collection frequency	:	Once a week at least by the year 2000. Twice a week for all households, and at least twice a week for business waste by 2005.
3. By 2010, Bucharest will be the cleanest city in eastern Europe.		

Collection frequency should be determined according to needs which depends on seasons and waste generation quantity.

5.2.3 Target Collection for Municipal Waste

The municipality should be responsible for managing all municipal waste, and other waste should be managed by generators. The target collection of municipal waste is estimated as follows.

Table 5.2-1 Target Collection Quantity

Unit: ton/day

Year	Total (e+f)= (a)	Municipal Waste				Non-Municipal Waste (f)
		Household (b)	Business (c)	Street waste (d)	Total (b+c+d=) (e)	
1995	1339	822	192	51	1065	274
1996	1384	842	208	51	1101	284
1997	1435	882	206	53	1141	295
1998	1512	932	216	55	1202	309
1999	1601	994	225	58	1277	325
2000	1694	1058	235	60	1353	341
2001	1742	1088	240	63	1391	350
2002	1790	1118	247	65	1430	360
2003	1840	1150	254	67	1470	370
2004	1892	1182	261	69	1511	380
2005	1945	1215	268	71	1554	391
2006	1999	1249	276	73	1597	402
2007	2055	1284	283	75	1642	413
2008	2113	1320	291	77	1688	425
2009	2172	1357	299	79	1735	437
2010	2233	1395	308	81	1784	449