Islamic Republic of Iran, Municipality of Tehran
Organisation for Waste Recycling and Composting

Executive Summary

Tehran Solid Waste Management
Integrated Waste Management Strategy and Implementation Plan

World Bank

September 2005

1 INTRODUCTION

The city of Tehran is, as many multi million cities, confronted with a steadily increasing population and a consequently increased production of waste. The Solid Waste Management (SWM) system is challenged to cope with the developments and find a way to manage waste, urban planning, environment and social requirements in a sustainable manner.

The waste generated in Tehran will grow form the current 2.6 Mtons per year to 3.2 Mtons per year in 2010 and it is expected that the composition will change and the percentage of organic waste is supposed to be slightly decreased.

Generally the fundamental policy of the Municipality of Tehran (MOT) concerning waste management is to move forward to a sustainable resource recovery and environmental protection. Accordingly the environmental impacts associated with overall Solid Waste Management (SWM) system components has to be minimised. This necessitates a practically achievable plan for SWM over time which is the final outcome of an Integrated Solid Waste Management Strategy (ISWMS). The World Bank is one of the stakeholders that is involved in providing financial means for implementation of such plan for achieving a sustainable SWM system, especially the development of the landfill capacity and the rehabilitation of the existing Kahrizak landfill. The MoU between MoT and WB gives a view on the issues that are found important by both parties.

The Mnicipal Solid Waste (MSW) composed mainly of household waste and commercial waste similar in natture to household waste is collected in a mixed form on a daily basis. The smaller amounts of Healthcare Waste (HCW) and Industrial Waste (IW) are collected separately. The so collected waste has been disposed of in an environmentally uncontrolled waste disposal site namely Kahrizak as the only MSW landfill. Most recently a major part of the MSW generated in Tehran has been diverted to a compost plant close to the landfill. The nominal capacity of this so called Arad Kooh recycling Complex is designed to receive a mixed waste stream of about 6000 ton/day whereas the operational capacity is determined to be less than 4000 ton/day.

The existing landfill has reached a full capacity with significant environmental impacts having been posed for years. Furthermore a risk of accumulated gas explosion already exists due to lack of any gas collection system. Strategically the estimated 16 million cubic meters of potential accumulated gas can provide a reasonable opportunity for partial cost recovery through a CDM scheme.

Healthcare Waste (HCW) and Industrial Waste (IW) comprising a small lportion of the overall MSW stream in terms of quantity but still being of concern in termsof advers environmental impacts fall partly in the scope of SWM system. The most recently approved Waste Management Law (WML) has clearly transferred the responsibility of these wastes to the producers. The HCW is currently managed trough a minimum but still acceptable level of disposal while IW is not managemed separately and the required infrastructure sems to be almost totally lacking.

From an institutional perspective, SWM system in the Tehran municipality is currently not integrated into one system. The tasks of various bodies are not well coordinated and inefficiencies in the waste management system are resulting from it. Also in view of the growing population and the more strict requirements of the municipality of Tehran (MoT) with respect to environmental issues, give a need for an integrated waste management system and the development of a basic strategy concerning the main issues.

The strategy that is being developed is based on an integration of various aspects that are related to waste management. These aspects are not only technical and financial but are also viewed from a socio economical and institutional perspective. One of the guiding principles is sustainability that has the following characteristics:

- Fitting to the conditions as they are in Tehran from a technical, environmental, social, economic, financial, institutional, and political perspective,
- Capable to maintain itself over time without exhausting the resources it needs

The waste management system can be envisioned as being constructed of the following elements:

Stakeholders	MoT, national government, NGO's, service users, informal sector, private sector, WB
Components	waste minimization, reuse, recycling, collection, transportation, treatment, disposal
Issues	technical, environmental, financial/economic, social/cultural, institutional, legal and political

The dynamic character of a strategy and required update proces is illustrated below.

2 APPROACH

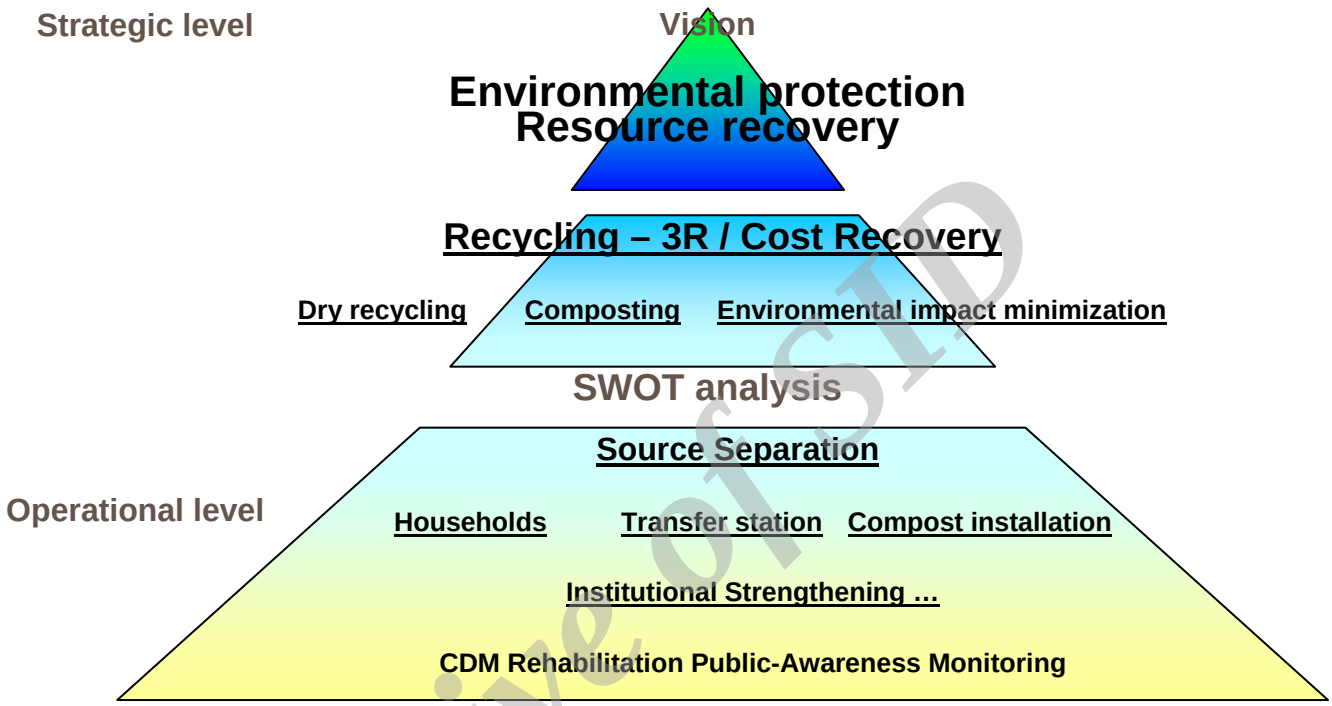
The development of an integrated waste strategy has been started in the recent years with basic studies to acquire the necessary baseline information. The BC Berlin study resulted in extensive data and additional data were gathered as well. The baseline information is being completed until today and since changes in approach do influence the action plan some aspects will change over time. The recent increased capacity for composting is just one of the examples of change.

However in the top-down approach for the development of a strategy, the high level objectives and philosophy of the MoT did not change. The more detailed (sub) strategies concerning specific waste streams or organisational aspects, can change and consequently this has an impact on implementation plans.

The approach towards the development of the integral strategy is based on the following steps:

1. Acquire analyse and update baseline information
2. Develop alternative sub strategies
3. Presentation and discussion of intermediate results with stakeholders
4. Formulation of a final strategic framework
5. Action plan

In the following picture the hiarchy of the waste management strategy is illustrated.



The step 1 baseline update is an ongoing process. Even after a strategy has been approved and actions started to implement the strategy, updated information has to be processed and targets have to be reviewed. This process of information updating and target review is part of the tasks of the integrated waste management organisation. Monitoring is required on technical aspects and on financial aspects.

Alternatives as indicated in step two comprise not only high level options (e.g. wet/dry separation, organisational options) but also more operational alternatives (e.g. Kahrizak extension vs Hoosang Abad development).

Presentation and discussions held in the past period revealed also differences of opinion on key issues. It is expected that during the ‘’transformation’’ process that results in one waste management organisation, various organisational option will give rise to differences in solutions

that are favoured. It is the task of the coordinating organisation to analyse and weigh the arguments and implement suggestions into the process.
In this process, the discussion with the World Bank concerning the key issues and pre requisites of the World Bank, is ongoing. The opinions of the World Bank concerning e.g. social issues, financial control and environmental topics like compost quality, have to be taken into account.

The final strategic framework is a result of the information collection, development of alternatives and considerations related to the current philosophy and objectives. It has a top down structure starting at views of the MoT and the chosen main road for implementation.

Finally the implementation/action plans are consequently formulated as the result. Here is the question of priority, responsibility and result monitoring an important one and directly related to the success rate of the action taken.

The main vision of the Waste Management is formulated as follows:

"Development of an environmentally and socially sound solid waste management system for greater Tehran in a cost effective and sustainable manner"

The municipality has defined high level strategic goals like the **Reduction-Recycle-Reuse** (**3R**) approach.

From this view the following strategic objectives follow:

- Waste minimization by recycling and composting
- Source separation in dry/wet fractions
- Cost recovery through polluter pays principle and using Carbon Fund facilities

The resulting strategy should result into actions that are acceptable from socio en environmental point of view, are cost effective and sustainable.

As part of the development of the main strategies, an SWOT analysis has been made aimed at selecting optimal strategies and institutional/organizational changes that are required to reach the goals.

here are four 'pillars' defined for the SWOT analysis:

- Human Resources

- Organizational
- Technical
- Financial

The results of the SWOT analysis can be summarized in the following major strategies:

- Renewal and empowerment of the personnel, especially the managers
- Reengineering the Waste Management System resulting in an integrated, efficient organization with transparent operations and Outsourcing most activities
- Improving the waste collection, recycling, composting, and disposal technology as well as information technology (IT)
- Cost management through maximizing the revenues and minimizing the costs
- Implementing the Waste Management Law, fully, to support all strategies

An integrated Municipal Waste Management Organization requires a manpower development plan to improve the knowledge and skills of the staff in order to be able to better fulfill the tasks on planning, financial control and monitoring.

Multi party discussions and agreements are needed to optimize the medical waste management with respect to source separation at medical institutions and hospital operators and the disposal facilities that are needed on middle and long term.
In order to further develop a composting structure quantity and quality parameters have to be considered. A quality management system based on international standards is required to reduce long term environmental risks related to contaminants. Parallel, a market development is required to optimize the revenues.

The financial structure of waste management has to further developed and monitored in order to be able review and analyse the effects of measures taken and review the effectiveness of recycle initiatives from the private sector.

Source separation at household level requires long term planning and the implementation of awareness programmes during a long period. Foreign experience suggests that 100% participation of households requires awareness, infrastructure and management to be developed. A phased approach in which the results of pilot projects are used to define following step is advised.

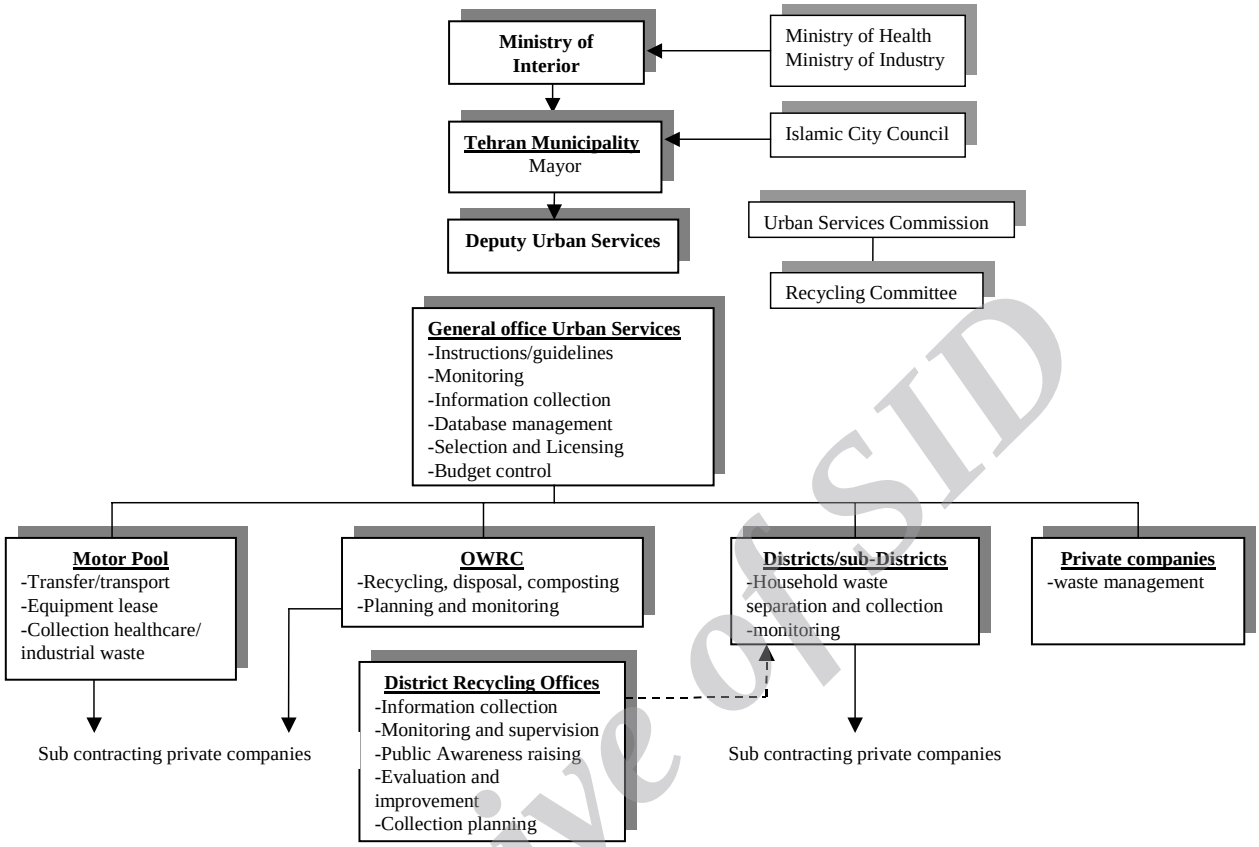
3 LEGAL & INSTITUTIONAL SITUATION

Municipal Solid Waste (MSW) generated in Tehran amounts to about 7000 tons/day. The waste is mainly composed of household wastes, commercial wastes similar in nature to household wastes, small amount of healthcare waste and some industrial waste originating mainly from small industrial establishments and workshops. The current activities accomplished for management of the waste is carried out by the municipality of Tehran. Different components of SWM system is distributed among a number of operational units. The simplified structure of the overall SWM system in Tehran is shown in figure below.

The existing SWM system has been ongoing since almost a decade ago with partial improvements during last couple of years. In accordance with growing need and concern for environmentally sound waste management, Organization for Waste Recycling and Composting (OWRC) was established as the sole planning body of the municipality of Tehran dealing with SWM. The main responsibilities and tasks of OWRC defined and approved as per the related articles of association is to provide SWM plans and take part in operations of waste disposal and compost production. The main objective of OWRC has been and is to promote resource recovery through creating and enhancing waste recycling schemes.

Other operational units of SWM system in Tehran mainly motor pool and districts provide services for waste collection, transfer and transport. In fact these units have been responsible for the required operations for keeping the city clean under supervision of General Office of Urban Services (GOUS). These operational units have also other responsibilities and are active for management of constructional works and street maintenance, landscapes etc. As a result OWRC has not been considered as an operational organization and has been supposed to make use of other operational units' facilities and equipment to meet its objectives.

Accordingly in the existing situation general planning for SWM is mostly accomplished by OWRC but other units specially districts and sub-districts are also involved in planning and implementing short term solutions for problems occurring in their services mainly through contracting private companies. In other words, although the plans made by different units are aiming at the same targets, lack of consistency in a number of cases is observed.



The almost recently approved Waste Management Law (WML) provides the basis for further improvements required within the overall system of Solid Waste Management (SWM). Although there has been several environmental laws and regulations in effect for nearly the last two decades, the WML was prepared and approved aiming to enhance the capacity of the SWM systems in the country for sustainable planning.

The WML was initiated mainly based on the requirements for environmental protection and minimizing the potential adverse impacts associated with SWM system. The main highlights of WML which could play significant role in the strategy of OWRC are as follows:

- ***Article 2:*** *Executive Manager of waste is a juridical or natural person who is responsible for planning, organizing, controlling and executive operations concerning generation, collection, storage, separation, transportation, recycling processing and disposal of wastes as well as publication and training activities in this regard.*
- ***Article 7:*** *Executive management for all wastes, excluding industrial and special wastes, within cities, villages and their borders is the responsibility of municipalities and rural governments.*
- ***Article 8:*** *Executive management may receive relevant costs from waste generators, via tariffs in accordance with instructions of the Ministry of Interior, determined by Islamic Councils related to type of waste, and to be spent merely for wastes management affairs.*
- ***Article 9:*** *The Ministry of Interior, with the cooperation of the Department of Environment, should schedule and make necessary planning and strategies for separating ordinary wastes. Executive managers referred to in Article (7) should separately collect, recycle and dispose ordinary wastes, etc.*
- ***Article 10:*** *To implement the duties referred to in this Law, the Ministry of Interior should provide instructions for organizing wastes executive management in municipalities, countries, rural governing and rural districts governing bodies, within 6 months after approval of this Law.*

Based on WML and the Articles stated above the following issues can be concluded:

- Clearly stated in Article 2 of WML, there is a well recognized need for integration of the overall SWM system in terms of achieving a single organization which is referred to as executive manager or Executive Waste Management Organization (EWMO).
- Also another important input from the WML is the compilation of Polluters Pay Principle (PPP) as stated in Article 8. This Article provides the basis for moving towards effective cost recovery through PPP. Although efforts have been made in this regard even earlier than the WML was approved, the PPP is not consistently and continuously undertaken yet.
- Special waste which is not yet clearly defined but includes infectious portion of HCW as well as hazardous part of industrial waste is not considered to be among the scope of MoT responsibilities. In fact the producers of such wastes are responsible for appropriate management. Strategically this can provide an opportunity for the future EWMO (if applicable) to recover part of the investments and running costs through providing services to

healthcare establishments and industries for collection, treatment and disposal of their wastes. This certainly needs extensive cooperation and understanding among the stakeholders which are Ministry of Health, Treatment and Medical Education (MHTME) and Ministry of Industries, Mines and Metals (MIMM) for HCW and IW respectively. Department of Environment (DOE) will also play a supervising role in the whole series of negotiation, planning and operation.

Taking into account these legal requirements and also the fact that resource recovery is a main goal of MOT, the sustainability of SWM can be achieved through and integrated SWM system to be responsible and capable of providing plans, outsource the plans and recover part or all of the associated costs. These should all be in compliance with the policies of the Ministry of Interior and in compliance with the legal requirements presented by DOE.

At a district level where the private companies are involved in urban services including city cleansing and waste collection, the main problem is identified to be the short term (1 year) contracts offered to a number of limitedly experienced private companies. This has led to a lack of interest within the private companies to make investments for longer terms. The typical contract encounters detailed tasks and requirements which are not met by the contractor nor supervised by the district.

Relatively unstable management setup of the municipality and consequently OWRC as the main organization responsible for SWM in Tehran has led to such a situation where the system can be generally considered unsustainable. Almost frequent changes of the management system both leads to some significant changes in the overall operational and budgetary practices. This indicates the lack of (or ignoring if any) firmly established legislations, municipal ordinance and organizational schemes. Accordingly no certain planning is carried out by the responsible organizations to overcome and enhance the existing system.

The management system is in deficiency of experienced and well educated staff that could assign solid tasks and to supervise and monitor the assigned tasks. Furthermore, OWRC plays also an operational role mainly including operation of the existing landfill and compost plant.

4 BASELINE INFORMATION REVIEW

In 2004 (1383) 2.55 million ton/year (7,700 ton/d) of Municipal waste was produced by 7.7 million inhabitants of the city, industry and commerce. The total solid waste flow is expected to double in 20 years time due to population growth and welfare growth. See Table 1.

	2004 (1383)	**2008 (1387) 3 years**	**2010 (1389) 5 years**	**2025 (1404) 20 years**
Inhabitants (million people)	7.7	8.4	8.7	11.5
Municipal waste (million ton/year)	2.55	3.0	3.2	5.0
% organic waste % dry waste	67% 33%	64% 36%	63% 37%	56% 44%

Table 1 Expected population growth and increase in produced waste in City of Tehran

The main component of the household waste is currently the organic waste (67%) fraction In the future the waste composition will change due to more packaging (especially plastics) and shorter life cycles of products. These figures show that source reduction of (dry) waste is a serious topic to address in future.

The Municipal Solid Waste (MSW) originates from the following sources:

- 2.35 million ton/year (6,400 ton/d) is household waste and comparable waste from commerce/offices/schools.
- 182,500 ton/year (500 ton/d) is industrial waste.
- 25,000 ton/year (70 ton/d) is hospital waste.
- Additionally it is expected that circa 182,500 ton/year (500 ton/d) of dry recyclables is collected by the informal sector (rough estimate).

The components of the current SWM system in Tehran were reviewed in terms of efficiency and potential rooms for further development in operational, institutional and financial aspects. The main objective is set to achieve sustainability in every component of the system. Household waste was considered to hold the outmost priority and importance in developing the strategy. Healthcare and industrial wastes as well as specific waste were also included in the overall strategy development scheme as part of the integrated SWM system.

Generally the main activities performed by OWRC during one year before development of this strategy which can be considered as the strengths of the SWM system providing the basis for development towards a sustainable SWM are as follows:

- ***Public awareness***
  - Efforts have been made and are made to enhance the public awareness and participation through clips in the television as well as providing information through public media. Also training classes have been and are provided to schools, mosques and cultural establishments.
- ***Source separation***
  - Distribution of 15,000 waste paper containers to all (6,700) schools in Tehran (done)
  - Distribution of 2,000 waste paper containers in the municipality offices
  - Accomplishment of 50 ton/d of waste paper collection with an income of 300 Rls/Kg (from the contractor) plus 300 Rls/Kg (reduction of previous costs) amounting to 600 Rls/Kg.
  - Distribution of 4,500 organic waste containers for fruit and grocery shops and alike;
  - Separate collection of city-landscape trimmings started last year with a capacity of 2,500 ton/year resulting in an income of 300 million Rls (from the contractor) plus 300 million Rls (reduction of previous costs) amounting to 600 million Rls.
- Preparing a technical and operational system for the dry waste collection contractors (accomplished)
- Waste collection fleet
  - The following equipment has been purchased and put to operation:
    - 400 semi-heavy vehicles
    - 400 covered trucks equipped with leachate collection chamber
    - 100 three wheel motorcycles
    - 50 curb washers and street sweepers

Transfer and transport

- Transfer stations:
  - The required studies have been conducted for improvement of waste transfer.
  - The results led to the requirement for 9 transfer stations with a capacity of 1200 ton/d for the next 20 years.
  - The new scheme of transfer stations comprises facilities and rooms for waste sorting
  - The construction of stations in the following districts has been started:
    - Station 1: 60% progress
    - Station 6: 50% progress
    - Station 15: 30% progress
    - Station 18: 30% progress

- ***Waste transport fleet:***
  - The following equipment has been purchased and put to operation:
    - 100 semi-trailers repaired
    - 100 new semi-trailers purchased
    - 50 haulers

Treatment

- ***Dry recycling industry***
  - Development of recycling projects with reasonable capacities. In this regard 10 ton/d of PET is recycled with an income of 300 Rls/Kg (from the contractor) plus 300 Rls/Kg (reduction of previous costs) amounting to 600 Rls/Kg.
  - Recycling of 2 ton/d of plastic aiming to reach 10 ton/d in April 2005, through producing colored waste bags for source separation purposes.
  - Production of about 1000 ton/d of sized gravel and sand from construction and demolition wastes (accomplished)

- ***Composting industry***

Composting regarded as a main component of a sustainable SWM has been subject to considerable changes during the course of developing the ISWMS. Briefly the almost limited capacity of previous compost plants of about 1500 ton/day of MSW input were increased up to a nominal capacity of about 6000 ton/day. The current composting is accomplished at Arad Kooh Recycling Complex geographically close to Kahrizak landfill site. There are six production lines which currently receive waste in a mixed form with partial separation (i.e. handpicking) at the plants (except for bio-mechanical plant which has no separation facility) as follows:

Unit Name	Nominal Capacity (ton/day)	Operating Capacity (ton/day)	Number of staff	Land Area
1- Formerly established compost plant of Kahrizak	500 ton/shift (currently just one shift)	400-450 ton/shift	50 for 2 shifts	50 ha
2- Carco, open system	150-200 ton/shift	100-150 ton/shift	Max 10	1.5-2 ha
3- Open 1000 ton project	1000 ton/day	600-700 ton/day	25-30	1.5-2 ha + 2-3 ha (for storage)
4- New 1000 ton project	1000 ton/day	500-600 ton/day	50 hand pickers + 5 maintenance + 15 service and driver staff	8-9 ha
5- 2000 ton project	2000 ton/day	1300-1400 ton/day	110-120	2*(8-9) ha
6- Biomechanical	1000 ton/day	700-800 ton/day	45-50	20 ha

The total nominal capacity of composting is about 5700 ton/day whereas the operating capacity is determined to be 3600 to 4100 ton/day of input MSW. It is worth noting that the newly installed plants (i.e. No. 3, 4 and 5) have only been in operation for about 4 month (at the time of preparing this report).

The critical issues to be addressed in terms of strategic significance are the following interrelated factors:

- Capacity for compost production
  - Separated waste
  - Mixed waste
- Quality of the produced compost in terms of
  - General applicability requirements
  - Specific contaminants (mainly heavy metals and pathogens)
- Marketing

It is worth noting that the capacity can to some extent depend on the type of incoming waste. Organic waste separated at source or transfer stations comprises about 70% of the total household wastes.
The current methods of composting are also described as follows:

Unit No.	Type of aeration	Separation Line	Drum Screen	Magnet	Total Duration of operation (days)	Product Screening	Granulization
							0-10 mm
1	Tilting and windrow with blower	Yes	Yes	Yes	5-6 weeks fermentation + 1 month	0-10 mm and 10-20 mm	30 ton/day to be increase to 100 ton/day (Sulfur added)
2	Tilting	Limited	Limited	No	About 2 months	0-10 mm and 10-20 mm	
3	Tilting by loader	Yes	Yes	No	About 2 months	No	
4	Tilting by loader	Yes	Yes	No	About 2 months	No	
5	Tilting by loader	Yes	Yes	Yes	About 2 months	No[1]	
6	Waste heaps and aeration with fan blower	No	No	No	About 6 months	Order 1 and 2	

[1] The fine compost production unit is not installed yet, therefore the product is stored in depot.

The amount of compost produced in the plants ranges between 11% (on contractual basis for newly installed plants) and 25% as a rough estimate based on operation of previously existing plants.

Quality of compost has a direct and significant relationship with he market potential and price. According to the latest updates obtained from the current compost plants manager, routine tests are performed for evaluating the general quality of the products in accordance with a certain standard method. Specific contaminants (mainly heavy metals and microbial contaminants) are tested on a regular basis every three months in accordance with a standard procedure. Despite the stated information it was found that the general characteristics of the products are not consistently analyzed in terms of timing and the relevant standard test method for sampling seems not to be present. Additionally the quality of products from the newly installed units is not yet tested.

Furthermore only one series of sampling for specific contaminants seems to have been performed as a result of which concentration of a number of heavy metals and presence of some microbial species is reported. Apparently all relevant heavy metals are not reported and also an almost incomplete set of microorganisms are reported for one sample from three of the plants.
In such a case comparison of the quality of the product to relevant standards is practically not valid. It is also worth noting that currently there is no national standard on compost quality which is necessarily needed as a basis for planning. Secondly a standard sampling and analysis of compost seems to be absent.

Understanding the advantages and limitations of a given compost is important for marketing success. Marketers should focus on the qualities of the specific compost products, how they can meet customer needs, and what the compost can and cannot do. To target the right markets the potential uses of compost must be identified and quality requirements established. In current situation no marketing practice has been undertaken by OWRC. The limited market comprises selling products to a number of local farmers of southern Tehran and Kerman province. The amount sold is not clearly monitored. A relatively good market exists for about 30 ton/day of granulized compost with sulfur added to it. Export potentials also exist (e.g. South Africa market) upon achieving standard quality.

- ***Landfill***
  - A 50 ha land within Kahrizak landfill which was highly polluted and left uncontrolled was covered.

- A new site was studied for construction of a sanitary landfill at Hooshang Abad area south of Tehran. However the site has not been fully confirmed by stakeholders and therefore regarding the immediate need for closing Kahrizak landfill an extension to it was planned and the site specified close to Kahrizak existing landfill.

- ***Health care and industrial wastes***
  - During the last year several studies have been conducted to evaluate the possibility of using one incinerator for healthcare and industrial (hazardous) wastes
  - As a result of initiate meetings with the relevant authorities about 20% source separation of health care waste is achieved which is planned to cover all healthcare establishments in 2006.

Shortfalls:
A number of shortfalls were also identified through studying the baseline conditions of the current SWM system. The main problems in this regard can be categorized into operational, institutional, financial and public awareness/participation components of the SWM system.

Household waste
Following is a list of the most important shortfalls identified in the existing SWM scheme:

- Environmentally and socially unfavourable landfilling
  - Kahrizak landfill at almost full capacity
  - Extensive environmental and social pollution caused by current waste dumping practice
- Inefficiency of collection system in terms of:
  - Truck size
  - Waste handling time
  - Labour conditions
  - Public participation
- Shortfalls of transfer and transport system
  - Small size of the transfer stations
  - Relatively inappropriate transfer station locations and layout
  - Inappropriate waste volume reduction schemes
  - Transportation fleet needs for frequent repair
  - No provisions for environmental control
  - Very limited (if any) provision for workers' health control
- Recycling
  - Small recycling industries
  - No capacity for recycling larger volumes
  - Limitedly known and unstable market
  -

- Composting
    - Low quality of final product
    - Technical and financial shortcomings
    - Limitedly known and unfavorable market

The operational problems stated above result from two main limiting factors of management and finance. The management unit or better to say the institutional configuration of the governing systems (i.e. OWRC, motor pool and the districts) seems not to have provided the required capacity for maintaining and developing the SWM system with respect to the growing needs associated mainly with the population and consequently waste generation growth.

Healthcare waste

Healthcare waste mainly generated at hospitals and medical centers is currently inappropriately managed in terms of source separation of infectious and non infectious wastes and the ultimate disposal. In fact apart from the general categorization of the HCW into infectious and non-infectious wastes, other constituents such as used and/or expired drugs, chemicals, radioactive waste and body parts should be taken into consideration.

Generally source separation of the infectious and non-infectious wastes has been and is currently practiced based on regulations provided by the MoH. The efficiency is evaluated to be practically low.

The so unfavorably separated HCW is collected and disposed in a mixed form. Disposal of the mixed HCW in a separate trench at the existing landfill site (i.e. Kahrizak) gives rise to the public health concerns and environmental contamination.

Separation of the HCW at source can be considered the main point of concern which is legally (i.e. based on the recently approved solid waste law) the responsibility of the MoH. Decentralized disposal of at least the infectious waste using incinerators have been experienced and failed in most the medical centers.

A pilot project is currently ongoing to determine the overall scheme required for the HCW management. Meantime the separation at source is considered to play a vital role through the course of HCW management. The final disposal option of HCW remain to be determined through evaluation of the feasible options including but not limited to introducing source autoclaves and sanitary landfilling or centralized/decentralized incineration.

Cooperation of the responsible organizations namely the municipality and the MoH seems also not to have been efficient in terms of establishing a sustainable HCW management system.

Industrial waste
The main part of the industrial recyclable wastes such as metals is recycled through an internal business to business scheme. In other words many industrial plants use the wastes or by-products of other factories in their production processes.

The remaining part of the industrial waste which normally covers a range of materials not being capable recycling is transferred to the existing landfill site and disposed of together with the municipal waste. This part of the industrial waste can potentially comprise the hazardous materials either in form of solid wastes or semisolid wastes such as industrial wastewater treatment sludge. Therefore the current disposal scheme is considered to pose highly adverse environmental impacts.

Lack of definition, categorization as well as handling procedures within the industrial units restricts the opportunities for safe collection and disposal of this waste. Separation at source in an uncontrolled manner has been and is currently being experienced by the industries. This is by law the responsibility of the MoI. The safe disposal of specially the hazardous materials generated at the industries seems to be totally lacking in the overall SWM system.

Financial aspects
The lack of a cost recovery component was observed within the SWM system and all costs are recovered through the municipal budget. This is partly because the Polluter Pay Principle is not implemented.

Lack of an appropriate (if any) information exchange system within the waste management scheme leads to unclear allocation of waste management functions to related organizations. In other words the financial information chain is not covering all stakeholders and is mainly restricted in a district level.
Multiyear budgeting as a basic prerequisite of strategic planning and integrated SWM is absent throughout the responsible organizations (mainly the Ministry of Interior).

Public awareness and participation
Pubic awareness can be considered as a basic requirement for achieving a sustainable SWM system. Concerning the basis of OWRC policy which is focusing on waste reduction, public have been recognized to be the main component of a successful waste reduction plan. As stated earlier localized efforts have been and are made to enhance public awareness through a series of public awareness campaigns. Such efforts have partly been successful in a sense that the public

awareness was enhanced in a certain locality. However these localized and lowly supported plans have not shown practical success since the downstream facilities are very limited (if any).

In addition inconsistency in the decision making process within different layers of the municipality including the districts and OWRC as well as lack of longer term planning has led to the fade of such activities.

On a contractual basis, the private contractors are to implement waste separation (mostly on a dry/wet) basis through offering a multi-bag system to the public. This is neither controlled or supervised by the district nor implemented by the contractor.

5 SWOT ANALYSIS

The SWOT matrix is one of the effective tools by which the collected data is usually compared. This comparison results in four groups of possible strategies:

1. SO Strategies -
2. WO Strategies -
3. ST Strategies -
4. WT Strategies -

In SO strategies, the waste management system utilizes its internal strengths to benefit from the external opportunities. In WO strategies, the organization takes the advantage of the opportunities to overcome its weaknesses. Choosing ST strategies, the system uses its strengths in order to minimize the external threats. Finally, in WT strategies, it takes on defensive role and tries to cut down on the weaknesses as it avoids the threats.
The SWOT Matrix is designed as the following. Four boxes show the main factors. Four boxes show the strategies. One box is always blank.

Weakness (W)	Strength (S)	
WO Strategies	SO Strategies	Opportunity (O)
WT Strategies	ST Strategies	Threat (T)

Based on four main categories (Human resources, Organization, Technology and Financial) the S, W, O, T factors are listed below:

1. **Strengths**
2. Increasing quantity in recycling facilities
3. Increasing quantity in composting
4. Increasing cost recovery through Carbon Project
5. Improving the environment through Carbon Project
6. Improving the public awareness
7. Enforcing new regulations for selection of contractors for waste separation and collection
8. Financial stability (guaranteed budget from municipality)
9. Improving the information technology
10. Senior management's belief in scientific methods
11. Trained staff

Weaknesses

1. Lack of integrated waste management system
2. Inefficiency in operations
3. Lack of trained personnel (line and staff)
4. Lack of transparent relations with districts
5. Traditional culture and organizational context
6. Low interest in innovation and change
7. Lack of system thinking
8. Lack of supervision on contractors
9. inefficient planning
10. Lack of experts in some departments
11. Inefficiency of personnel training
12. Lack of human resource planning
13. Absence of industrial accounting
14. Inefficiency in cost management and analysis
15. Minimal profit making
16. Low level of modern technology in office and operations
17. Low productivity in all aspects
18. Low standard of equipment and machinery
19. Low quality and quantity of landfill
20. Dominance of older technology
21. Lack of updated information
22. Inefficient management of information systems
23. Low level of computer literacy
24. Low quality of hospital waste management
25. Low quality of industrial waste management
26. Drastic shortcomings in source separation
27. Lack of planning to reduce waste production
28. Low quality of composting
29. Low quality of recycling
30. Lack of correct and precise information and statistics
31. Lack of private sector investment

32. Lack of waste treatment

Opportunities

1. New Waste Management Law
2. Increasing number of scavengers
3. Growing concern of the Environment Protection Organization
4. World Bank loans and other financial facilities
5. International and national standards
6. Increasing level of education and social responsibility in the public
7. Relevant NGOs
8. Cultural characteristics of the public

Threats

1. Differences in cultural and socio-economical levels of the people
2. Insufficient regulations
3. Parallel activities by other organizations
4. Disorder in treatment of informal recyclers (scavengers)
5. Lack of public interest in source separation
6. Lack of environment protection culture in the society as a whole
7. Lack of competition among the contractors
8. Increasing amount of the special waste
9. Lack of private sector investment

The mentioned raw data will be processed, using QSPM model in order to select the most significant strategies to be recommended.

6 INTEGRATED WASTE MANAGEMENT STRATEGY

Based on the analysis made during the development of the strategy, the key elements of the Tehran waste strategy became apparent. Mentioning the key elements does not imply that not mentionned elements and components are not relevant. The elements that are listed can be considered as the spearhead of the Tehran waste policy as they come forward from the basic propositions.*environmental protection* and *resource recovery*

Integration of various elements make the strategy effective. Integration is not only related to the organisation but also related to collection systems and treatment/disposal systems.

Key elements and goals

Environmetal protection

- Development of environmentally friendly transportation facilities
- Kahrizak landfill rehabilitation
- Improve healthcare and industrial waste waste management practises

Resource recovery

- Source separation for wet/dry fractions in households
- High recycling percentage for industry
- Composting capacity, quality and market

Sustainability

- Institutional strengthening
- Cost recovery (through Carbon fund compost marketing, recycling)

Critical success factors

The succes of the introduction of an integrated management is depending on the results of the various actions aimed at the waste infrastructure and environmental protection but also the succes depends on management and control through one consistent system.

The critical succes factors are:

- An effective financial system
- The (legal) responsibilties and tasks of stakeholders are coordinated
- Source separation and high household participation rates
- Implementing international environmental standards

The strategic goals can be considered at various levels. The high level goals are not quite specific and going to more operational level, goals can be more expressed in numbers. However the number of fields to be covered do increase and priorities have to defined.

6.1 Source separation

The legal requirement for source separation of household waste is 100% participation of the households. It is however doubtful if the goal can be reached and moreover the barriers are not clear yet. Continuation and extension of the public awareness programmes is required.

Pilot projects have been identified and will have to be implemented in order to be able to see what is needed for high participation.

Source separation experiences
Programs for community participation are ongoing for more then 10 years. Educational and awareness programs were implemented. The results vary depending on the specific cases and causes for low participation are various. Participation rates can be close to 25% (pilot test) to 40% with a 47% recovery rate for recyclables. The low participation rate was caused by an insufficient level of knowledge within the public on how to separate and lack of suitable infrastructure and recycling facilities.

Separation of household waste as the main waste stream to be composted at any given plant can play a major role in terms of improving the quality of compost which can be translated into contaminant free product and a better potential market. The main advantages and disadvantages of composting mixed waste versus source separated waste are as bellow:

Source separated materials	**Mixed materials**
Advantages: - Less chance of contamination. This can result in a higher quality compost product - Less money and time spent on handling and separating materials at the composting facility - Provides an educational benefit to residents and might encourage waste reduction	***Advantages:*** - Usually collected with existing equipment and labor resources - Convenient for residents because no separation is required
Disadvantages: - Can be less convenient to residents - Might require the purchase of new equipment and/or containers - Might require additional labor for collection	***Disadvantages:*** - Higher potential for contamination which can result in a lower quality compost product - Higher processing and facility costs

6.2 Medical/healthcare waste

The current practice of disposal at the Kahrizak landfill has operational problems that can enhance the health risks. Improving the operational procedures is required in order to have an acceptable landfill practice based on WHO standards.
Source separation is required to minimize the volumes of medical waste. An effective labeling system has to be used to support source separation.
For middle to long term perspective, an enhanced capacity of alternative disposal techniques (e.g. incineration) can be considered, however a more clear view on responsibilities and cooperation between stakeholders is required.

In the current healthcare waste disposal there are various problems identified of which the main one is an adequate disposal of what is called 'infectious hospital waste'. In fact the used definitions for characterisation of healthcare waste and subsequently the procedures for separation need to be clarified. Having better procures will optimise a needed capacity for autoclaving. The current practised procedure to mix e.g. body parts in household waste to be disposed to the landfill, needs reviewing and plans for source separation and waste labelling should be re-initiated. On short term the separation process should be optimised and the options for special locations on the new landfill for the approximately 30 ton/d 'real' hospital waste, should be investigated..

6.3 Industrial waste

A major part of Industrial waste is recycled, and reused in a business-to-business system. Of the net produced 550 ton/d, approximately 15% can be considered as hazardous.
On a legal basis industrial waste management is the responsibility of the Ministry of Industries. A coordination scheme between stakeholders has to be defined so that the scope of responsibilities are identified and established. Moreover the key issues to be addressed in industrial waste management are clear definitions of hazardous waste, relevant standards and test methods and operational procedures includimg collection, transfer/transport and treatment/disposal of hazardous waste.
On medium term the programs for a higher recycling effort and source reduction should be stimulated in cooperation with the industry. The use of a special landfill facility or incineration for hazardous waste is a long term option for reducing environmental risks.

6.4 Composting

Composting is one of the key factors in the strategy and recently the nominal capacity for composting has been enhanced to 6.000 tons/day. The capacity is divided over 6 units with each its own characteristics. Separation is done on site in 5 of the 6 units.

The fields of work related to composting are: Equipment, Capacity, Quality and Market.
The ongoing activities need to be followed with respects to quality of the products by a monitoring system that uses international standards and procedures to assess the product.

The current quality monitoring is based on daily sampling for basic parameters and month sampling for contaminants. However data are not consistantly recorded and monitoring results on heavy metals are not availble.
The market information is limited a more extensive market study related to produced quality is reuired.

Composting processing practices in the 6 units needs review and monitoring in order to assure quality consience production.

Current plans for further extending the capacity by introducing echnology from Italy are part of the efforts to focus on composting.
Compost quality in compliance with international standards and the World Bank requirements can be accomplished through the following steps:

Quality:

1- Establish standards and quality control procedures (this is considered a focal point in initiating any compost activity since it has a direct impact on the market potential and environmental consequences)
2- Establish quality control procedures for separation, collection and composting processes
3- Identifying the potential sources of waste to be composted and classifying the sources in terms of contaminants (mixed waste, source separated waste, wastes from fruit market etc.)

Capacity:

The capacity has to be gradually increased in accordance with the results of monitoring which should include a continuous assessment of source separation efficiencies, collection, transfer and transport of waste, market demand and quality of the product.

Marketing:

4- Identify potential compost uses and market
5- Initiate public awareness programs with regards to compost usage
6- Inventory materials available for composting (in current situation the main waste stream to the compost plant is mixed household waste whereas other potential sources like landscape trimmings, fruit and vegetable market wastes etc should be identified and characterized in terms of compost production)
7- Initiate composting operation and monitor results

6.5 Cost recovery

It can be expected that any sophistication of the waste control system will lead to an increase of the overall costs. Control of cost allocation is therefore important. The polluter pay principle should especially for industries and healthcare sectors be effectuated in order to have a cost recovery. The development of a tariff system based on a clear characterization of the waste streams should be started.

The agglomeration of financial data shows that for the future development, two basic options are apparent: one option where the focus for recycling is with the private sector, so risks and revenues are pushed to the private sector. The other option is a more pronounced role of the government in the recycling business and thereby having more direct control. Consequently however the risks for the government increases and the governmental organization to handle it all, has to be available. The current estimated costs for waste management range between 30 million USD/year 50 million USD/year. The “Do Nothing” option (i.e. sole landfilling) can lead to costs of about 75 million USD/year in 10 years time. Participation of the municipality in an integrated waste management system can lead also to a reduction of costs down to about 45 million USD/year. The downside of the yearly lower costs is higher risks and the requirements for investments and organization.

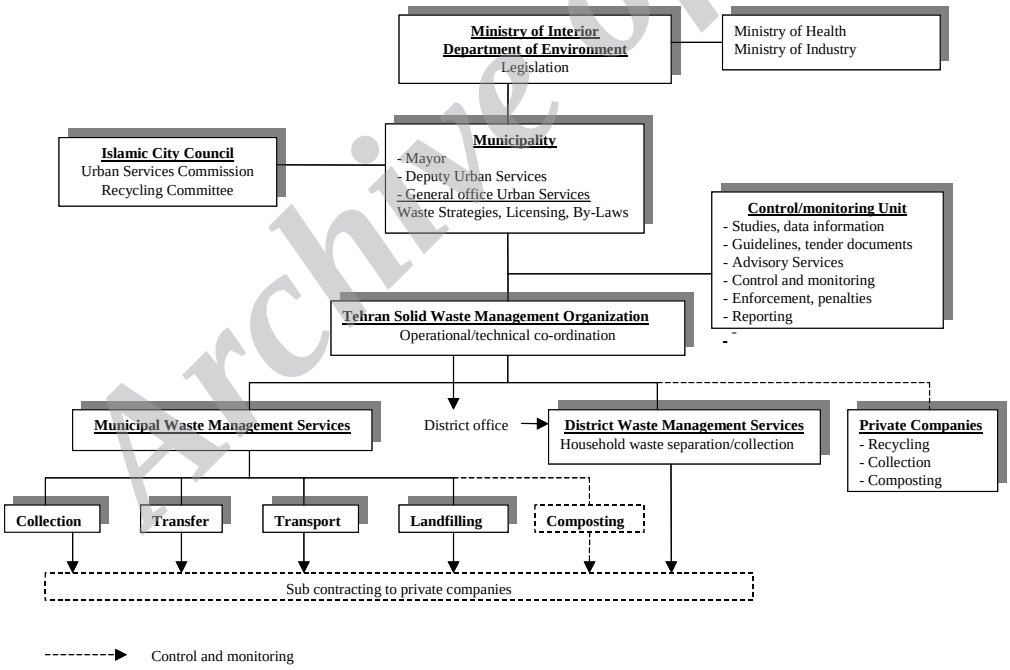
In addition to the revenues potentially obtainable through recycling of dry materials, composting, and tariffs a major cost recovery potential exists as Carbon Fund. This can be accomplished through extraction of gas from Kahrizak landfill. The total amount of the fund is estimated to be between 27 and 45 Million USD. However the recently initiated project will provide a more concise basis for estimation of the potential cost recovery.

6.6 OWRC Institutional reorganisation

The OWRC reorganization is part of the institutional strengthening component that is required to come to an integrated waste management system.

The strengthening components in addition to the reorganization are financial management system and human resources.

The final structure of the municipal waste organization has been discussed based on various models that were proposed. There is a preference for one integrated organization, rather then two organizations for management and operations.
The advantage of one organization is a better management control and coordination.
Since a strong management organization is a key factor for implementing the strategy, the reorganization is has a high priority and has to be complemented with a manpower development plan and the implementation of the Financial Management System. The proposed organizational structure is as illustrated in the following chart.



6.7 Landfill disposal

The current used landfill area on the Karhizak landfill, is not sufficient in capacity and until recently the development of a new landfill on the Hooshang Abad site was considered as a replacement for the Karhizak disposal site. External factors related to urban planning however, urged a reconsideration and currently an extension of the Karhizak landfill is being considered as well. However both option require a rehabilitation of the existing landfill of Hooshang Abad.

Kahrizak landsfill site
The Kahrizak landfill site has an integrated functionallity since the site is planned to be used for landfilling of houhold waste, inudstrial waste and heatlth care waste, leachate treatment, gas extraction and composting activities.
The current landfill will soon be closed and in order to minimize the environmental impact caused by leachate and the emissions of landfill gasses, a rehabilitation plan has to be implemented.

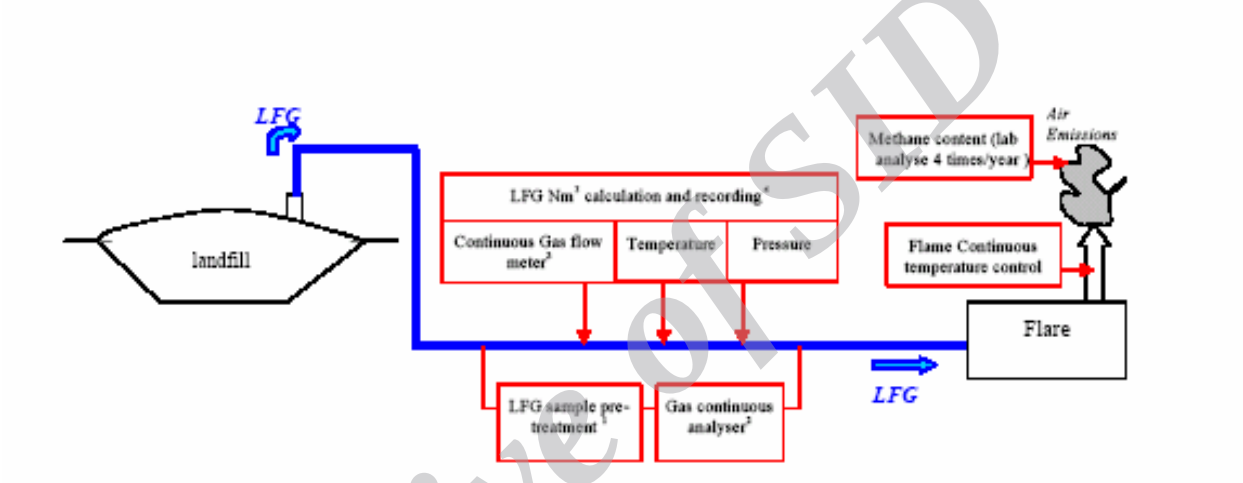
Extension of the Kahrizak landfill is currently considered as an alternative for the development of the Hoosang Abad site. Clearly external factors play a role in the decision. Basis environmental studies are started for the Kahrizak extension.

Clearly the landfill design must be based on adequate environmental standards and the extension should be designed for disposal of industrial hazardous waste and healthcare waste. A phase approach is needed since capacity estimates will have to be reviewed regularly since ongoing programmes to promote composting, source separation and recycling will have its influence. Pilot projects (household participation, improved healthcare source separation, industrial waste characterisation and labeling system) will result in actual information which can be used to specify capacity needs.

Gas extraction
Under the Kyoto protocol Clean Development Mechanism (CDM) projects can be developed that enables the trading of carbon credits. As recent as 22 august 2005 Iran accessed the Kyoto protocol. Projects that are eligible under the Kyoto treaty do include gas-extraction from landfills and subsequent processing of the LFG.

A CDM project has a highly structured project control that includes several formal documents to be submitted and procedures to be followed. The Kahrizak gas extraction project entered the ‘pipeline’ with a Project Identification Note (PIN) however its not clear if a Project Design Document has been prepared.

Two main options are possible for processing the extracted gas: flaring and electricity generation. Clearly the last option looks favorable but it requires a complex installation and control. Flaring can be done with a more simple and cheaper installation. In both cases the extracted methane is converted into CO_2 giving the greenhouse gas emission reduction since CO_2 has a lower Global Warming Potential (GWP) then methane, the greenhouse gas that is extracted from the landfill.
The picture shows an overview of the landfill gas flaring system.



In order to present the gas extracxtio nand flaring sytem as a CDM project, a strickt procedure with respect to the documentation and monitoring has to be followed.
After Project Indentification Note, the Project Design Document has to be made and submitted. The process results in the production of CER's (certified emission reduction) which can be capitilized.

Gas extraction trials are ongoing. Its expected that 6-10 Mtons CO_2 equivalent can be extracted and with a price of 4.5 USD per ton, the revenues are estimated on 27-45 M USD.

Recycling
Realization of private dry recycling industry in 2010: 1,300 ton/d

The current processing of 8% of recycled waste is mainly realised by small enterprises with different capacities and technical standards. Many recycling plants are in the immediate vicinity of residential areas. Paper and PET is processed in Saleh Abad, an OWRC recycling centre in

the south of Tehran. Iron is processed outside of Tehran in the steel factory of the city of Isfahan. The industry is small and not able to scale up to large quantities. The combination of the informal sector and the formal sector into a consistent recycle structure must be considered as a medium term goal. The recycling processes used are detrimental to the environment since they often contaminate waste water or air. The products from recycling processes are often of a poor quality which means that only little income can be achieved and only limited low-quality markets are reached. In order to improve the situation corresponding environmental and process standards have to be laid down. The industrial and commercial plants should be given technical and commercial support in order to improve their process engineering. The recycling market requires more analysis in the near future, on the priority of recycling initiatives related to specific components like PET, polyethylene, glass, textiles, electro-waste, etc.

7 IMPLEMENATION & ACTION PLAN

The implementation of actions coming forth form the strategy are partly ongoing or being starting on short notice. Other actions are to be taken on middle and long term. These actions have often a conditional nature and cannot be fully implemented when certain barriers are not removed or certain financial and organisational requirements are met.

The short/middle term implementation plan consists of the following main actions based on the main topics and in line with the project items in the MoU:

1. Institutional strengthening
2. Recycling & source separation
3. Pilot projects for healthcare waste and industrial waste
4. Waste management Kahrizak site
5. Gas extraction project

Action name	**Institutional reorganization**
Objective	Integrated waste management organization
Description	A reorganization plan that consists of a description of responsibilities, tasks and resources is required. It will further more contain: • Financial monitoring and control capabilities • Expertise build up and availability • Professional planning
Benefits	The reorganization will result in an integrated waste management with a consistent policy development and better monitoring/control possibilities
Costs	4.5 M USD
Timeframe	1-3 year duration
Requirements	Implementation of the new basic organization structure and appointment of key staff

Action name	**Composting operations improvement**
Objective	To use the full potential of composting and optimize the current facilities
Description	Improvements of the composting process efficiency and compost quality through improved processing in order to reduce contamination and improve the market position of the product. Application of international standards and facilities to monitor quality.
Benefits	Reduce potential environmental risks, improves cost recovery, optimize capacity

Costs	10 M USD
Timeframe	1-3 year duration
Requirements	International Standards, monitoring procedures & facilities

Action name	**Realization of source separation pilots**
Objective	Find the key succes parameters and barriers for introducing source separation on a wide scale
Description	The pilot project require a combination of awareness raising, available infrastructure and management.
Benefits	With the accurate analysis of what is needed for source separation in all disctricts the wide scale introduction will go faster and better.
Costs	9.0 M USD
Timeframe	Approx 2 year duration
Requirements	Supporting awareness campaign, good infrastructure

Action name	**Public awareness raising**
Objective	Reach high level of household participation
Description	Awareness campaigns are ongoing and have to be continued. Resultst need to be analysed with respect to household participation rates and recycle effectiviness
Benefits	Prevention of contamination of compost Waste reduction Recycling
Costs	15.7 M USD
Timeframe	Needs a continuous programme
Requirements	Consistent approach by expert team on public information issues Supporting infrastructure

Action name	**Separation/Recycling at transfer station**
Objective	Optimize transfer station operation and support waste infrastructure
Description	Pilot projects to find design basis for stations in all districts and provides data on recycling rates
Benefits	Contributes to an efficient recycling system
Costs	10 M USD
Timeframe	1-2 years
Requirements	-

Action name	**Healthcare waste management pilot**
Objective	Develop procedures healthcare waste based on minimum WHO requirements
Description	Improve source separation, labeling, transport and disposal procedures
Benefits	Optimize capacities and reduce environmental and health risks
Costs	10 M USD
Timeframe	3 year duration
Requirements	Standards, equipment, disposal site development, coordination with stakehold

Action name	**Kahrizak landfill site extension and rehabilitation**
Objective	Provide adequate landfill capacity
Description	Design and operate landfill extension Rehabilitation of existing landfill Operate gas extraction and flaring system (PCF)
Benefits	Environmental sound landfill Cost recovery for carbon fund
Costs	100 M USD
Timeframe	3-8 year duration
Requirements	Final decision on location of landfill

Action name	**Kahrizak LFG extraction and flaring**
Objective	Cost recovery from carbon fund
Description	Design and operate extraction system Monitoring system Fulfill CDM requirement
Benefits	Kyoto protocol contribution Cost recovery for carbon fund
Costs	100 M USD
Timeframe	3-10 year duration
Requirements	Final decision on location of landfill

8 CONCLUSIONS AND RECOMMENDATIONS

The design and implementation of the Tehran waste strategy covers a variety of fields and many aspects that require the attention.
It order to handle all aspects in way that is both effective and along the line of the basicappraoch, a well coordinated system is required. Priorities have to be defined as a way to realise the strategic goals.
The top-level priorities are related to the waste management organisation. Without a strong organisation, the waste management will still develop but it will not result in an integrated and sustainable system ,where integration also means that stakeholders play a role.

When identifying key succes factors, there are several ways the success can be measured and every participating organisation will have its own vision on what success is.
With this background the following is concluded:

- Resource recovery and consequently recycling is a main strategic goal and has to be developed on all levels and for all waste streams.

- The institutional reorganisation is a high priotity since an integrated management organisation is required from technical, economical and policy making point of view.

- The implementation of a compost quality system based on international standards is required for reasons of environmental protection and market development.

- Source separation with a household participation rate as defined by law, requires a long and sustained effort on improving public awareness, infrastructure and management. Pilot programmes are needed to identify critical barriers and social consequences.

  Source separation programmes for healthcare waste will reduce heatlh risks and optimize the disposal process. Current disposal procedures require attention from operational point of view but alternatives other then the currently used disposal technique (basically landfilling) require only review on long term basis.

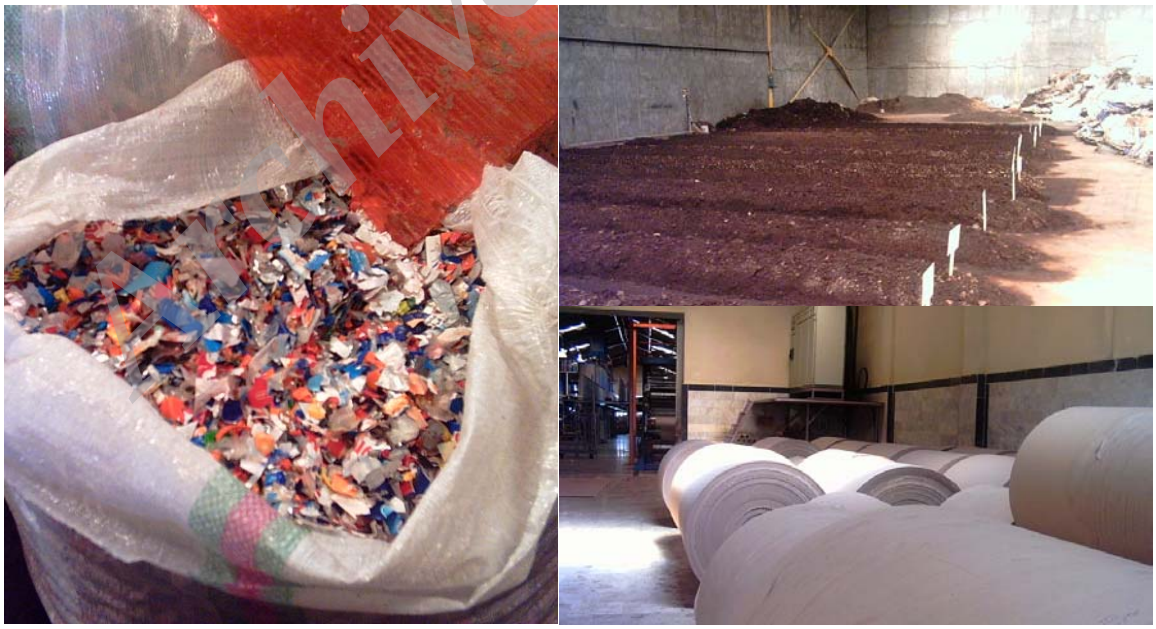
- Sanitary landfill disposal capacity has to be developed to replace the current Kahrizak landfill. Rehabilitation of the current landfill is required and partly already initiated. Methane recovery from the landfill has been a target and will result in a CDM project. In addition to the environmental benefits, it will contribute to cost recovery from the Carbon Fund.

Islamic Republic of Iran, Municipality of Tehran
Organisation of Waste Recycling and Composting (OWRC)

Phase 1 Report (draft)

Baseline review of Solid Waste Management chain

Tehran Integrated Waste Management Strategy and Implementation Plan



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EXECUTIVE SUMMARY

The Municipality of Tehran is in an ongoing transition towards integrated waste management and further introduction of reduction-reuse-recycle (3Rs) Six strategic targets have been defined:

1- Waste reduction through 10 % separation at source and 10% separation at transfer stations.
2- Recycling the dry waste amount to 1500 to 2500 tons/day.
3- Renovation of four existing transfer stations and addition of five new ones.
4- Enhancement of existing transportation system through addition of trucks and semi-trailers
5- Enhancement of composting to 3000 tons/day of the wet waste
6- Establishment of a new sanitary landfill

The objective of this assignment is to assist the Municipality in her transition taking account of the above targets. A strategy and implementation plan is to be prepared with firm, cost-effective and achievable targets and actions for the short-term (1-2 years), for the project duration (5 years) and for a long-term of 10-20 years.

This report sketches the baseline of the current solid waste management chain. The findings form the input for the strategy development. Main financial, operational, legal and institutional aspects of the current solid waste management chain are covered.. The main solid waste components (generation, collection, transfer, transport, recycling and disposal) are systematically described for municipal, health care, industrial and demolition waste and relevant data gaps, shortfalls and needs for improvement are identified.

Waste quantities

The total amount of municipal waste disposed of in Tehran is approximately 2.55 million tons per year or almost 7.000 tons per day. The majority (92%) of this total amount is municipal waste, while industrial waste accounts for 7% and hospital waste 1%. Other main waste streams are demolition waste (24.000 tons/day) and dry recyclables from informal sector (500 tons/day, uncertain quantity)

Institutional and legal framework

The Municipality of Tehran has the final responsibility for the management of household waste including demolition waste, non-infectious healthcare waste, decayed or unusable agricultural products and animal corps. OWRC holds the responsibility for both planning, monitoring, control and for operational activities (landfill, recycling). Transfer and transport are the responsibility of the Municipal Motor Pool, while private waste collectors are also renting trucks from the district Motor Pool. The Districts execute the operations. Public Awareness raising activity and it is left to the private waste collector. Districts and private contractors indicated that the lack of public participation in waste collection is the main problem in achieving efficient waste collection services. Clarifying and decentralising the responsibilities is to be further considered. Legislation endorsement requires attention.

Financial Framework
Total annual Municipal costs are US$ 30.1 million and annual revenues are US$ 9.8 million, based on year 2003. Total net benefits is US$ -20.3 million. With street sweeping included the municipality pays about US$ 12,0 per tonne, and without inclusion of street sweeping about US$ 7,6 per tonne. Revenues on transfer & transport, recyclables and land filling are US$ 3,9 per tonne. The invoices from hospital, industrial waste, demolition and construction debris are paid by the respective organizations. These costs seem low compared to international benchmark. Attention is required to be able to trace the true costs.

Collection
Less than 90 % of the 6550 tons household waste per day is land filled. Formally circa 2,4 % is recycled in dry components and 7 % is composted by the composting industry. An estimated additional 7 % of dry recyclables is recycled by the informal sector. Every night the waste is collected from the streets by small trucks. The municipality offers a high level of service (7 days per week) for very low costs (4.6 dollars per tonne). Public participation is low especially on central waste collection locations (i.e. small alleys and commercial areas). There is scope for efficiency improvement in collection by introducing larger trucks and a good renewal program.

Separation of dry recyclables
The separation at source targets could be increased from 10 to 15 % if the contribution of the informal sector is also included and formalized (7% of waste volume). Tailored collection strategies need to be put in place building up on the experience from recycling pilots.
On the other hand, obtaining a 10% separation of dry recyclables at transfer stations seems difficult to achieve. It requires that all mixed waste is treated via a sorting installation which requires 4 hand picking lines per transfer station. This will be cost-inefficient and difficult to implement (limited space at most locations).

Transfer and transport
After collection the waste is transported to 12 transfer stations before being transported to the landfill by 56 m3 semi-trailers trucks. Transfer and transport system are simple, flexible and costs-effective. In future several waste fractions can be transferred separately using the platforms with trailers. When waste composition is changing (more dry components) and larger collection trucks are used in future, the introduction of a compaction press and special containers might be an alternative to consider.

Composting industry
The existing composting installation at Kahrizak is not functioning well due to technical problems and water shortage. A clear decision has to be made if or how to continue with the existing composting plant. The potential for upscaling the composting capacity up to a quantity of 3000 tons/day needs to be investigated. Combining existing facilities with the bio-mechanical approach needs to be investigated.

Dry recycling industry
Attention is required to create a healthy market for recycling industries with a capacity of 1500 to 2500 tons per day. It should be further analysed which industries and entrepreneurs are recycling dry recyclables from households and industries. Industrial initiatives should be started on the short term since separation at source has already started on a larger scale. A

(procurement) procedure should be developed for the selection of private sector proposals for waste recycling projects. Possibly special funds will be required to support these initiatives.
It should be investigated how the Municipality of Tehran can help to promote large-scale usage of recycled products (i.e. compost for parks, recycled paper for public administration, recycled plastic for waste bags). In this way the Municipality can "close the circle" and start a "Tehran-made" recycling campaign.

Landfilling
A strong commitment has been made by the Municipality to stop all land filling operations at Kahrizak before the end of 2006. This is in line with one of the requirements of the PCF funding. From the start of 2007 a new sanitary landfill site with appropriate capacity has to be available for this residual waste.

Industrial waste
Circa 1500 tons of industrial waste is generated every day: 400 tons non-hazardous waste, 100 tons hazardous waste and 1000 tons of recyclable waste. Non-hazardous and hazardous waste is is not separated in a proper way and is land filled at Kahrizak, the rest is expected to be recycled within industrial boundaries. The hazardous waste is not well documented and requires specific attention.

Healthcare waste
Circa 70 tons/day of health care waste is generated in one of the 310 major health facilities. Circa 40 % can be classified as risk waste. Health facilities are responsible for the adequate separation and collection and storage of their waste. The waste is transported for disposal as mixed waste (10 tons/day) and hazardous waste (50 tons/day). A small fraction is treated in special auto-clave installations and small incinerations plants. The healthcare waste management system is being reviewed by the world bank. Findings should be adopted within the strategy.

Construction and demolition waste
Circa 24.000 tons/day of construction and demolition waste is generated in Tehran. Most is directly transported to Ab Ali disposal site and to 6 smaller sites. This includes spoiled soil resulting from excavation works as well as demolition waste collected in mixed form by private sector contractors. There are some small-scale recycling activities for sand/gravel and clay-type soil. The contractors are controlled by Office of cleanness of Tehran (supervised by OWRC). The main challenge is to review whether all 7 disposal sites are required in future and if further recycling activities can be started.

This report provides a birds eye view on the current baseline of solid waste treatment in Tehran. We conclude that the current solid waste management chain is cost effective in collection, transfer and transport and needs further development in recycling and composting activities. Improvements have to be made in operational and institutional strengthening of especially hazardous waste, dry and wet recyclables to achieve that all key players are sensed, urged and ready to participate in an improved solid waste management chain.

1 GENERAL LAYOUT OF SWM IN TEHRAN

1.1 Background

The current waste management system in Tehran covers three main categories of Municipal Solid Waste (MSW) including household waste and commercial waste similar to household waste, industrial waste and hospital waste. Tehran has an estimated daytime population of 10.5 million and a resident night time population of 8.5 million.

According to data and statistics obtained from OWRC, the total amount of municipal waste disposed of in Tehran is approximately 2.55 million tons per year or almost 7.000 tons per day. The majority (92%) of this total amount is municipal waste, while industrial waste accounts for 7% and hospital waste 1%. Other main waste streams are demolition waste (24.000 tons/day) and dry recyclables from informal sector (500 tons/day, uncertain quantity). The general layout of the waste stream is demonstrated in Figure 1.1.

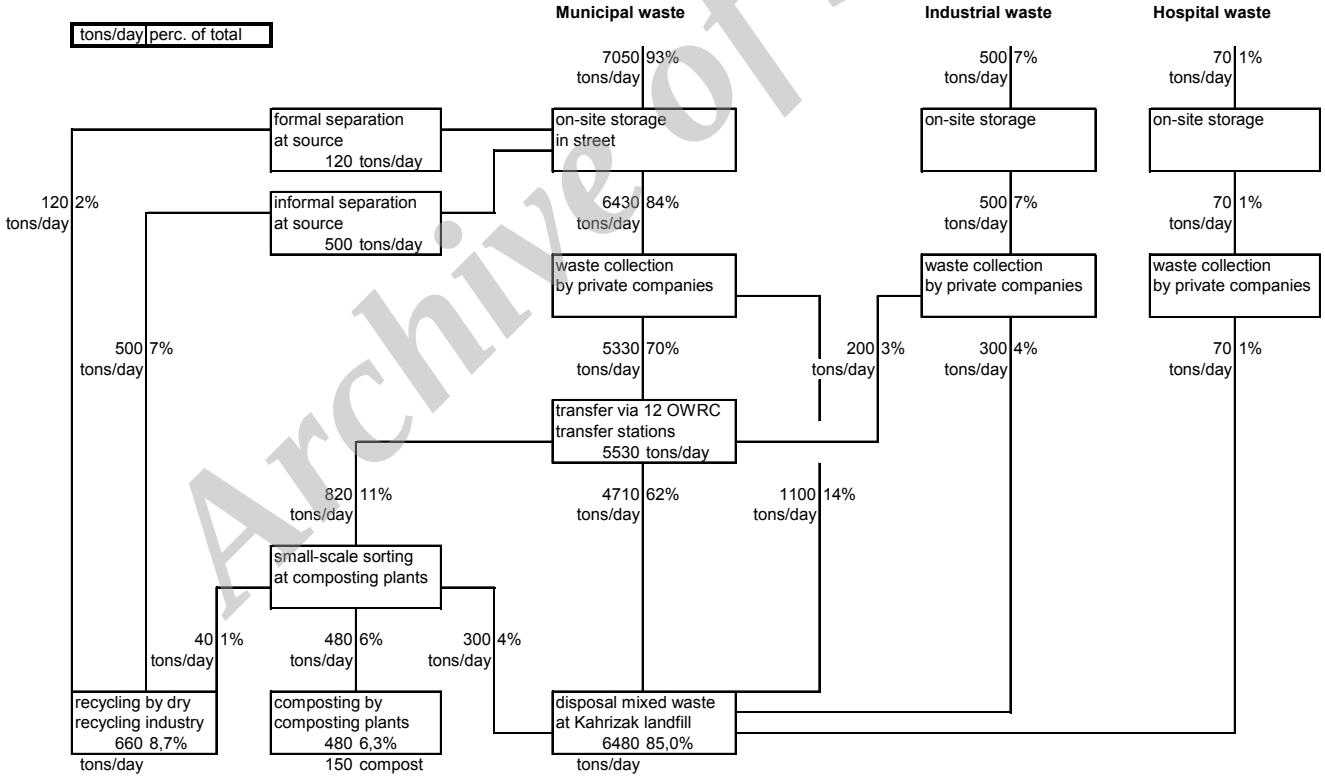


Figure 1.1 - General layout of MSW in Tehran

Most of the municipal waste (70%) is collected and transferred via 12 transfer stations. Part of the municipal waste (14%, especially from commercial centra and inner-city companies) and industrial waste (4%) is directly transported to the disposal site.

Most of the solid waste (85 %) is currently disposed at the Kahrizak Landfill. Approximately 11% is transported to Kahrizak for sorting and composting (820 tons/day). The Kahrizak

composting plant has a capacity of circa 250 tons/day, the bio-mechanical composting plant has currently a capacity of 500-600 tons/day. The bio-mechanical plant is still in its starting phase and has a contract for 1000 tons/day.
Approximately 9 % is recycled in Saleh Abad, by small recycling companies or exported to other countries (China). The recycling figures are relatively high due to collected dry recyclables by the informal sector (estimation of 500 tons/day, or 7% of total waste).

Future population and waste growth
Projections have been made for the future situation regarding population growth and waste volumes (Table 1.1).

	Total no. of capita	Municipal waste quantity (tons/year)	Waste composition (% organic)
Current situation (data 2003)	**8.5 million**	**2.55 million**	**67%**
Expected in 2009 (5 years)	9.2 million	2.8-3.1 million	Approx. 63%
Expected in 2014 (10 years)	10.0 million	3.2-3.6 million	Approx. 58%
Expected in 2024 (20 years)	11.4 million	4.3-5.0 million	Approx. 50%

Table 1.1 - Waste generation rate projection

These figures are based on:
- Total no. of capita: based on BC Berlin report, march 2004: growth range between 1.88 to 1.59 percent (OHADI, 2000), used is the average growth rate 1,73% per year
- Total waste quantity: based on BC Berlin report, march 2004: top range is based on growth to 1,061 kg/day/capita (in 2019), bottom range is based on 0,969 kg/day/capita (in 2019). Current situation is 0,845 kg/day/capita. Average growth is 1,2% per year.
- Waste composition: growth of dry recyclables in waste fraction is 0,8 % per year.

Waste composition, waste quantities per district and seasonal fluctuations are presented in Appendix 1.

1.2 Background on the SWM sector

Several administrative units within the municipality, including the Districts, the Motor Pool Department and OWRC operate the overall municipal solid waste collection system (Table 1.2).

Description	Municipal		Hospitals		Industrial & hazards		Demolition	
	Supervisor	**Executers**	**Supervisor**	**Executers**	**Supervisor**	**Executers**	**Supervisor**	**Executers**
Collection	Deputy of Urban Services Municipality of districts	90 Private Contractors in 21 districts' municipality	Ministry of Health	private contractors	–	producers and private contractors	–	private contractors
Transfer and Transport	Motor Pool	Motor Pool and 13 private contractors	Motor Pool	Motor Pool and private contractors	Motor Pool	Motor Pool and private contractors	–	private contractors
Process/ recycling	OWRC	OWRC and private contractors	–	–	–	–	OWRC	OWRC
Disposal	OWRC	OWRC and private contractors	OWRC & DOE	OWRC and private contractors	OWRC	OWRC and private contractors	OWRC	OWRC

Table 1.2 - General administrational and operational Framework of Tehran Waste Management

1.3 Current vision and strategy

The objective of the project as defined in the TOR, is to reinforce the Municipality of Tehran to encourage the ongoing transition towards integrated waste management and further introduction of Reduction-Reuse-Recycling (3Rs) by preparing a strategy and implementation plan for domestic, industrial/commercial, special (hazardous) and healthcare waste management.
The strategy is to present firm, cost-effective and achievable targets for the short-term (1-2 years), for the project scope duration (5 years) and for the long term (10 and 20 years) with the emphasis on the short-term and five year planning horizon for domestic waste.

As discussed with OWRC and World bank there is already a vision and main strategy for Solid Waste Management in Tehran. It is defined in six main strategic tasks:

7- Separation at source and transfer stations through public education and training as well as propaganda aimed to achieve a 10% reduction at source and 10% reduction at transfer stations.
8- Recycling the dry waste amount to 1500 to 2500 tons/day.
9- Renovation of four existing transfer stations and addition of five new ones (figure 1.2).

10- Enhancement of existing transportation system through addition of trucks and semi-trailers
11- Enhancement of composting to 3000 tons/day of the wet waste
12- Establishment of a new sanitary landfill

OWRC and Worldbank both agreed that these 6 tasks form the basis for the strategy study and should be further investigated, evaluated and worked out in an implementation plan for the coming 2 to 5 years.

Figure 1.2. - The proposed structure of 9 transfer stations in Tehran

2 LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 Legal framework

On a national level the pollution of the environment in terms of soil, water resources and air are controlled through environmental laws, regulations and standards. Environmental protection in Iran is laid down by the fiftieth principle of the constitution, which states:

"In the Islamic Republic, the protection of the environment, in which the present and the following generations should have a social life of constant development, is a public responsibility. As a result, every economic or other form of activity, the execution of which necessitates the pollution or the irretrievable destruction of the environment is forbidden."

Existing environmental legislation contains general requirements to prevent irreversible changes and damage to the environment. Table 2.1 provides a brief description of environmental and environment-related legislation pertinent to waste management including transfer, transport and disposal. These laws, regulations and standards are to control environmental pollution and are enforced by the Department of the Environment (DoE).
There are also applicable environmental standards for effluent discharge which can be applicable to the landfills and transfer stations in terms of leachate treatment/management facilities In addition ambient air quality standards are found to be applicable to a lesser extent in terms of potential for landfill gas emissions.

Table 2.1 Relevant Environmental Legislation

Environmental Legislation	Key Relevant Provisions
• The Law of Protection and Improvement of the Environment (approved in 1974 and modified in 1992)	• Prohibits any actions/ activities which (may) result in environmental pollution. • Authorizes DoE to "warn" polluting establishments. If compliance is not achieved within the timeframe set by DoE, the establishment could be closed.
• The Law of the Method of Air Pollution (approved in 1995)	• Prohibits all establishments from conducting activities that would result in air pollution
• The Law of the Third Plan of Economic, Social and Cultural Development of the Islamic Republic of Iran (approved in 2000)	• Requires all large scale projects to be environmentally assessed during the feasibility and site selection study phases. It also requires the proponent of the project to meet all requirements/ measures set by the EA. This includes also landfills for cities with population of greater than 200,000
• Agenda for Water Pollution Prevention (approved 1994)	• Prohibits any activity that would result in water pollution. In particular, it prohibits discharge of wastewater exceeding pollution limits.
• Waste Management Law (2004)	• Definitions of waste streams • Tasks of Ministries, Organizations and Municipality • Waste reduction, separation and recycling principle • Violation and penalties • Principle of polluter pays

Although during the past three decades a number of environmental and environment-related legislations have been enacted, there have not been any specific regulations enacted for solid waste management. Over the last years attempts have been made to regulate the environmental and institutional aspects of municipal solid waste management and a number of guidelines are prepared and submitted to Parliament but not yet approved for the following issues:

- Guideline for the separation, collection, transport and disposal of medical waste
- Guideline for municipal solid waste landfill site selection
- Guideline for separation, collection and transport of municipal solid waste

In 2002, the Department of the Environment and the Ministry of Interior have prepared and proposed a law for solid waste management in Iran. The Waste Management Law (WML) covers Ordinary (including household) waste, industrial, healthcare, agricultural and special wastes. The WML was approved by the Commission's Office in 2002 and has been approved very recently by Parliament (July 2004). The executive guidelines and regulations for this law are planned to be prepared within six month after approval date. Therefore it is anticipated that this law will be in force by February 2005.

In the "First Program of Social, Cultural and Economic Development" adopted by the Government of Iran on 21 January 1989, it is stated that all industries and factories should shoulder their responsibilities in protecting the environment. They must share the cost for recovering pollution damages, and that a certain percentage of their sales revenue should be used for the protection of the environment. Accordingly, the WML clearly transfers the responsibility of the industrial waste management to the waste producer industry.

Article 7 of the Waste Management Law is saying: "Executive management for all wastes, excluding industrial and special wastes, within cities and villages up to their borders is the responsibility of Municipalities and rural governorates. For areas beyond the borders of the villages, the responsibility will be with the governing bodies of the rural areas".

In Article 2 of the Law the following definitions are given:

- Ordinary Waste: means any wastes which are commonly generated as a result of man's life process inside and outside cities and villages such as household and demolition wastes
- Medical wastes: means any infectious and harmful wastes generated by hospitals, health care and treatment facilities, medical laboratories and other similar facilities. Other harmless hospital wastes are not included
- Special wastes: any wastes requiring special care due to containing at least one of the hazardous components of poisonous, pathogenesis, explosiveness, inflammability, corrosiveness and the likes. Those medical wastes, as well as some part of ordinary, industrial and agricultural wastes which needs special management are included as special wastes
- Agricultural wastes: any wastes resulting from productive activities in the agricultural section including animal refuse, animal corps (cattle, poultry and marine animals) decayed or unusable agricultural products
- Industrial wastes: any wastes resulting from mine and industrial operations and gas, oil, petrochemical refinery and power stations wastes and the likes such as fillings, slag and industrial sludge.

It appears that on a Municipal level there are no Regulations (By-Laws or Ordinance) for waste management defining the roles of the stakeholders (public, shopkeepers, private waste collectors, institutions, industries, hospitals, etc). Normally the By-Law regulates the tasks and obligations of each of the stakeholders, any penalties in case of violation, payment for the waste collection services, need for licensing, reporting, etc.

Moreover it is noted that there is no Waste Management Plan on a National level or on a Municipal level. Normally the Waste Management Plans aim to provide a planning framework for compliance with waste policy and target achievement, waste characteristics and capacity for managing waste, control of technological measures, investment requirements. The structure normally comprises the actual status part and a planning part.

From the above it can be concluded that:

- The Municipality of Tehran has the final responsibility for the management of household waste including demolition waste, non-infectious healthcare waste, decayed or unusable agricultural products and animal corps.
- Infectious healthcare waste is a special waste and it is the responsibility of the hospital to arrange for proper treatment, collection and final disposal.
- Industrial waste (excluding household type waste) is the responsibility of the industry and they have to arrange for proper treatment, transport and disposal. However no lists exists for definition of industrial (hazardous) wastes.
- The waste classification in the Law is not always clear and not in accordance with internationally used definitions. Detailed lists specifying each waste stream are missing. Hazardous wastes are not mentioned as such and a detailed specification is missing. Also the classification of electrical and electronic waste, batteries, tyres, end-of-life vehicles, etc. is not mentioned.
- No specific requirement is included in the Law for the preparation of Waste Management Plans on a National and municipal level.

2.2 Institutional framework

The overall institutional set up is given in figure 2.1 showing all relevant stakeholders.

The institutional framework of the current waste management system can be regarded in national and municipal levels. On national level, the Ministry of Interior, Department of Environment (DOE), Ministry of Health and the Ministry of Industry constitute the decision making body for waste management along with other urban development tasks. The Management and Planning Organization (MPO) allocate the required budget to different institutions.

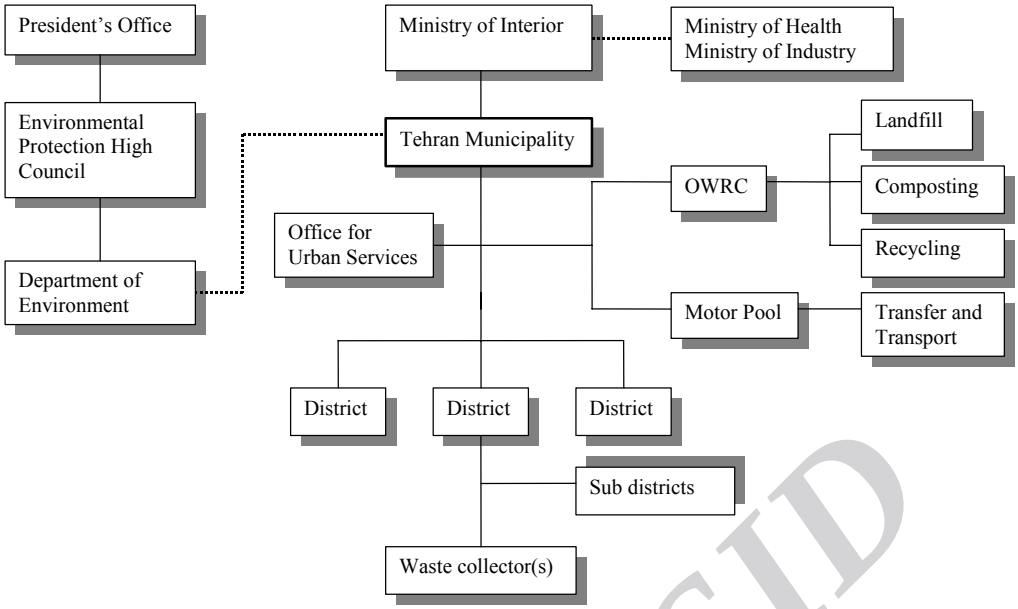


Figure 2.1 - Tehran Waste Management Strategy-Overall Institutional Set up

The tasks and responsibilities of these organizations are presented in table 2.2.

The Municipality of Tehran is the sole authority responsible for solid waste management. Its responsibilities are carried out by the following organizations playing the major role in MSWM system:

- The Organization for Waste, Recycling and Composting (OWRC),
- Motor Pool Organization and
- Districts

The following can be concluded:

- OWRC holds the responsibility for (i) planning, monitoring, control and (ii) for operational activities (landfill, recycling). This might introduce a conflict of interest. The core activities of OWRC should be made clear.
- Transfer and transport are the responsibility of the Municipal Motor Pool, while private waste collectors are also renting trucks from the district Motor Pool. It can be questioned if a transport company should be made responsible for waste management activities like management of the transfer station.
- The Districts are hardly involved in long term waste management planning. The only activity is in the budget planning for new activities next year. It is recommended to make the District more involved in planning.
- Districts are hardly carrying out any Public Awareness raising activity and it is left to the private waste collector, however his contract is only for one year. Districts and private contractors have indicated that the lack of public participation in waste collection is the main problem in achieving efficient waste collection services.

Institution	Roles and Responsibilities
• Department of the Environment	• Regulating authority for implementation of all activities according to environmental laws and regulations • Preparation of Legislation
• Ministry of Health	• Monitoring of abiding by the rules and regulations pertaining to all solid waste handling activities • Supervision of the separate collection of waste in all hospitals, polyclinics, clinics and doctor's offices. • Control of hygienic conditions in all waste treatment plants
• Ministry of Interior	• Supervising all the activities in accordance to the law
• Ministry of Industry	• Representing the interests of the industries in the development of new Legislation and Decrees
• Municipality of Tehran	• Monitors all activities of the municipal solid waste management system of Tehran to ensure its stable and smooth operation. • Final responsibility for waste management
• OWRC	• Monitor, control and coordinate all the activities of solid waste management system in Tehran • Recycling and composting • Land filling (at the Kahrizak an Ab Ali site) • Preparation of the solid waste management plan • Preparation of an annual waste report • Preparation and implementation of public relations campaigns proposals for investments • Information and statistics related to solid waste management • Consulting services for the erection of waste treatment plants and new technologies for recycling
• Motor Pool Organisation	• Transfer and transport all kinds of municipal solid wastes to Kahrizak landfill • Lease vehicles to private haulers • Supervise, control and monitor private companies engaged in transfer and transport activities.
• Districts	• Collection of wastes within the districts • Conclude contracts with private collectors • Conclude contracts with private companies for material recycling within their jurisdiction • Monitor, control, coordinate and supervise all the activities of their districts.

Table 2.2 Institutional Framework for Solid Waste Management in Tehran

2.3 Organizational set-up

The organization of the Municipality of Tehran is given in figure 2.2.

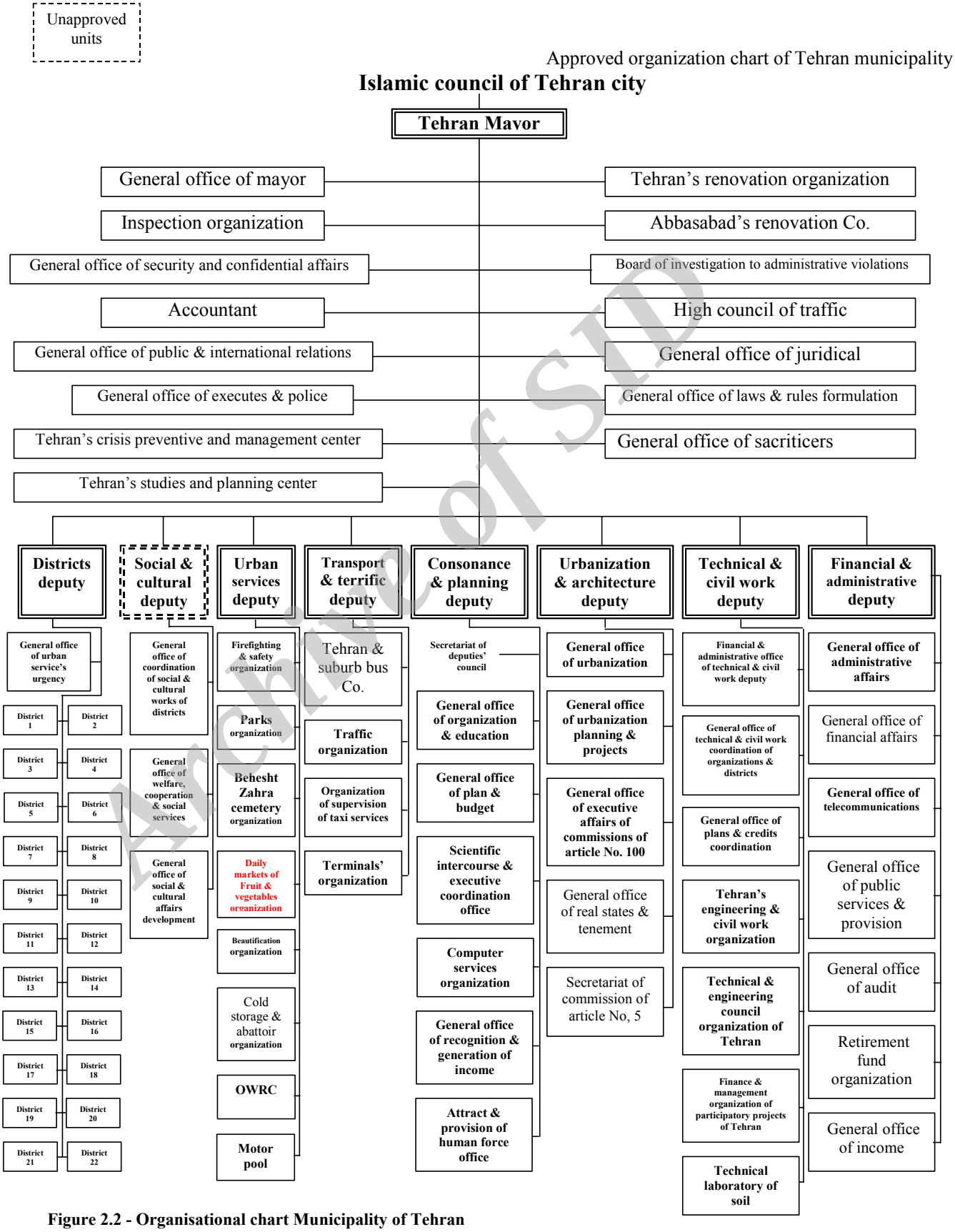


Figure 2.2 - Organisational chart Municipality of Tehran

The following departments of the Municipality are involved in waste management:
- District's Deputy Office
- Urban Service's Deputy Office

The District has no special office for waste management and the relevant tasks like finance, administration etc. are a part of the overall tasks. The organizational set up of the District office is determined by the Municipality. All contracts for the collection of domestic waste are concluded between the contractor and the District. Likewise the District is paying to the Motor Pool for the transfer and transport of waste to the landfill and to OWRC for the landfill. The District is making the operational plan for waste collection and the District is tendering the collection services using a standard contract prepared by the Municipality. The contract normally includes all urban services such as waste collection, drainage channel cleaning, street sweeping, disinfection, street washing, cleaning public places, removal of debris, etc.

The District prepares annually a budget for the Municipality and the budget consists of two elements:
- general budget based on the budget of the previous year with 10-15% inflation correction
- budget for proposed new activities.

The organization chart for the sub-District is given in Figure 2.3.

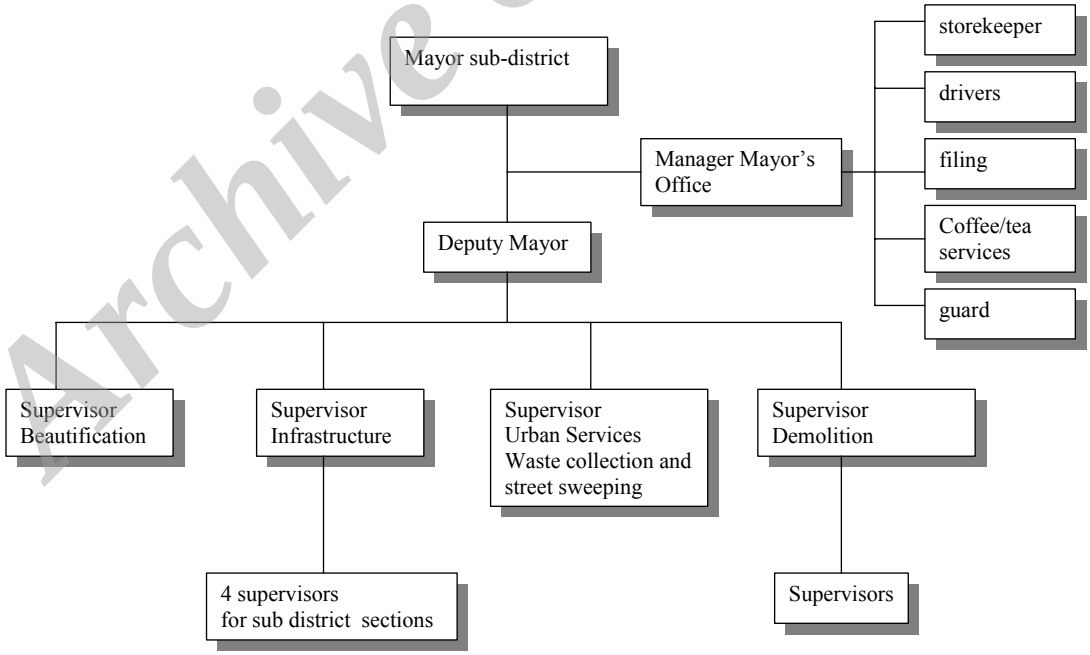


Figure 2.3: Tehran Waste Management Strategy-Organization sub-district

It shows that this organisation is only carrying out supervision and that they are not involved in any data collection and planning. The supervisors are checking the operations of the contractor

and they report to the District based on a standardised form. This form is countersigned by the contractor. The contractor can be fined based on the contract conditions.

The obligations of the contractor are laid down in the contract and include a.o.:

- reporting on a monthly basis about number of workers, equipment, etc
- develop facilities for the operations
- forbidden to sub- contract his obligations
- rent of equipment from the Municipality unless he can proof that he can hire at a lower rate from others
- workers should be provided with shoes, uniforms, helmet, gloves, masks, identification card
- workers will be hired from the sub-district and a deduction to the contract price will be applied
- contractor and its workers will not charge the citizen for waste collection
- waste collection will start at 21.00 hours (except dry waste)

Although the contracts look rather well detailed, in practice the conditions are hardly followed. The contracts have a duration of one year and can be extended upon agreement of the contract parties, otherwise the contract will be tendered again.

2.4 Data gaps and needs for improvement

2.4.1 National level

Gaps	Needs
Legislation	-Amendments to Waste Management Law (definitions incl. wastes lists, tasks and responsibilities of all stakeholders, Decrees (By-Laws), requirement for National, Regional and Municipal Waste Management Plans, obligation to make Municipal By-Laws (Ordinance), quality requirements for SWM, licensing procedures, reporting requirements, enforcement procedures, dispute settlement, etc)
National Waste Management Plan	Preparation of a policy plan for Solid Waste Management for e.g. the next 10 years with e.g. revisions every 2 years. This plan could comprise: -Description of the national policy (existing situation, definitions, targets, scenarios, organisation, etc.) -Action Plan per waste stream (household, industrial, institutional, electric and electronic, organic, cars, infectious hospital, construction and demolition, paper, glass, plastics, metals, etc.) -National policy concerning final disposal (landfilling, incineration)

2.4.2 Municipal level

Gaps	Needs
Regulation (By-Law or Ordinance)	(i)Develop a Municipal Ordinance with tasks and responsibilities of all stakeholders, separate waste collection, frequency, licensing, penalty, etc.
Municipal Waste Management Plan	(i)Policy paper for the next 3-5 years is needed including: - inventory of the problems, - development of scenarios in consultation with the population, financial consequences - annual action plan for selected scenario's for each problem, financing modes and tariffs, communication improvement, etc. (ii)Setting up of a WM planning group comprising a representative from each District. The group could be chaired by OWRC.
Organization	-Establish a clear operational structure with division of tasks and responsibilities for (i)collection, (ii)transfer-transport-disposal and (iii)recycling -Establish a control, monitoring and planning unit with a reporting system, databank, policy development, planning, etc. This unit should be independent from operational aspects. -Prepare training programmes for staff at municipal level. -Arrange for more continuity in the waste management policy by avoiding frequently changing staff and different policies and thus avoiding confusing and confidence with the population -Organizational set up and role of OWRC should be critically analysed -role of Motor Pool should be critically reviewed
Public Participation	-Make available special budget for the Districts -Develop P.A. programmes

2.4.3 District and sub-district level

Gaps	Needs
Organization	-Establish a specific Solid Waste Management Department at District level for waste collection and street sweeping including manuals for operations -Prepare training programmes for the staff at district and sub-district level and for (private) waste collection workers -Prepare annual action plans in consultation with population
Operations	-Make waste collector responsible for preparation of operational collection plan as part of tender -Improve tender conditions
Public Participation	-Develop Public Awareness Programmes -Carry out Public Surveys to assess the satisfaction rate

3 FINANCIAL AND ECONOMIC FRAMEWORK

3.1 Waste Collection

On average more than 7,000 tonnes per day are produced. In addition industrial and hospital waste account for 570 tonnes per day, and are transported directly to the landfill. From the domestic waste an estimated 500 tonnes are collected daily through the informal sector. The remainder enters into the formal circuit. The district level is responsible for waste collection. The district level tenders contracts to private contractors on an annual base. The tender refers to guideline prices per Kilogram from the municipality. Contracting is based on this price and the overhead. Contractors collect the waste and transport it to the transfer station. Rolling stock used by the contractors is rented directly from the Motor Pool, District Motor Pool and private companies. At district level two separate collection systems are operational. One for the collection of dry materials (in preparatory phase not yet full coverage), operational at daytime with a collection frequency of twice a week, and one daily collection system operational at night for the remaining materials.

Districts have a total of 90 contracts for daily waste collection at night with an average value of US$ 240,000 per annum (total value US$ 21.6 million). More than one contractor services the Districts. Contractors are responsible for street cleaning and washing, channel cleaning, soil and debris cleaning, leaves and trimmings, and house-to-house waste collection. Excluding street sweeping about half the budgets are allocated to waste collection and related functions. They deliver the waste at one of the 9 transfer stations in the city, where it is weighted. The (sub) district takes the tallies from the weighbridge. Monthly he forwards the signed sheets to the contractor, who invoices the District. The Districts reclaim these monies with Tehran Municipality. This implies that waste collection costs are estimated at US$ 10.8 million per annum, and corresponds to an estimated price of US$ 4,6 per tonne. With street sweeping included this price doubles (US$ 9,2 per tonne).

For the collection system of dry materials under the current pilot scheme one contract per district is the rule. Private contractors pay the District US$ 10,000 per month for a contract. With the assistance of the informal sector workers the dry waste (estimated at 120 tonnes a day) is collected, sorted at the sorting station and sold by the private contractor. The remainder will be delivered to the Transfer Station. The private contractor recovers the operational costs with the profits from the sale of the secondary materials to industry.

Although, the polluter pay principle (PPP) is mentioned in the law on waste management, cost recovery has till now no role in Tehran waste management. Subsequently, all these costs are recovered through the municipal budgets.

3.2 Transfer and Transport

Not all of the waste is transferred. Private operators transport about 15% of the waste straight to the landfill. At the transfer station the waste loaded into the semi-trailer and transported to composting plants (250 tonnes a day) and the landfill (5,200 tonnes a day). A pilot is underway to sort the waste at the transfer station 15. The Motor Pool currently operates and maintains the transfer station, plus the transport to the landfill. Private contractors carry out the transport to the landfill. For transport semi-trailers (56.1CbM) are rented from the Motor Pool or private sector. For its activities of transferring and transporting the Motor Pool invoices the District, while the contractor invoices the Motor Pool. Apart form that the Motor Pool provides a number facilities related to hospital and industrial waste and construction and demolition debris. It is estimated that for transferring and transport of domestic/household and industrial waste only total costs reached US$ 3.8 million (US$ 1.9 per tonne) for the year 2003, while their income from the Districts reached at US$ 5.5 million (US$ 2.6 per tonne).

Other waste transported by the Motor Pool refers to hospital, industrial waste disposed at the Kahrizak dumpsite and construction and demolition debris dumped at the Ab Ali dumpsite. It is estimated that for the year 2003 total transport costs are about US$ 1.5 million, while revenues reached a total of US$ 2.2million. Invoicing is directed to the hospitals and clinics, and private industry and building contractors directly. Transport costs per tonne of waste does not vary much among the differing types of waste (US$ 1.9 per tonne).

The Motor Pool was privatised in 1997 and not able to introduce depreciation policies prior to privatisation. Currently half the rolling stock is in active service. Aging rolling stock, maintenance schemes and lack of replacement investments in the past contribute to this low performance rate. It jeopardizes increasingly the operational effectiveness of the contractors.

3.3 Composting plants

Sorting and biological composting started 10 years ago in a plant nearby the existing Kahrizak landfill, with a daily capacity of 1,000 tonnes. Of the four sorting lines currently one is operational, facilitating an intake of about 280 tonnes per day. Questioned are the premises and outcome of the feasibility study, as the current situation is contrary to the one originally portrayed. Market development lacked behind expectations due to lower product qualities and commercialisation remained confined to Tehran, while technical breakdowns interfered with production targets. Depreciation policies based on historical prices in an economy with high inflation rates undermined the internal financing capability for replacement investments. The plant is currently managed by OWRC and operated by private contractors. Currently the plant is loss making with revenues (US$ 0.1 million) recovering less than 10% of the operational costs (US$ 1.1 million, year 2003). This implies a cost of US$ 119 per tonne of outgoing compost, and revenue of US$ 10 per tonne. Due to the low utilization of installed capacities depreciations absorb 36.1% of total costs. The category other costs claim 26.9% of the budgets. This means that more than 60% of recurrent costs go into cost categories other than consumables, remunerations and contracting fees. Other composting facilities managed by OWRC refer to

those located at Hata and Carco. These are small-scale operations with no significant contribution to the recycling effort.

With private sector initiative a new bio-chemical composting plant is started up in the vicinity of the existing composting plant. As a pilot it will start operating with an intake of 1,000 tonnes a day shortly. OWRC subsidizes the intake price (US$ 2 per tonne). The operator expects a better product quality at a lower cost price, with marketing potential in the agricultural sector.

3.4 Reuse and recycling

Separation at source by private contractors facilitates a transfer of 120 tons a day of carton mainly to the paper recycling company managed by OWRC. A very limited array of products is produced and sold. The costs of production for 2003 reached a total of US$ 2.2 million (US$ 0.9 per tonne), while marketing the products created revenues of US$ 0.9 million (US$ 0.4 per tonne). Also this activity is loss making. Figures referring to the informal sector on paper recovery and recycling, or recovery of metals, batteries, plastics, car tyres and car wrecks are not available.

Recovery of demolition and construction debris is high due to high level of enforcement. Annually 4.9 tonnes are delivered to an OWRC managed site at Abali. Depositors pay a fee, while some of these materials are recovered and sold. For 2003 was meant an additional income of US$ 0.45million.

3.5 Final disposal

OWRC manages the Kahrizak landfill site at 40 Km distance from the centre of Tehran. Operations have been contracted out. This site has reached full capacity and will be closed. A new site has been identified (Houshang Abad) of 818 Ha located at 60 Km from city centre and a design study is recently finished. The existing dumpsite at Kahrizak is not environmentally safe with little equipment on site. Therefore operational costs are low US$ 1million (2003).

Industrial, hospital, construction waste and other waste are also dumped on mentioned site with the exception of construction debris. Gate prices at the landfill do not differ from domestic waste prices. The revenues of the dumpsite are to offset the losses on other operations. With a gate price of US$ 1.3 per tonne annual revenues for 2003 is realised of US$ 3.2million. About 25% of the costs are allocated to consumables and remunerations, and 59% to contractor fees.

3.6 Total costs and money flows

The figures mentioned above are reflected schematically in table 3.1 and are described in more detail in appendix 2. Total annual Municipal costs are US$ 30.1 million and annual revenues are US$ 9.8 million, based on year 2003. Total net benefits is US$ -20.3 million. With street sweeping included the municipality pays about US$ 12,0 per tonne, and without inclusion of street sweeping about US$ 7,6 per tonne. Revenues on transfer & transport, recyclables and land filling are US$ 3,9 per tonne. The invoices from hospital, industrial waste, demolition and construction debris are paid by the respective organizations.

Description	Organization Involved	Total Costs US$ million	Total Revenues US$ million	Costs per ton US$/ton	Revenue per ton US$/ton	Net benefit US$/ton
Collection & Recovery - Waste Collection incl. Street Sweeping	Districts	21.6	0.0	9.2	0.0	(9.2)
Transfer & Transport	Motor Pool	3.8	5.5	1.9	2.6	0.7
Reuse & Recycling - Composting - Paper	OWRC	 1.1 0.4	 0.1 0.1	 12 406.8	 9.9 79.4	 (2.1)
Other	OWRC	2.2	0.9	0.9	0.4	(0.5)
Final Disposal	OWRC	1.0	3.2	0.4	1.3	0.9
Total Costs Municipality		**30.1**	**9.8**	**12.0**	**3.9**	**(8.1)**

Source: Economic and Financial Framework - Mrs.T.Aryan

Table 3.1 - Estimated Costs on Integrated Waste Management Services for Tehran Municipality, Year 2003

Annually municipal budgets are adjusted mainly for the estimated annual inflation rate. In real terms budgets remained stable over the last couple of years as waste generation and growth rates varied little. For planning purposes economic and demographic factors do play a role in projecting overall waste management costs. Waste reduction and commercialisation of recyclables could reduce costs over time.

From the analysis above it is concluded that all money flows pass through the District. This creates clarity, valuable for both analysis purposes and future application of polluter pay principles. This is schematically referred in figure 3.1.

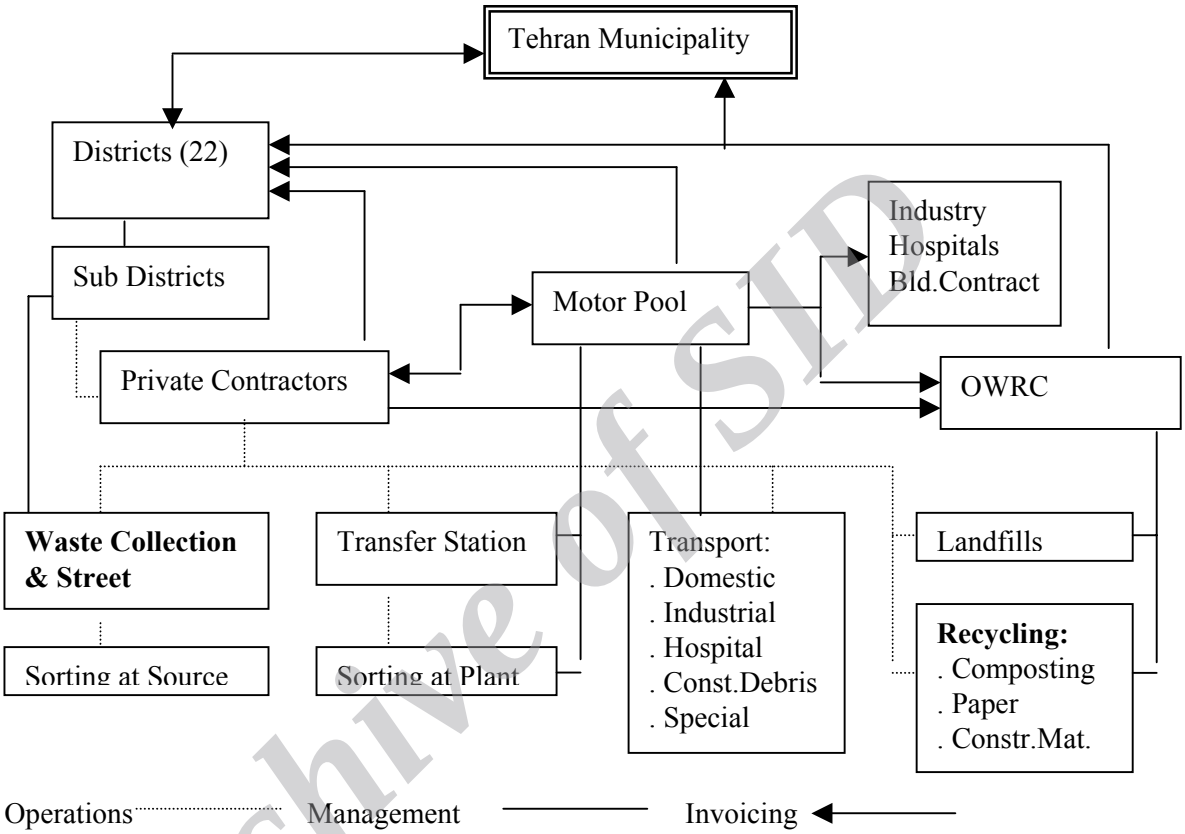


Figure 3.1 - Money Flows Integrated Waste Management System Tehran Municipality

3.7 Data and Information Availability and Main Findings

- Accessibility: Information gathering and exchange among stakeholders is limited as organizations are not obliged to publish their data for the general public.
- Functional continuity: There is no clarity regarding the allocation of waste management functions to organizations. The case in mind is the Motor Pool and OWRC. It complicates considerably an analysis on operations and budgets over the years.
- Continuity in management: The frequent change in management positions in public or semi public bodies undermines the continuity that contractors appreciate. If contractors were to procure rolling stock, multi year contracting would be in conflict with current management practices within the public sector.
- Management Information Systems (MIS): Although, supervisors at (sub) district level do have a system of reporting, its scope remains confined to the area of penalties. The results are exchanged within the district level. Thereafter the chain stops. There is no organization

that supervises or monitors waste management activities for waste management planning purposes. OWRC has a statistical department. The data produced seems to have a limited demand and does not fit the requirements for planning activities. Consequently, the haphazard management information systems are to be redirected, focused and extended.

- Municipal Data Bank (MDB): What counts for the information systems on waste management operations is also true for the municipal data banks. Such data banks refer to a wide array of variables relevant for planning. It details the 'demand side' in waste management. Variables refer to dynamic indicators on demography, physical characteristics of the services areas, economic activities, waste generation, housing and living conditions, socio-economic profiles, and services rendered.
- If supervision, control and monitoring on ISWM were considered a must, integrated MDB and MIS systems are to be set up, kept up-to-date, and exchange mechanisms put in place.

3.8 Financial Shortcomings and Main Findings

- Contracting: Annual tendering refers to guideline prices issued by the municipality. These prices are based on price corrections over the prices of the foregoing year, and known to all parties prior to tendering. For evaluation of the bids the overheads play a role too. Unknown is the substantiation of these guideline prices. Defining the scope of the contract and performance criteria is a proper procedure. It is questioned, however, why the District should prepare the plan of operations. Having experienced contractors in the field, it would be better to leave it to the contractor. Both mentioned elements mitigate the gains from privatisation. Annual contracting is possible if continuation of a motor pool activity is secured. Cessation of activities of the Motor Pool could imply the emergence of private lease companies, or contractors buying their own rolling stock. Not all contractors are in the same position to do so. In any case, it would imply structural revision of contracting policies and procedures.
- Depreciation policies: The fact that half the fleet of the Motor Pool is under repair and maintenance, and only one of the four sorting lines on the compost plant from OWRC operational highlights a main shortcoming in the financial administration of the public enterprise system. Its statutes and regulations are based on the law for commercial companies. However, depreciation is based on historical cost pricing. In an inflationary economy (15<20% per annum) such a policy is killing. The advantages of internal savings and reserves are completely undone with the type of depreciation policies applied. Irrespective the date of privatisation the applied depreciation policies contributed to the current technical conditions of both the transport fleet and the recycling plants.
- Auditing: An external auditor at OWRC prepares annual reports. No such reports seem to exist for the Motor Pool. Due to this situation the insight into the operations from the Motor Pool remained superficial.
- Subsidies: Fuel prices for pick-ups, collection trucks and semi trailers are subsidized. For Main findings on evaluation of investment plans such subsidies have to be taken into account, by introducing shadow pricing.
- Financial sustainability of current recycling efforts: The two plants (paper and composting), managed by OWRC, are structurally loss-making activities. The under utilization of installed capital combined with limited replacement investments urges the question whether OWRC should not concentrate on recovery only, leaving risks and opportunities of

recycling to the private sector. By concentrating on clearly defined core activities future waste management services may be more cost efficient. The fact that these activities have been going on for so long emphasizes the need to introduce more check and balances in the financial management system. Also the expertise required for recycling differs substantially from core activities such as collection, recovery, transfer, transport and disposal.

- Cost recovery: In the fore-going paragraphs an assessment is made on the overall costs of waste management. Apart from the payments made for transport and disposal services of hospital and industrial waste, and demolition and construction debris, no other payments are made for domestic waste other than the municipality. The polluter pay principle, though mentioned in the Law on Waste Management, has not been put into practice. Subsequently, no cost recovery systems are currently in place.
- Accounting information systems (AIS): Instructions, rules and guidelines are to be concise and uniform throughout the public sector. The Ministry of Interior is the responsible authority to make such directives. It seems that uniformity is lacking in the system and contributes to a lack of transparency. Likewise the current system is too limited to enable a proper insight for budget control purposes. The public enterprises fall under the directives of the 'commercial companies'. In principle these enable that better accounting practices are adhered to.
- Budgetary procedures: Due to the fact that a concerted activity planning is missing, the annual budgetary process is limited to an inflationary correction of the fore-going budget corrected for the specified additional activities. This procedure undermines the budget as a tool of management.
- Multi-year programme budgeting: Such systems are nowhere in place. For strategic planning and integrated waste management such a system becomes pre-requisite. It refers to the formulation of activities within cost centres, founded on functional and economic categories referring to UN classifications systems. MDB and MIS are an integral part of this system. It refers to uniform budget coding systems and concise instructions, rules and regulations. These are set-out in well defined directives from the ministry of interior and consistent with the commercial companies.

3.9 Framework for gap analysis and need assessment

Data gaps and financial shortcomings are to be seen in the light of future requirements and not refer to the existing information system only. Figure 3.2 refers to an overall planning framework and highlights the elements of planning, the place multi-year programming AIS, MIS and MDB have. Problem formulation leads to strategies and planning. It sets targets and defines policy instruments. These are reflected in the institutional set-ups, multi-year recurrent and capital budgets and activity planning. To keep track on the implementation of activities a coherent reporting system is developed referring to key indicators. This facilitates the supervisory and monitoring functions. The results are translated into policy adjustments regarding WM activities, targets, and policy instruments. It is a circular process. Goals and objectives are thus translated into structures and actions in time that are transparent and focused, resulting in better managed and effective systems at affordable costs.

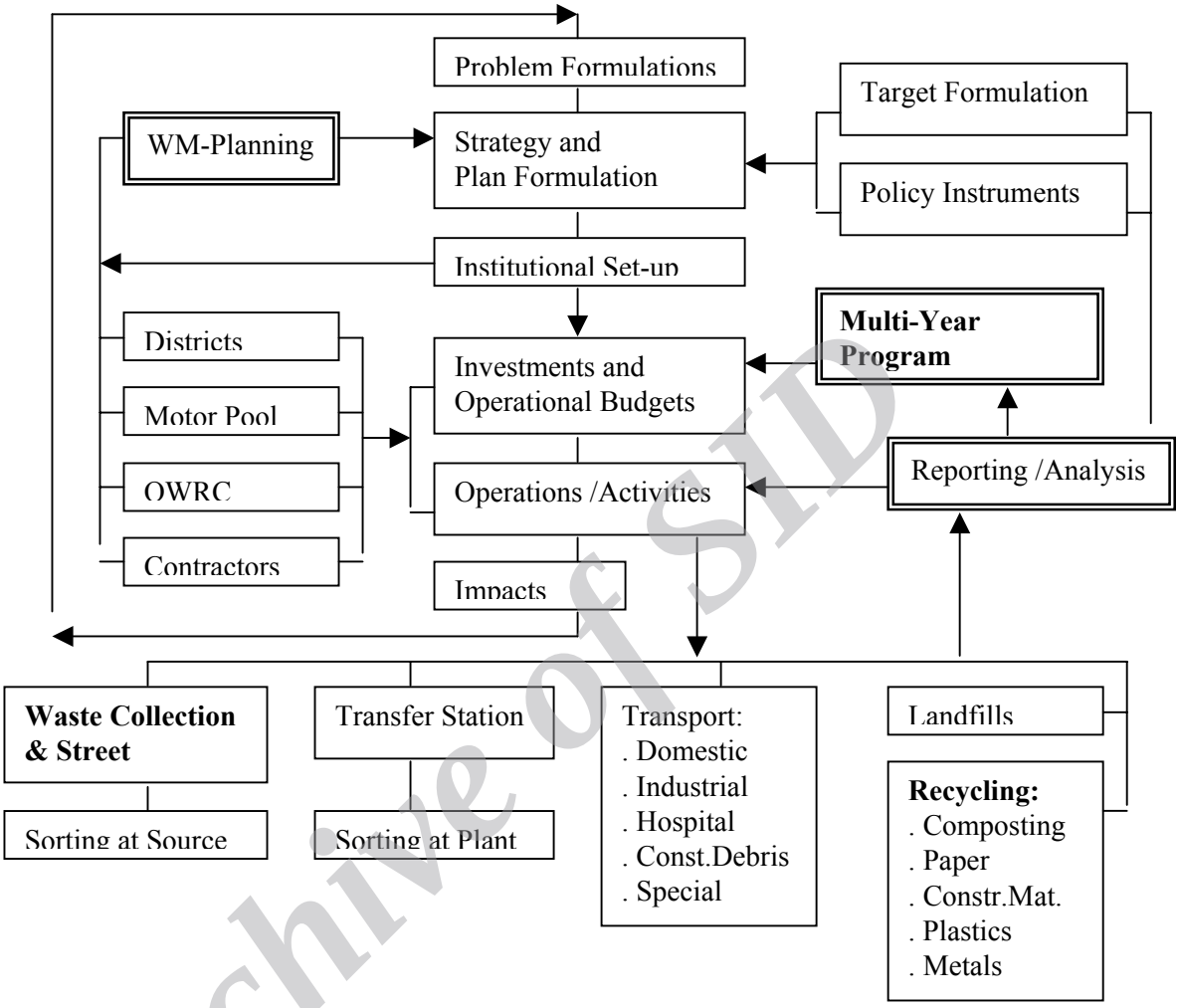


Figure 3.2 - Planning Process and the Role of Accounting and Management Information Systems

Gaps on Data and Information Availability

Gaps	Needs
Municipality & Districts: Reporting Systems Data banks Management information **OWRC & Motor Pool:** Reporting Systems Data banks - Management information	Elaborate and implement concise management information systems (MIS) and municipal data banks (MDB) based on the waste management cycle and waste streams as indicated in the figure above, indicating the variables, hierarchy, procedures, responsibilities, and exchange mechanisms

Gaps on Financial Shortcomings

Gaps	Needs
Municipality & Districts:	
Guidelines on unit prices	Update guideline unit prices for services
Budgetary process	Establish multi-year programme budgeting/accounting systems.
Accounting information	
Polluter Pay Principle	Elaborate schemes for cost recovery
OWRC & Motor Pool:	
Depreciation policies	Update depreciation policies
External auditing	Compulsory external auditing
Loss making activities	Redefine activities
Budgetary process	Establish multi-year programme budgeting/accounting systems.
	Establish a unit responsible for integrated waste management planning and policies

4 OPERATIONAL FRAMEWORK MUNICIPAL WASTE

4.1 Household and commercial waste

Domestic waste is generated at households, at public places and (small) commercial enterprises. It is the majority of the waste that is produced every day, about 6550 tons/day estimated based on collection and separation at source. The main components and quantities are shown for the waste management chain in Figure 4.1.

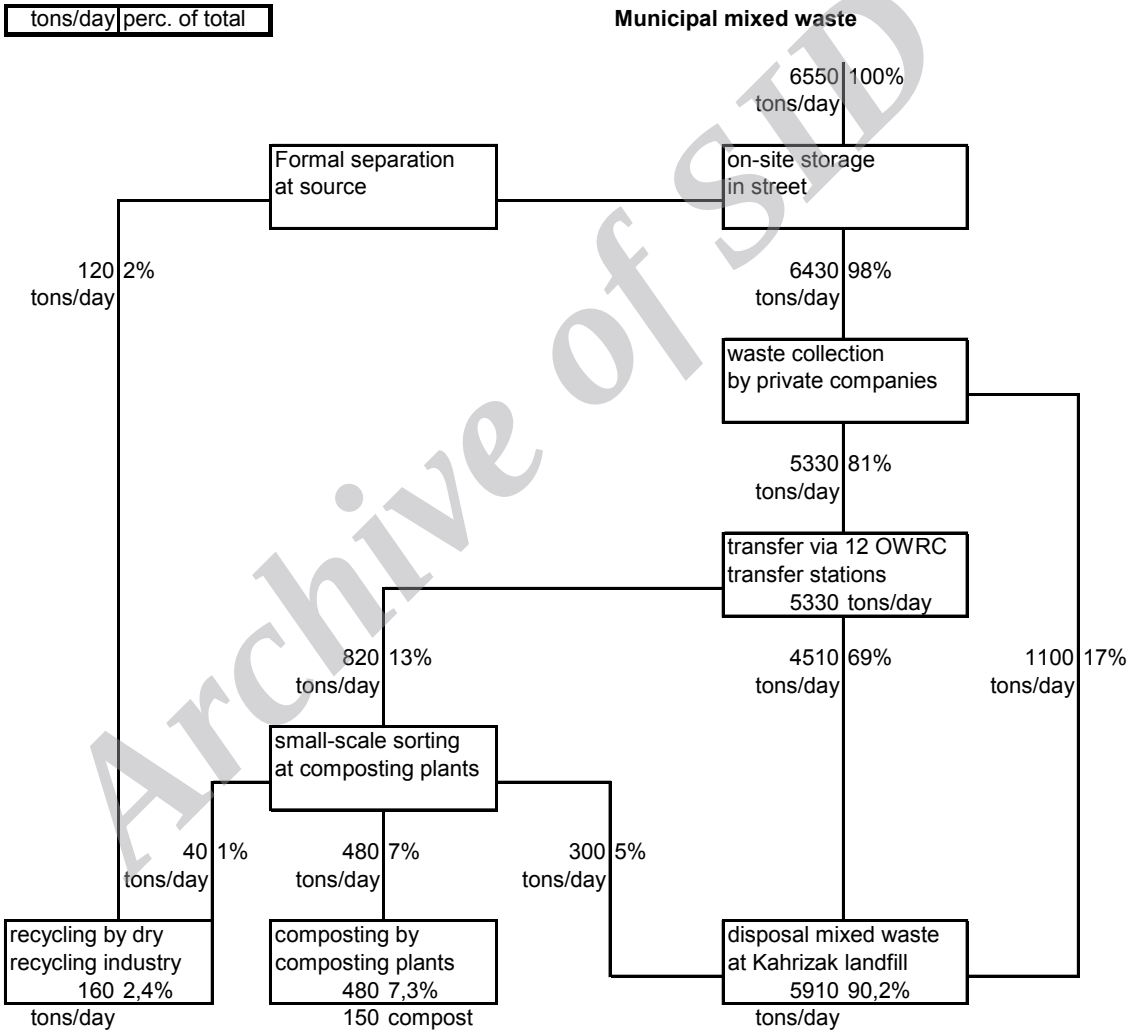


Figure 4.1. General scheme of the household waste stream

From the figure we can see that most of the household waste is land filled (90 %), circa 2,4 % is recycled in dry components and 7 % is composted by the composting industry.

4.1.1 Generation

Waste is generally stored in 30 litre waste bins in the houses of civilians. Wet waste is collected in the kitchen, dry waste is collected in the kitchen, living room and bedrooms. People generally use special black bags (from recycled materials) or transparent shopping bags as storage medium.

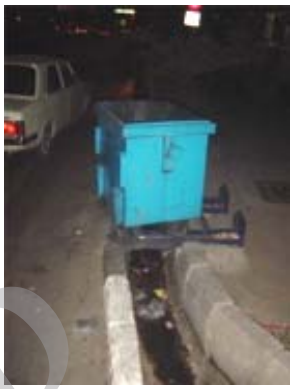
People are allowed to put their waste on the curb side after 9 o'clock in the evening, but after 6 o'clock there are already bags in the street. Sometimes people put their bags outside after the collection truck has already passed. Because of rotting process and moisture during the warm season, it is preferred by most civilians to get rid of the organic waste every day of the week.
The solid waste collection in Tehran is every day of the week. This is a very high service level. It is expected that 40 to 60 % of the people put their waste outside on an average day.

Valuable components like furniture, refrigerators, paper are sold via intermediates, who pick them up inside the house or shop. Some shops also gather valuable dry recyclables and sell or give these to informal collectors for further recycling. Larger and invaluable dry components are put separately from the bags in the street.

Organic waste (fruit, vegetables) is not separated at source, neither for houses or restaurants. There is no (in)formal sector as far as we know to collect and re-use organic waste. This is different for bread, that is stored separately, collected separately and has its own recycling industry (i.e. re-use as cattle feed).

Sweeping waste is also stored in small heaps in the street. People put their bags next to these heaps. There are families that do not use a bag inside the bin and dump the contents directly in a container or on the street at a collection point. Another problem is that people do not close the bags properly or the bags are opened by cats and scavengers to pick out valuable materials.

Blue containers for grouped collection



In several streets in the City special blue containers are used with a capacity of 800 litres. These containers are normally situated in shopping centres and sometimes at ends of small alleys where trucks can not come. Small lorries are used to transport the waste from the alleys/shops to the central collection point.
The containers are owned by the municipality and emptied 1,2 or even 3 times per day. The system covers less than 5 % of the total waste collection system.
The Department of Urban Services say they have good experience with these containers on most commercial locations, but for urban areas the problems rise because containers run full. At the moment they do not see it as an integral system for all of Tehran.

Public awareness and participation

- participation in primarily collection: medium/low interested
- share the vision of reduction/re-use/recycling: medium/low interested
- scavenging: what is the attitude from households to these people: medium interested.
- Drivers for people are:
  - Economic (low costs and little space at home)
  - Religious (separation of bread)
  - Environmental (awareness of local and world wide environmental problems)

Shortfalls

- Low public participation: people use different kind of bags, open bags, separate dry components, demolition waste, heaps of sweeping waste: it gives a lot of rubbish and bad environmental quality of the neighbourhood. The effect is that people do not really care how to discharge their waste in a proper manner, especially when it is not in front of their own house. That is why the city municipality prefers not to use central collection points but to use door-to-door collection.
- Effectiveness of public awareness campaigns: how many people have read campaign brochures, how many people have understood the brochures, how many people do change their behaviour? What is this response after 3 months, after 12 months?
- The rubbish at collection points requires a lot of extra work for the collection people. They have to clean almost every central collection point with shovels and brooms which takes a lot of time and physical effort.
- Application of legislations: put penalties on wrong waste time/method of waste disposal.
- Clear guidelines what to separate. Especially in future it will become important what to separate and how to separate.
- Budget for communication, training of staff and civilians: this is insufficient (only 1 % of total municipal waste collection budget).

Highlights

- Several districts have gained experience in separate collection of dry recyclables. Recycling pilots are set up and there is good knowledge what works and what doesn't work.
- In the pilots there is also experience in incentive schemes: how to motivate people in a positive way to separate their waste.

Needs for improvement

- Clear regulations and communication how people should dispose their waste. It should be clear what waste fraction should be in what bag, a clear time frame (for instance between 19:00 and 21:00 o'clock), disposal means (for instance OWRC plastic 50 litre bag), disposal location (in front of your house door) and frequency rate (for instance every day except Friday).
- Communication can be more effective. Make it personal ("I am a recycling household") and group oriented ("We are a recycling area", "We are recycling in our company"). We would propose to start a partnership with a creative agency to make target group specific publications and put public participation in a wider context. They know how to address information to specific client groups and do good client surveys.
- Activate NGO's, schools, religious places to participate in implementation of Reduce-Reuse-Recycle program.
- Get engagement from collection companies, recycling intermediates and recycling industries to obtain a transparent and clear recycling chain. People must know what is changing in the waste chain, that recycling is seriously started up. This should be communicated to all partners in the chain (from shops and households to producers of new products).

4.1.2 Collection

The Municipal Waste is collected every night in 21 districts using different types of vehicles. The vehicles, which belong in part to the Motor Pool Department and to private sub-contractors, carry out curb side waste collection. Every district is subdivided in several rayons where these subcontractors are responsible for daily waste collection and street sweeping.

According to the Department of Urban Services in total 1572 collection vehicles are currently in use, doing 4587 services per day. This is subdivided in different type of vehicles according to the following table:

Collection trucks (2004)	no. of trucks	no. of services/day	services/truck/day
Pick ups	865	3075	3,6
Vans without roof	441	1310	3,0
Vans with roof	47	35	0,7
Others	219	168	0,8
Total	1572	4587	2,9

Table 4.1. Number of waste collection trucks and service per day in Tehran

The numbers of services are based on the month of march 2004 with a total of 137622. In that month 212.839 tons of waste was collected, which means an average truckload of 1,5 tons per service.

collection truck with compaction

pick up truck

From weighing bridge information of Transfer Station 15 we learned that circa 70 % of trucks are small pickups and 30% are larger collection trucks. They bring almost the same amount of waste (51% vs. 49 %), both working especially at night time (68%).

Waste volume and number of trucks Transfer Station 15 (1 day in sept 2004)

Time	Number of vehicles		Weight (tons)		Total/day (tons)	
	Pick up	Truck	Pick up	Truck		
06.00 – 22.00 hrs	156	72	137	142	279	32%
22.00 – 06.00 hrs	243	102	300	280	580	68%
Total	399	174	437	422	859	
	70%	30%	51%	49%		

Table 4.2. Waste volume and number of trucks at TS 15 (1 day in sept 2004)

The average weight in a pickup truck was 1,1 tons and 2,4 tons in a collection truck. This data is in line with the data of the Department of Urban Services:

Average weight in pickup truck 1 to 1,1 tons/truckload
No. of services per shift: 3 to 3,5 truckloads/shift

Average weight in collection truck: 2 to 2,1 tons/truckload
No. of services per shift: 2 to 2,5 truckloads/shift

Number of shifts per day: for large collection companies 2 shifts (change of driver) for small companies 1 shift (only at night). Based on day- and night schedule at TS 15, ca. 50% of the trucks drives both at night and in daytime. It is assumed in general 1,5 shift per truck are driven.

Effectivity of collection trucks

The consultant looked to the effectivity of the trucks. How many trucks are daily required for collection, knowing the total waste amount, the average truckloads and the number of services they do every day. When extrapolating the figures for all of Tehran, we see that every day 1022 trucks are required for waste collection.

Type of	Collection of waste in all Tehran		avg. truckload	no. of truck-	truckloads/	required no. of trucks	
coll.truck	%	tons/day	tons/load	loads/day	vehicle/day	netto	bruto (+20%)
Pick up	50%	3220	1,0	3220	5,3	613	746
Truck	50%	3220	2,1	1533	3,8	409	497
Total		6440		4753		1022	1244

Table 4.3 Calculation of required no. of trucks

Since collection continues 365 days per year and collection trucks needs maintenance, it is expected that each truck is only in operation during 300 days per year. This requires an additional 20% in trucks (1244 trucks). Comparing this to the real number of trucks (1572 trucks), the effectivity is 79%.

Efficiency of collection trucks

Looking at the efficiency of the collection trucks, we calculated the total quantity of waste that each truck collects per shift:

- A pickup truck collects on average 1,0 tons per truckload and drives 3,5 rounds per shift, which means a total amount of 3,5 tons/truck/shift.
- A collection truck collects on average 2,1 tons per truckload and drives 2,5 rounds per shift, which means a total amount of 5,3 tons/truck/shift.
- When we compare this to the usage of large compaction trucks (as used in The Netherlands, Germany, etc) the daily operational amount is circa 17 tons/truck/shift for inner city areas (comparable to Tehran). This is due to a large collection capacity of 9 tons of municipal waste (in Tehran this would even be more due to organic fraction).
- Looking at the logistic efficiency of the existing pick ups and collection trucks, we can see that these are low (resp. 21% and 31%) compared to large compaction trucks. It shows that from a logistical point of view larger trucks are preferable in future.
- A point for further investigation is where and how many larger compaction trucks can be integrated in the logistics network, knowing the infrastructure and traffic problems in small streets and urban areas.

Personnel

Based on the number of trucks and shifts that each truck works, a calculation is made on the number of people that is working in the collection process. We come to a number of 4600 people that are daily active with waste collection in the streets. Because waste collection continues 365 days per year and a worker is allowed to work 176 hours per month, we come to a total no of personnel of 6360 persons (excl. supporting staff and management). We didn't get a verification of the Department of Urban Services what is the real number of persons working in the solid waste collection.

Type of Coll.truck	personnel on truck	no. of shifts/day	Required no. of personnel	
			netto	bruto
Pick up	3	1,5	2760	3816
Truck	3	1,5	1840	2544
Total			4600	6360

Table 4.4. Calculation of required no. of personnel

Labour conditions

An aspect that we would like to address is the ergonomy of the waste loading in a truck. The workers do have to throw the bags in the truck up to a height of circa 1,80 m. Also a lot of waste has to be loaded with shovels, which requires a lot of work and hard labour conditions. It would be preferable if the entrance height could be reduced to 0,8 or 1,0 m (for compaction trucks). This is the EU standard for collection trucks in order to optimise work conditions and handling speed.

Collection costs

Based on the number of trucks and the number of personnel a calculation is made on the expected operational costs for waste collection.

Operational costs (including investments)

Type of coll.truck	bruto no. of trucks	annual costs per truck	required no. of personnel	annual costs per person	overhead 10%	Total operational costs	
						per year	per ton
Pick up	746	$4.000	3816	$2.160	$1.100.000	$12.300.000	$10,5
Truck	497	$7.000	2544	$2.160	$900.000	$9.900.000	$8,4
Total	1244		6360		$2.000.000	$22.200.000	$9,4

Pick up: 20.000 investment, or 2.000 per year, larger truck 50.000 investment or 5.000 a year.
Other costs: petrol: ca. 800 dollars; maintenance, insurance, etc: another 1200 dollars.

Operational costs (excluding investments)

Type of coll.truck	bruto no. of trucks	annual costs per truck	required no. of personnel	annual costs per person	overhead 10%	Total operational costs	
						per year	per ton
Pick up	746	$2.000	3816	$2.160	$1.000.000	$10.700.000	$9,1
Truck	497	$2.000	2544	$2.160	$600.000	$7.100.000	$6,0
Total	1244		6360		$1.600.000	$17.800.000	$7,6

Source: $ 180/month

Table 4.5. Calculation of waste collection costs

If we calculate with these figures we come to an annual costs for collection of 22.2 million dollars (including investments in trucks). This is a really low figure in our opinion. If we leave out the depreciation costs for collection trucks –which we should not- the total annual costs become circa 18 million dollars per year.

Collection costs according to ToR

There are ca. 99 collection service contracts covering the metropolitan region with each having an average value of 240,000 US$/year. This means a total budget of 23.760.000 dollars per year. This budget is allocated for both street sweeping and collection. It is expected that total costs for collection are in between 12 and 18 million dollars.

Collection costs according to Department of Urban Services
The consultant has received a total budget for solid waste collection from the Department of Urban Services. The total budget is 10.85 million dollars per year.

Data gaps
- There is a big difference in calculated collection costs between Urban Services (10.85 million/year) and DHV (22.2 million dollars/ton). It requires further examination what is the basis for this large difference. It seems that investment costs in trucks are paid off in the first year.
- Exact number of trucks and number of personnel involved in solid waste collection, divided per sub district. How clean is the district every day? If these figures are known and monitored in future, effectiveness of collection and contracts can be evaluated.

Shortfalls
- Truck size of most trucks is limited and results in a low effectivity (3.5 tons/truck/shift). Most trucks are older than 10 years.
- Working conditions are time consuming and tough due to manual loading and shovelling of waste.
- During the life span of the truck there is only calculated with daily operational costs. A risk is that a public or private company is not able to save money for future investments.
- It is very luxurious to get a service everyday to pick up your waste for only US$ 1,= per civilian per year. In our opinion people are willing to pay more!

Highlights
- If the budget of Urban Services is correct, the economic efficiency of the collection system is very high. One doesn't want to have big changes from an economic point of view. However, we see that truck loads are relatively small and that effectivity of collection process can be improved.

Needs for improvement
- Truck size: what are the preferred dimensions of the truck in each type of district (low-income area, high-income area, suburban area, industrial area)? What can be the maximum truckload (tons/truckload)?
- The Department of Urban Services should consider what to do with the vans with Roof and smaller vehicles because some have a low service rate per day (0,7 and 0,8 services per day). If this number of trucks can be decreased, the effectivity might rise up to 90%, which we see as a good performance.
- What trucks are best applicable for mixed waste, what trucks for separation at source (organic waste or dry waste)? Is compaction an interesting alternative that can be easily implemented in most areas? How to prevent leachate leakage.
- Improvement of working conditions and working speed. Loading height, loading capacity, reduction of small bags/loose waste, introduction of more containers.
- Usage of 600-800 litre containers for collection in dense low-income areas (at end of alleys) and for shops/markets/restaurants)? Usage of 140 litre roll containers for shops in shopping centres, restaurants, offices and households with gardens?

- Frequency: Is it an option to collect only 3 times per week (half sub district: Saturday-Monday-Wednesday, other half sub district: Sunday-Tuesday-Thursday). Is daily collection really necessary all year round? And in all districts (high-income have less organic waste)? And in 5 or 10 years (due to increase of dry component)?
- Monitoring of solid waste collection.

4.1.3 Transfer and transport

Transfer
OWRC acts as a contractor for the Municipality of Tehran by fully operating the transfer and transportation to the central Kahrizak Landfill and the Kahrizak Compost Plant.
However, most of the operational work is sub-contracted to the private sector. There are at present 12 transfer stations in operation owned and operated by the Municipality of Tehran, through the district administrations.

The transfer stations use a system of raised platforms or surface level platforms for arrival of collection vehicles which tip their loads into open topped transfer vehicles without compaction. There are two basic designs for the transfer stations:
- Above ground level raised platform without any roof for 13 transfer stations and
- Surface level with transfer trailers placed below ground level also without any roof for 3 transfer stations).

The current strategy is to reduce the number of transfer stations from 12 to 9. Four transfer stations will exist on the same location, 5 new locations for transfer stations are found near main high ways. New layouts for these locations are already made. The dimensions are in between 20.000 and 40.000 m2.

Transport
The formally collected waste is transported by large 56.1 m3 transfer semi trailers from a set of 12 transfer stations. There are approximately 210 semi trailers owned by the Motor Pool Department. The system is rapidly transforming into full privatization. Approximately 50% of the semi trailers are usually in maintenance or repair status, and 50% are in active service (note: for example in mid-2002, the status was 107 semi-trailers in active service, 30 undergoing repairs and 30-40 awaiting repairs). There are approximately 74 trucks or cabs (also called "horses"), of which 28 are owned by the Motor Pool Department and 46 are owned by private sector contractors. Each truck hauls 2-3 semi-trailer loads every night.

The transportation analysis done in the Landfill Study by BC Berlin assessed all transfer stations in order to determine best practices, and proposed optimisation measures and pre-treatment options for every station. Consequently, after improving current practice at the transfer stations, a gradual change of system is proposed. The waste will be transported to the landfill in 65 qm containers on semi-trailers after pre-load compaction. This would result in US$4.71 per ton for transported waste.

Review on strategic task: retrieval of 10% dry recyclables at transfer stations is difficult
Requested output: 10% dry recyclables means 700 tons/day. Incoming waste at transfer stations is 6.300 tons/day (excl. separation at source), consisting of 1400 tons/day of dry recyclables of

which 50% is valuable and retrievable. This means that 100% of waste must be treated in a sorting installation to pick out 700 tons/day. Having 9 transfer stations the capacity of each sorting plant should be 900 tons/day (current design 250 tons/day per line, so you need 3 to 4 lines per transfer station. As far as we know there is not enough space at most transfer stations to implement a large-scale mixed waste sorting plant.

Shortfalls

- Some smaller old transfer stations are located in busy urban areas and have the problem that they are not easy to reach. It takes long time for collection trucks to get there. They loose much time on the collection process.
- The platforms are not covered, resulting in undesirable odours which might result in complaints of nearby residential areas.
- There were many problems with availability of trailers and transport trucks due to bad maintenance and planning. This resulted in long waiting times for collection trucks or direct dump in the dumping pit. OWRC already took this up with Motor Pool to solve this problem.
- The suitability of trailers for transport of wet waste is not optimal. It is important to reduce the risk of leakage of moisture. This happens especially when the trailers are in use for more than 2 years.

High lights

- The transfer system of direct dump in a semi-trailer is simple, flexible and cost-effective. Total costs for waste transfer and transport are low: 1,9 dollars/ton. Advantage of platforms is low maintenance and large number of unloading places for collection trucks.
- Waste capacity of 20 tons per semi-trailer seems reasonable. When transport distances are increasing or waste composition is changing (more dry waste), alternatives with more compaction might be an alternative.

Needs for improvement

- According to the future strategy it is planned to decrease the number of transfer stations from 12 to 9. Each transfer station will be able to handle a capacity of 1000 tons of waste per day. This is a large amount of waste that requires a good layout of transfer station, using preferably 2 weighing bridges and a platform with enough unloading places for trucks.
- The consultant advises to investigate in real practice whether the new locations result in less transport time for both collection trucks and transport trucks.
- The transfer stations might be able to handle different kinds of fractions: dry waste, wet waste, demolition waste, green waste and residue/landfill waste. This requires a good logistic plan for the required number of container places on the platform and number of trailers. It should be investigated if compaction or baling is an alternative for respectively mixed waste and dry recyclables.
- There are plans to introduce a sorting plant for mixed waste at each of the 9 transfer stations. It should be investigated if there is sufficient space at these places and environmental impact to neighbourhoods can be prevented as much as possible.
- The efficiency of the transport system should be further analysed when waste composition is changing and waste volumes are going to more different locations. A good balance of trailers and trucks on each location will be essential.

4.1.4 Disposal

Existing Landfill at Kahrizak

One of the main drivers of the integrated waste management strategy is the fact the Kahrizak Landfill has arrived at its full capacity. A new landfill design has been proposed and is in the process of being accepted.

Currently, the incoming waste is tipped on top of previously created landfill compartments. In order to deal with the urgent capacity problem, the Municipality is in the process of acquiring 818 ha of land adjacent to the Kahrizak landfill to continue current operations. The site can be described as a "semi-controlled" landfill operation, and the costs of waste disposal are in the range of 12.500 Rls/ton or 1,5 US$/ton (gate-fee). The leachate and gases generated at the facility are not well managed, and the short and long term environmental risks need to be evaluated so investments in appropriate mitigation actions can be carried out in the future.

New Landfill at Houssang Abad

- A new large sanitary landfill site is essential to ensure a sustainable SWM system for Tehran. Several new landfill sites have been studied[1] (approximately 13 candidate sites), and the most preferred site is located 50-80 km from the Tehran transfer stations in an arid area without residential or industrial development. This site is referred to as the Houshang and Aziz-Abad site. A strategic design for the period of up to 50 years is developed.
- The first section of the landfill will be located in the north-western part of the designated area and has a capacity of 56.1 Million cubic meters on 370 ha.. With an estimated increase of waste volumes from currently 7000 to 8700 million t/a in 2019, this site has sufficient capacity for up to 15 years.
- The site will be developed in four cells and a number of sub-cells, which are built onsecutively to a height of 40 m and slopes of 1:3. The waste is to be compacted permanently into layers of 50 cm at the maximum. Leachate will be collected and treated in sealed aerated or evaporation lagoons and partly be re-circulated. Gas will be actively collected by gas wells and a suction system. Surface run-off water will be drained around the area.
- For the bottom liner system the on-site material is not suitable due to its inhomogeneous
- physical and chemical composition. Favourite options in terms of cost efficiency, environmental impacts and technical implementation is 20 cm asphalt. The surface will be covered with 50 cm on-site material. The suitability of off-site clay must be analysed in tests and the used material has to be of homogenous consistence.
- The investment costs for the landfill are calculated at US$ 142 million, with an initial spending 15% in the construction year. The operational costs range from US$ 2.3 million to almost US$4.39 million per year. With an estimated reserve of US$ 42 million for aftercare, a gate fee of US$ 5,72 is required for the landfill operation.

[1] Tehran Solid Waste Management Project Landfill Preparation Study
OWRC August 2004
Annex to Part 2 – Design of Hospital Waste Cell
Submitted by BC Berlin in co-op with Gueno

Shortfalls

- Waste flow to land fill does not take large recycling activities into account. A new long-term phasing plan for the landfill is required for different kind of recycling scenarios.
- Leachate from the landfill site is not controlled and treated. Dangers of leaking of hazardous waste substances into the groundwater exist.

Highlights

- Well-developed design of new landfill for a long period (up to 50 years).

Needs for improvement

- Landfill tariff: allow for competition with composting and promotion of recycling
- In view of the current vision of OWRC optimisation of recycling and composting on the new landfill design is missing. A sensitivity analysis is required for several more and less rigorous recycling and composting scenarios.

4.2 Organic waste

Composting of organic waste is an important part of the current strategy of OWRC. If and where and how much composting can take place is of great importance to the choice to be made in the separation strategy and the design of the new landfill.

4.2.1 Generation

The wet fraction of the total Tehran waste is potentially suitable for composting: 67% of 7000 ton/day or 4.700 tons/day. At the moment ca. circa 820 tons/day of mixed waste is collected for recycling and composting. Circa 250 tons/day is treated in the Kahrizak Composting Plant, 20 tons is treated by the Carco installation and 500-600 tons/day is since august 2004 treated in the bio-mechanical treatment plant. See figure 4.2.

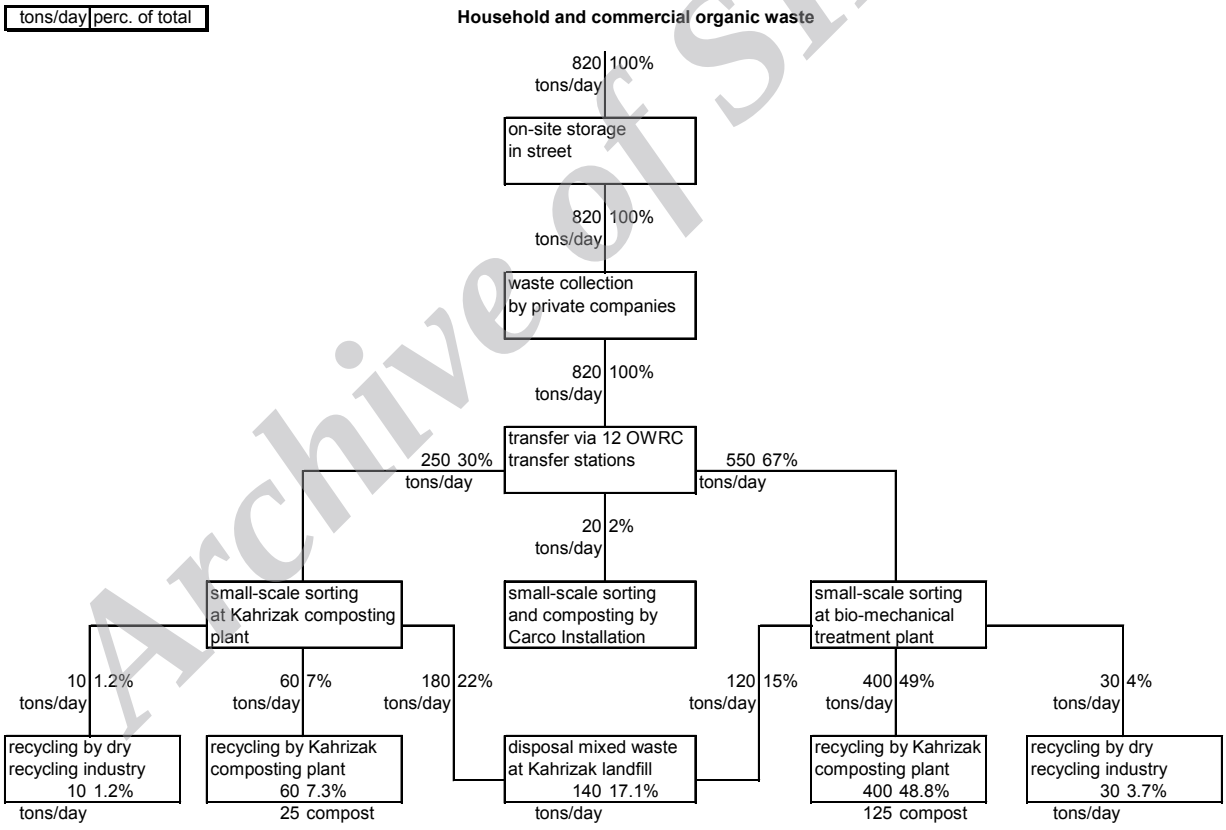


Figure 4.2. General scheme of the organic waste stream

Looking at the output of the chain we see that circa 150 tons of compost is produced every day, 310 tons of waste is evaporated, 40 tons of dry waste is recycled and 400 tons of residue has to be land filled. One can see that the performance of the bio-mechanical treatment plant is expected to be higher in input and output (more compost and recyclables, less residue) than the Kahrizak plant. We say "expected" because the bio-mechanical plant is still in its start-up phase and no long term monitoring and evaluation is obtained.

4.2.2 Collection , transfer and transport

Since source separation is not practiced at great scale in Tehran, most of the organic waste used for the composting process is mixed municipal waste, preferably from the stations 15, 18, 19 and 20 which have a higher organic waste portion compared to other stations and other city districts. These stations are located more or less in southern Tehran and are populated mainly by lower socio-economic groups, who produce more organic waste and less non-organic waste due to their living habits. Circa 100 tons/day is collected directly from fruit markets and green areas. All waste is transferred via one of the transfer stations (most at TS 15). It is unclear what part of the wet waste is coming from shops, restaurants and what part is coming from households.

In some transfer stations green waste from parks etc. are further separated and recycled. In transfer station 15 there is one corner of the area where wood is chipped in small pieces for further recycling. Tonnage is unknown.

Shortfalls

- Separate collection at source is tried in one pilot project. It was difficult for households to separate their wet waste from dry waste. It produced more fermentation and leakage of moisture already in the households. For this reason this pilot was stopped.
- Leakage of moisture is a general problem, for collection, transfer and transport of waste.
- At the moment there it is not known what is the waste composition as it comes to the composting plant. The waste might be contaminated with hazardous components. In future a clear intake procedure is required and regulations which waste is sent for composting and which waste goes directly to the landfill.

Needs for improvement

- further explore potential input sources for organic materials (fruit markets, restaurants, parks, leaves, agriculture, separation at households) in order to obtain clean compostables.
- Make clear procedures what waste should be in the organic waste bag or mixed waste bag from households and shops. If mixed waste is transported to the composting plant, make sure that hazardous components are collected separately (or with dry waste and sorted out).

4.2.3 Recycling and composting

The present composting plant in Kahrizak

The present composting plant was built between 1994-1996 with a design capacity of 1000 tons per day. The Kahrizak Compost Plant is operated by OWRC and is a large-scale operation receiving approximately 250-300 tons/day of mixed municipal waste over the last years. The plant produces 15-20% of the input (equivalent to 50-60 tons/day) of high quality compost.

One of the main problems is that there is not enough water to spread on the fermenting compost. The waste dries out very quickly and the composting process stops after a short while, resulting in an immature compost which can't be sold at a desirable price. As the composting process is not finished, buyers need to commingle the compost with soil and wait ca. 3 months before using it. The quality of the compost is also reduced because of the amount of broken glass and small metal particles which is due to the use of drum screens.

Much of the input (40-65%) is "rejected" during the sorting process and is disposed of at the Kahrizak Landfill. Another large proportion of the input mass (about 40%) is moisture that evaporates. Chemical testing of the finished products for contaminants (e.g. heavy metals) still has to be carried out.

The plant has high operating costs (equivalent to 18 US$/ton for treatment of input waste, excluding depreciation costs). The expensive compost plant is still justified partly by its ability to reduce demand for precious landfill space at the existing Kahrizak site.

At the moment the outgoing compost at the plant is produced in 3 different qualities. The coarse compost (class III) is sold for about 50 Rials per kg with all it's impurities (like glass, plastic, stones etc.) The class II compost is sold for about 100 – 120 Rials and the class I compost which is the fine compost (less than 10 mm) for around 200 Rials. These composts are usually bought by local farmers who have to store it further on their farm to make it usable (because of the immatureness of the compost). The fine compost is sold to big farmers like pistachio farmers in a special time of the year because of an acute shortage of fertilizers.

Biomechanical composting

A new contract for composting is assigned by OWRC to private company PZA for 1000 tons/day based on forced aeration of shredded mixed waste in heaps. Since august 2004 the biomechanical composting plant is in operation with a capacity of 500-600 tons/day. Preceding 3 years there has been extensive testing of the process. The process of making compost takes 6 months (in future they want to reduce to 3 months by adding bacterial incubators).

The heaps are build up of a coarse finished compost bottom layer of 50 cm, a 1,5 m layer of shredded organic material and a 0,5 m top layer of coarse finished compost. The moisture is caught in the bottom layer and slowly evaporates during the composting process of 6 months. One heap with dimensions of 20 m x 100 m x 2 m (w x l x h) contains 350 tons of organic waste. Circa 50 or 60 heaps are continuously in use, every 2,5 days an old heap is removed and a new one is built. Circa 3 blowers are used per heap. The area required for 1000 tons/day is 50 hectares.

PZA has a contract with OWRC who pays an entrance fee of 2 dollars per ton to deliver the mixed waste from Tehran at the dumpsite of the plant. The total operational costs for the plant are estimated at 2 to 3 dollars per ton.

Main process steps are:

1. Intake procedure
2. hand picking large particles
3. shredding the waste (7 cm), capacity 100 tons/hr
4. handpicking valuables (glass/metals plastic/non-ferrous metals (by private company))
5. spreading on heaps. Covering with coarse finished compost.
6. After six month the compost is sieved in a disc separator (nozzle size 1 cm) and circa 75 tons are removed (some with market value). Then a fine sieve is used (nozzle size 3 or 5 mm) and another 125 tons are removed.

Per 1000 tons of incoming waste, ca. 500 tons evaporates, 300 ton of compost is realised, 50-100 ton is recycled, and 100-150 ton is land filled.

The quality of the compost of the first large scale heaps can be tested in April 2005. There are concerns from the World bank whether the compost will meet the western standards required for agricultural usage. Category I compost is suitable for biological industry, category II for other food industry, category III for parks. It is expected that category III+ can be met.

The potential presence of heavy metals due to batteries can mean that according to western standards the compost is not suitable. There is no legislation in Iran on the composting quality. We advise to set up legislation and a control unit for sold compost, in order to give composting a professional chance as good recyclable product.

Current market for compost is not strong in Iran. There is a potential market for composts if high qualities can be obtained and continuous quantities. It is interesting if the compost is prepared into total solutions by adding fertilizers for specific soils. Market prices are in a range of 7 up to 40 dollars per ton.

Shortfalls and needs for improvement

- The existing composting installation at Kahrizak is not functioning well due to technical problems and water shortage. A clear decision has to be made how to continue with the existing composting plant.
- The potential for upscaling the composting capacity needs to be investigated, up to a quantity of 4000 tons/day. Combining existing facilities with the bio-mechanical approach needs to be investigated.
- Until what year can the bio-mechanical composting plant remain in the current location if Kahrizak Landfill is earmarked as a Carbon Credit area?
- The quality issue of the compost needs to be resolved. A certification system needs to be put in place to classify the usage of the compost.
- The market potential for different qualities of compost has to be further explored.
- The separation strategy will have a great impact on the quality of the compost. If compostable materials can be separated at source (from fruit markets etc), the quality of the compost will improve and different composting methodologies will be required due to the absence of inert materials.

4.3 Dry recyclables

Based on field trips and conversations with members of the Iranian DHV expert team, OWRC representatives, district representatives and World Bank representatives we developed the following characterisation of the activities. An assessment of the market for dry recyclables was conducted in the design phase of the sorting plant at transfer station 15. The results are reported here.

4.3.1 Generation

The total waste volume of dry recyclables can be separated in collection by formal sector and informal sector. Circa 120 tons/day are collected by the formal sector. It is expected that the informal sector collect approximately 500 tons/day (+/- 50%). See figure 2.3.

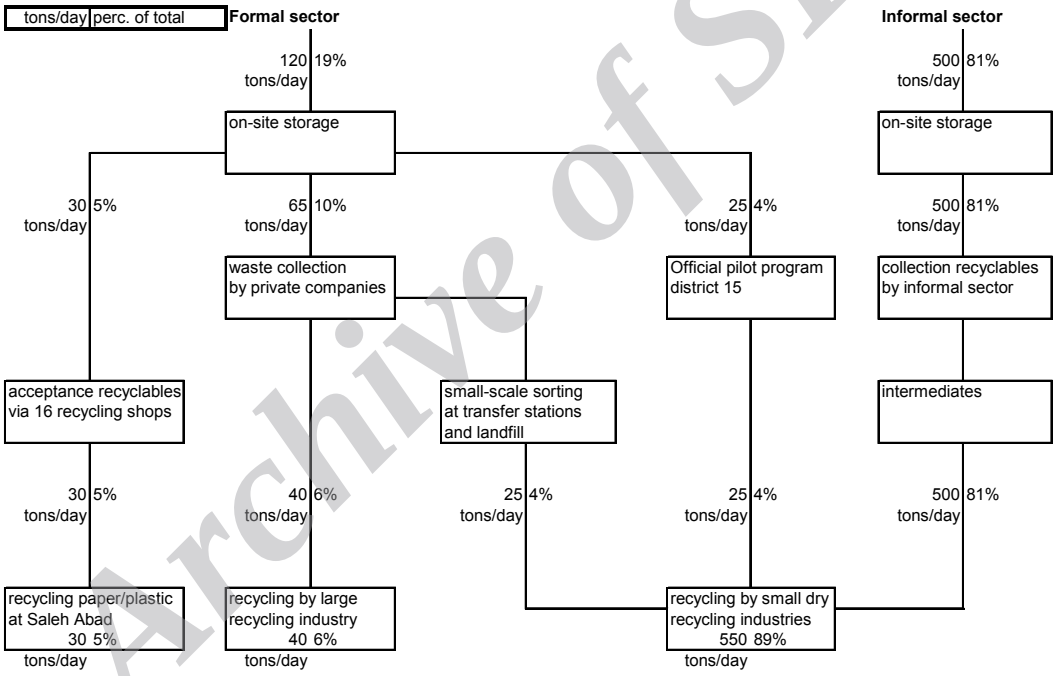


Figure 2.3. General scheme of the dry recyclables waste stream

Circa 30 tons/day is recycled at Saleh Abad and 40 tons/day is recycled by large paper companies (PEKA). Most of the dry recyclables (ca. 550 tons/day) are recycled by small recycling industries in the inner City of Tehran and in surrounding areas of Tehran.
Waste collected by Informal sector is calculated at 500 tons/day, based on 5000 people who collect 100 kg per night (3 lorry-loads) to local informal collection stations. The waste volume and composition is different per district. The high-income districts have a higher value and larger component of dry valuables than the low-income districts. There is also a difference in households and small enterprises. The latter group normally has more paper and cardboard which is disposed of in larger quantities. Most collected valuables are quality paper, plastic PET bottles, metals, cardboard and newspapers.

4.3.2 Collection, transfer and transport

Formal sector
There are economic operators who have an agreement with a district to pick up dry recyclables. Several scheme have existed and still exist in Teheran. The value of contracts that exists in three districts (8, 14 and 20) are in a range of 6-20.000 dollars per month. District 20 is often quoted to have tried out many recycling schemes. Guidelines on how to promote dry recycling have been issued by OWRC to the districts (Mr Navagi). This guidelines need to be translated.

Recycling shops
There are 16 formal recycling shops (waste kiosks) run by OWRC where businesses and households can bring their recyclables (paper, PET) and get some money. The waste is transported to the dry recycling site at Saleh Abad, where small recycling industries are set up: one paper installation for making card board foils, one shredder and PET separator bath for separating green PET and transparent PET from labels and other bottles.

Recycling at transfer stations and landfill
At transfer station 15 and some other transfer stations some handpicking of dry recyclables from the mixed waste is executed in the early morning period. A formal recycling operator would pick out off the garbage from 6 to 9 o clock in the morning, In a period of 3 days he picked out circa 300 kg metal, 1500 kg paper, bread and 20 bales with plastic bags. Circa 6 people are involved in this process.

OWRC undertakes recycling efforts at the landfill. They pick the valuable recycle items out off the garbage. Often it is not the contract holder who actually carries out the work. The contracts are outsourced to other organisations. Mainly paper is collected and valuable plastics. It is not clear how many people are involved in waste recycling at landfill and what waste quantities are recycled.

Informal sector
It is expected that circa 5000-6000 people are active in the dry recycling informal sector. The group is called informal because they are not contracted by OWRC or the districts. Nevertheless a small group of them have official businesses. An example is a company called PEKA that collects waste paper and pays in coupons for buying books (10,000 IR for 20 kg of paper).

It is estimated by OWRC that the total value of separately collected dry recyclable waste by informal collectors is around 200.000 dollars per month.

All informal recyclers are considered as scavengers. Their activities are illegal but often tolerated. They are reducing the volume of waste to be treated by OWRC, but also reduce the income of OWRC. The people involved in scavenging or subcontracting the formal recycling contracts are often t people with the most vulnerable economic condition carry out the work. Afghan refugees or poor Iranian seasonal workers coming in Tehran during the winter often carry out the physical work.

The people are collecting, trading and sometimes buying dry recyclables directly from households and reselling them. Although it is not considered as a prestigious economic activity it is vital source of revenue for many people living in or around Tehran.

High valuable components such as appliances, washing machines, furniture etc are usually picked or bought from households and sold to traders. They are called up by telephone. It is unclear how many of these traders are formal or informal. The size of their business is not known.

4.3.3 Separation of dry recyclables at source

There have been several pilots initiated by OWRC and districts to start up separation of dry recyclables from households and enterprises. Recently a large-scale program on introduction of separation at source has started in all districts of Tehran.

Large scale introduction of separation at source in all of Tehran
In 2004 OWRC initiated together with all 21 districts the introduction of separation at source of dry recyclables. The system is based on two basic elements:
1. night time: mixed waste collection in bags
2. day time: dry recyclables collection in bags

For the collection of dry recyclables they select one contractor per district, who is in charge of a group of formal scavengers. These people get clothes, specific routes, and are registered and trained. They shout or ring a bell. Households open their doors and give their dry bread and dry recyclables (mostly paper, than PET, plastic bottles, glass, metals, wood and fabric).

Each district is implementing the system in its own way. Some use special containers with two compartments (glass, paper) instead of bags. The usage of coloured bags is also an option. The workers go around with manual lorries for small streets and with 3-wheel scooters and pick-up trucks for larger streets. The dry recyclables are transported to a special station for city services, where the waste is sorted out and sold to traders or directly to industries. In total 21-25 stations are required, for each district one (district 20 has 4 stations at the moment)

At the end of 2004 the system is in operation in 16 of all 21 districts. In some districts they started only with main shopping streets and restaurants, in order to collect large volumes of recyclables. OWRC expects at the end of 2004 to retrieve 3 % of all waste by separation at source, this means 150 tons/day assuming 5000 tons/day as domestic household waste (without green from parks, markets, etc).

Expected costs and benefits
The contractor is responsible for public awareness campaigns, collection, transfer and trade. It is his own responsibility to obtain as much as possible valuable recyclables in order to have enough profit. He may choose to give an incentive (money, small gift) to households or not in order to make his business attractive. A contractor will have collection costs of circa 13 dollars/ton and another 7 dollars/ton for manual sorting. In general the district doesn't pay anything and in some districts they even get paid 10.000 dollars per month or 330 dollars/day.

The revenues for dry recyclables are expected to be minimal 80 dollars per tonne, but it can be expected that 20% of collected materials have to be land filled (5 dollars/ton). Looking at an average load of 7 tons per district per day as is assumed by OWRC the costs are 145 dollars/day plus 333 dollars/day for district (not everywhere), and benefits are 480 dollars/day. This is without management and public campaigns. In this case the profit will be negative. It shows that more has to be collected in order to be profitable.

This will help OWRC in meeting their target of collecting at least 10% dry recyclables at source. Since the informal circuit is forbidden, it should be possible to reach at least 5 % or 7 % dry recyclables (now informal sector is estimated at 500 tons/day, already 7 %). Important will be public participation and municipal legislation that subscribes that specific dry recyclables have to be separated in-house and disposed of separately at source.

Recycling Pilot in district 20 (south Tehran)[2]

Separate waste collection started 15 years ago with organising dry brad (for salt) collection and using small pick-up trucks for used electrical appliances through the informal scavenging system. Later, some years ago, a source separation pilot project started in one quarter, at the time planning was from OWRC (managing director was also mayor of district 20). The pilot lasted 7 months. OWRC put contracts for separate dry waste collection in five districts of Tehran including district 20. Criterion for contractor selection was how much they paid for the contract. Contractors started to organise the scavengers (contractor divided in district areas and blocks) to make them use small cars and carts gathering all dry parts to one location per district. Problems arose over the unfamiliarity of the contractors with the areas and the fact they paid little to the scavengers who run into problems and creating competition between contractors and scavengers. This situation could not last and the contracts were cancelled.

The new and current initiative started early 2002. District 20 has 7 areas. Each area has a contract for city services (street cleaning, waste collection, green waste disposal, sludge from gullies removal, etc.). It was decided to have these contractors also collect dry waste. They are not paying the District to be allowed to carry out these services. Starting with one area, other areas followed later. Per area, special collection stations for receipt, sorting, some treatment and transfer were built. The existing informal scavengers per block remained but they are now registered and licensed, trained, provided with a uniform and a three wheel motor cycle cart through a loan. Per area 10-15 NGO members train the public. They themselves are trained by university staff and students. Additionally, brochures and billboards have been made and ‘ceremonies of recycling’ were organised for the public and scavengers (in which prices were drawn on tickets given to people who co-operate in the recyclables collection by filling in questionnaires and handing over recyclables). Special activities with dedicated scavengers are set up for banks, schools and shopping centres (special containers).

Collection from households applies coloured bags, yellow for dry waste, green for wet waste. Black bags are used for hazardous waste such as hospital waste. Yellow bags are not put outside the houses but collected door-to-door handing over some money or sweepstake tickets. Since the collectors are now well-known, the problem of opening doors to collectors by women had been reduced substantially. Types of separate collected dry waste are: metals, plastic, paper,

[2] Waste minimization for Tehran, F. van Woerden, 13 December 2003

glass and dry bread. In high rising building areas scavengers run banks paying money to people bringing waste (scavengers can not go up to collect directly from apartments).

Scavengers have to sell their materials to the contractor for fair prices (if they refuse they can get fired). A supervisor of the District monitors the price mechanism (prices for selling waste materials in Tehran are very transparent for every step in the chain: house to scavenger, scavenger to contractor, etc.). Each area has a contractor representative for recyclable waste collection and a person that manages the scavengers to organise dry waste collection. This manager (called the 'scavenger king') is paid by the contractor on a commission basis. Two district supervisors monitor operations.

According to the District the dry waste problem is now well managed with a keen eye to the social impacts that waste recycling and particularly change in the waste management system can have. The last two months District 20 performs best among Tehran districts in the quality of city services. It is assumed important that organising city services is independent from changes in (political) administration. Dry waste collection generated roughly 100-150 kg per day per block. It is commonly agreed that a collection system in North Tehran (more prosperous) would require a different approach.

Everyone in District 20 is very enthusiastic including the mayor. Relevant to the success is that the concerned manager is both managing the city services contract and solid waste collection and recycling. Most important drive for separate waste collection is the saving of approximately 10 dollars/ton in avoided waste to landfill.

Other recycling pilots

Since 1997, a number of districts started separate collection of dry recyclables. Special containers or baskets were provided to households for this purpose. In the period 1998-99 a massive promotion and education campaign was held in Tehran for 620.000 people (family representatives). The program included (i) information about volumes of waste in Tehran and individual districts and percentages of wet, dry and special waste, (ii) training how to separate wet and dry at source with 2 containers/bag method, (iii) how to transport special waste, (iv) training how to co-operate with the municipality/district. The training methods included: (i) face-to-face by NGO's, (ii) district brochures, (iii) special sessions also house-to-house for women, (iv) training of contractor directors and managers of city service of each district.

Other districts with current activities in dry recycling are 4, 6 and 15 whilst 5 is supposed starting a scheme for dry recycling. As far as we know the pilot at district 4 has stopped. District 4 worked with split waste collection trucks with one compartment for mixed/wet waste in black bags and one for dry waste in yellow bags. The dry waste bags were taken to Saleh Abad and hand-sorted.

Reasons given for stopping separate waste collection and recycling activities are:

- initiatives were not supported by legislation
- OWRC stopped financial support
- Lack of attention (political support) from the central municipal organisation.

Recycling Pilots for separation at source
During a visit in October 2004 to Mr Jahan Beglou of City Services a DHV and world bank representative discussed about the recycling system in district 4.

Over the past 5 years efforts have been made to recycle at source. In the past, 30-40 NGO have undertaken the task of educating the citizens on how to separate waste in dry recyclables and wet remaining waste. The priority was given to tall apartment buildings and schools. These activities have ceased. The collection activities were contracted to a private company that distributed different coloured bags (yellow for dry waste, green for wet waste) and pick up the recyclables. The operator is self-supporting. The operator would give incentives, for example a sewing machine to the local school in return of paper. The quantity of recycled waste was estimated at 1 % of the total waste generated by this district. This took place with 6 trucks and had its own transfer station. The district has only a small budget to spent on recycling (1% of the waste treatment budget). The low status of this type of enterprise refrains other entrepreneurs to join. The district has also undertaken action to recycle paper in offices by distributing recipients. The district also recycles wood from trees.

4.3.4 Dry recycling Industry

Formal or informal recycling schemes will not be economically robust unless stable recycling markets are created in Iran. Currently most dry recycling companies are using small-scale and low-tech processes working in small factories inner-city areas. It is essential to build up a professional recycling industry which can handle large quantities of recyclables and is able to market and sell recycled products and materials at a high and constant quality.

Paper Recycling
A good example of a professional industry is the Waste Paper Recycling Project from Iran Papyrus Co. Iran Papyrus operates 2 paper mills in Tehran (total 20.000 tons/year). A third plant of 15.000 tons/year has started in December 2003. All raw materials are local and imported waste paper plus 3-10% virgin pulp from Russia. The proposed project is to build a new factory to process 75,000 tons/year waste paper in order to produce 60,000 tons/year writing/printing paper. Most equipment has already been purchased 3 years ago (second hand, never used in Iran) from Norway worth 4 million USD and is stored in Tehran. Other operators are also investigating possibilities to recycle waste paper in Iran.

OWRC has offered a site for the project in Saleh Abad: 60-75,000 ton/year waste paper can be provided by OWRC and Saleh Abad has water too. There is a proper facility for waste water treatment and a Kraft water recycling system is included in the project. Papyrus wants to use sorted waste paper (European standards), this is discussed with OWRC. Papyrus is a family business. Option is to start a joint venture with OWRC, where OWRC brings in the site, infrastructure and utilities connection, sells waste paper and shares in profits. Additional investments required amount 7,5 million USD excluding property and equipment already purchased. Papyrus can get commercial loans at 16% interest rate. Papyrus expects to sell its products at 3.8 million USD per year (USD 60 per ton)

Other sectors

The information below was taken out off the existing draft report: Detailed Design and technical specifications Part 1 - Preparatory Report v2.

The DHV team had executed a market study to see the state-of-the-art of the recycling industry in Iran. It is not easy to find relevant data because the recycling industry is not transparent. It is a network of collectors, intermediates, retail shops and small one-room enterprises that make all kind of household products from recycled materials.

An interesting result is presented in figure 3. It shows the potential share of each dry recyclable to the total revenues for recycling.

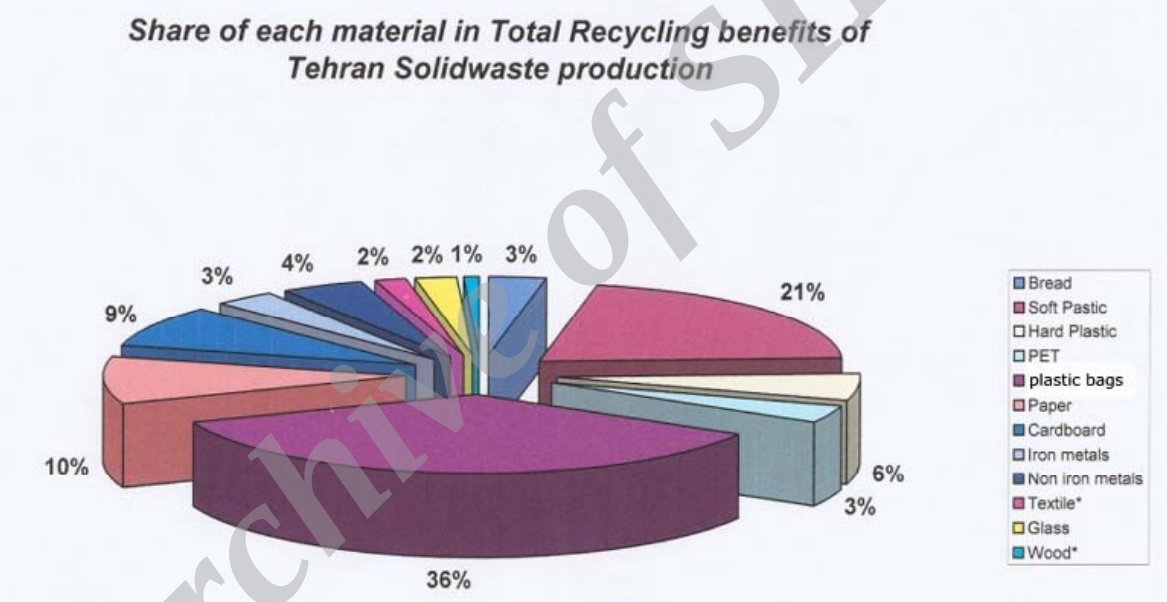


Figure 2.4 - Potential contribution of each waste fraction to the total recycling benefits

From figure 2.4 we can learn that plastic bags (36%) and soft plastics (21%) already contribute to 56 % of the revenues to be gained. Paper and cardboard contribute for another 19 %. It shows that it is important to get these materials in good qualities and large quantities out of the household and industrial waste. Off course these figures are depending on the stability of the market price and on the development of a professional recycling industry that is able to consume a continuous and large volume of recyclables.

An indicative review for 6 main fractions is presented in Table 2.5 and 2.6. It shows there are a lot of data gaps to be filled in the coming years.

Table 2.5 - Market analysis for hard/soft plastic, plastic bags and PET

	hard/soft plastic	**plastic bags**	**PET**
(i) Current market players	5 - 10 large companies, 30-100 small "underground" factories around Kahrizak and on Shour Abad	5 - 10 large companies, 30-100 small underground factories around Kahrizak and on Shour Abad	OWRC and other organisations collect PET and sent this to China
(ii) Important market mechanisms	Formal circuit: Separation at Kahrizak sorting plant. Informal circuit: collection of quality plastics directly from households and sold via intermediates	Formal circuit: Separation at Kahrizak sorting plant. Informal circuit: collection of quality bags directly from households and sold via intermediates	Formal circuit: After collecting by contractors it is picked up by OWRC and sorted and shredded at Saleh Abad
(iii) Total product volumes *	400-800 tons/year	3000-6000 tons/year	1000-2000 tons/year
(iv) Required product qualities	Pure plastic without other materials for making plastic baskets, toys, balls and etc.	From transparent bags they can make new coloured bags, from other coloured bags they make some rough plastic products.	Transparent and green PET have a good value, after shredding it is cleaned and labels are separated.
(v) Price variations (expected, price variations)**	0.26 (+/-0,1) dollars/kg	0.16 (+/- 0,1) dollars/kg	0.14 (+/- 0,05) dollars/kg
(vi) Relations between product prices, quantities and qualities	Large quantities will reduce the price. For this reason we calculate with average prices.	Large quantities will reduce the price. For this reason we calculate with average prices.	Transparent and green PET: good price. Yellow PET: low price. No quantity relation.
(vii) Sensitivity of the market to moderate and large increases in volumes of dry recyclables	Sensitive: we expect that current industries are not ready for large volumes***	Sensitive: we expect that current industries are not ready for large volumes***	Not sensitive, there is a large international market (China). No local market.

* Data gap: rough estimates based on output of Kahrizak x factor 5 to 10 for all of Tehran.

** Data gap: we have taken the daily price as agreed with OWRC as the expected price. Minimum and maximum price are first estimates of expected fluctuations of market prices.

*** Data gap: small factories are not easy to trace and it is not our target group. But large companies prefer using pure plastic resources (mono stream).

Table 2.6 - Market analysis for metal, paper/cardboard and glass

	Metal	Paper/cardboard	Glass
(i) Current market players	Circa 5 large factories in Tehran, 20-30 small factories around Karaj, Saveh road and Khavaran	70 small and large factories located all over Tehran province	3-5 large factories and many small shops
(ii) Important market mechanisms	Collected directly from small industrial factories / attracted from sorting systems in Kahrizak	After collecting by contractors it is picked up by OWRC and sent to Saleh Abad. Citizens can bring their cardboard and paper to 17 shops in Tehran. Newspapers are recycled abroad.	Formal circuit: no real collection or separation. Informal circuit sell via intermediates to small manufacturers for bottles etc.
(iii) Total product volumes (tons/year)*	3500-7000 tons/year	2000-4000 tons/year	3000-6000 tons/year
(iv) Required product qualities	Melt metal and make profiles and bars and cast iron for cover and the steps used inside manholes.	White/office paper: usable for paper industry, but they don't do it yet. Cardboard reused for cardboard industry	Transparent glass: high quality for quality products, coloured glass for bottles etc.
(v) Price variations (minimum-average-maximum)**	0.06 (+/- 0,02) dollars/kg	Quality paper 0,16 (+/1 0,05) US$ /kg Cardboard 0.06 (+/- 0,03) US$ /kg	0.03 (+/- 0,01) dollars/kg
(vi) Relations between product prices, quantities and qualities	We expect no real relations. Large international market.	Quality is important for product price. No relation with quantities.	We expect no real relations.
(vii) Sensitivity of the market to moderate and large increases in volumes of dry recyclables	Half sensitive: depending on the international market price of metals	Not sensitive: because the raw materials are expensive and there is already a big internal market.	Sensitive: industry still has to get used to possibilities with old glass.

* Data gap: rough estimates based on output of Kahrizak x factor 5 to 10 for all of Tehran.
** Data gap: we have taken the daily price as agreed with OWRC as the expected price. Minimum and maximum price are first estimates of expected fluctuations of market prices.

Improvement of dry recyclables industry and private involvement

It is important that OWRC initiates new recycling activities together with commercial entrepreneurs. OWRC should have a fund available to execute basic data studies and start tender procedures. Businesses with own ideas told the consultant that they had to do too much effort to get enough information to make a good proposal, so some of them stopped, came back a few years later, and saw that the same problems (i.e. hospital waste to be incinerated) was not solved.

Data gap

- A clear view on the recycling market is not obtained due to a wide variety of small enterprises without central representatives or supporting organisations.

Shortfalls and needs for improvement

- At districts there are and have been strong initiatives to reduce the amount of waste to disposal. It does not appear recommendable to centralise separate waste collection but to use the local drive and knowledge of districts. Central assistance in the form of providing blueprints for waste recycling schemes etc. seems more appropriate.
- Public awareness and public participation programs should be initiated and implemented in order reach the strategic target of 10 up to 15% of separating dry recyclables at source. It is recommended to work together with a creative agency with good knowledge of marketing of consumer concepts to target groups.
- OWRC and districts should develop a good incentive or penalty scheme either to promote separation of dry recyclables or to promote separation of wet waste. Households need extra motivation to make a long term behaviour change.
- A clear role should be introduced for scavengers, either in collection, sorting and/or selling of dry recyclable products and second hand valuables. They have a social role in every district and have a face-to-face relation with households and shops.
- It should be regulated that offices and industries can sell their recyclable products to commercial private collection and recycling companies (i.e. PEKA).
- A decision has to be made whether hazardous waste is collected with dry recyclables or is collected separately.
- It should be investigated whether extra recycling shops are required, maybe in combination with sorting of collected dry waste. Where is the collected waste being sorting, at 9 transfer stations or at 130 small recycling warehouses?
- The recycling activitities of OWRC in Saleh Abad (plastic chipping, paper production) face operational problems and lack of efficiency. Private sector involvement should be investigated. This would make the management of these operations less sensitive to changes in administrative positions.
- Industrial initiatives should be started on the short term since separation at source has already started on a larger scale. A (procurement) procedure should be developed for the selection of private sector proposals for waste recycling projects. Possibly special funds will be required to support these initiatives.
- Recycling businesses should pick up the opportunities of dry recycling. It is important to find entrepreneurs with a strong incentive to earn money and sell recycled products to specific consumer or business markets. They have a different drive than OWRC who wants to reduce waste for land filling.
- It should be investigated how the Municipality of Tehran can help to promote large-scale usage of recycled products (i.e. compost for parks, recycled paper for public administration, recycled plastic for waste bags). In this way the Municipality can “close the circle” and start a “Tehran-made” recycling campaign.

5 INDUSTRIAL, HEALTH CARE AND DEMOLITION WASTE

5.1 Industrial and hazardous waste

5.1.1 Introduction

The growing need for elimination and reduction of toxic materials from any type of waste in terms of both quantity and toxicity, promotes worldwide awareness of preventive environmental protection strategies and to encourage their adoption by industries.
In the I.R. of Iran, there are still a lot of subject areas yet to be undertaken to identify effective management for environmental protection, especially among industries. Point and non-point sources of pollution from industries are dumped into the soil, rivers and the groundwater everyday. Most of these pollutants have neither been identified, quantitatively or qualitatively, nor have been properly treated before disposal.
Finding the best management practice and to assess the impact of pollution on the environment, reliable records and data, as well as additional information obtained by further researches, are essential. However, the records and data available from different ministries, organizations, institutes and universities are inadequate or sometimes incorrect. Recently, the issue of managing industrial and hazardous wastes has increasingly received attention in the country.

Therefore, the aim of this part of the present study is to report the current situation and major problems of City of Tehran in the generation, collection, transportation, storage, handling, processing and disposal of hazardous and industrial substances and wastes.

5.1.2 Country profile, economy and industries

Iranian economy is heavily depended upon export of oil – 80% of export expenditure, 40 to 50% of government budget is relied upon oil, which is 10 to 20% of Gross Domestic Products (GDP). Iran is the 2nd largest oil producer in OPEC with 2nd largest known oil reserves (8.7% of world total) and 2 largest natural gas reserves (15%) produces 2 largest. Iran is a key state for political stability in the region. Table 3.1 shows historical trends in changing industrial structure in Iran.

	1980	1990	1999	2000	2001
(GDP %)	100.1	91.5	---	101.6	114.1
Agriculture	18.0	23.5	20.9	18.9	19.4
Mining and manufacturing	32.5	28.6	31.2	24.4	26.2
Commercial and services	49.5	47.9	47.9	58.8	54.4

(Source: WB 2001 data)

Table 3.1 - Changes in industrial structure

Tehran is the capital located on the base of Alburz Mountains in northern Iran. Geographic coordination is from 35° 36" N to 35° 44" N, 51° 17" E to 51° 33" E. Elevations are 1,100-m in southern, 1,200-m in central, and 1,700-m in northern part of the city.

Tehran observes relatively distinctive four seasons, summer is hot and while winter is cold. Average yearly temperature is 17 degrees C. Highest temperature recorded to date is 42 degrees C, when the coldest is minus 16 degrees C. Average annual precipitation is approximately 230mm.

Major industries such as oils, petrochemicals, and steel are very active and do have lots of exports. In addition, lots of foods and agriculture products are produced and exported. The share of industries in Iran's GDP is 23.7%, which is lower than industrialized countries. The share of agriculture is 26.9%, oil 18.1%, and others 31.3%. At present, the Ministry of Industry categorizes Iran's major industries as follow:

1	Foods and soft drinks products	630 industries
2	Chemicals and pharmaceutical	592
3	Cellulose, cardboard and paper products	202
4	Textiles and leather products	739
5	Metal products	735
6	Non-metal products	372
7	Electrical and electronics products	115
8	Machines manufacturing	45
9	Automobile, motorcycle and off-road vehicles	10
10	Oil and petrochemical products	?

Table 3.2 - Main industry categories and number of main enterprises per category

There are over 157,000 people employed by the industries in Tehran. The number of industries that employs more than 1000 people is more than 32, with most of the rest employ as low as 10 to as high as 400 workers.

The Great Tehran City is divided in to 21 Districts. Almost 50% of industries, dominantly including Petro-Refinery, army, Power Plant, Food, Processing, Textile, Cement, Pharmaceutical, Chemical, Agri-chemical, Plastics, Machinery and Foundry, are accumulated in this area. Most of these industries are located in highly developed districts, mostly in West, South and East of City of Tehran:

- West Industrial Zone: dominantly containing machinery industries, closed to residential and commercial areas, with a heavy traffic and near to Mehrabad Airport.
- East Industrial Zone: with mostly light industries, there are metal fabrications, woodworking, pharmaceuticals, and industries.
- South Industrial Zone: with individual plants, as well as Tehran Petroleum Refinery Corporation, two Cement Companies and two Power Plants. Leather tanning, stone quarrying, electrical cables and soap factories, are also among the industrial plants active in this zone.

The Department of Environment (DOE) has established standards and regulations to provide guidance on the discharges of waste and effluents to the environment. Significant effort has been made to meet the regulations and standards, which needs to consistently continue.

Generally speaking, the industries in Iran can be divided into three categories:
(1) Highly polluting industries;
(2) Highly unsafe and hazardous industries;
(3) Clean and high-technology industries

The latter group of industries is characterized with high standard of technical equipment and good conditions for solving the environmental problems. Examples of the three industries are:

- Highly polluted industries: slaughter houses, poultry, food processing, packing and canning (meat, fish and chicken), wool and leather, tannery, dyeing, synthetic fibers and paper, and processing of wood.
- Highly unsafe Industries: armament and chemical factories, production of pesticides, and industrial plants with radioactive emissions.
- Clean and High-Technology Industries: alimentary industry, knitting and spinning, fiber production, pharmaceutical industries, refineries, manufacturing of paper, chinaware, iron smelting and processing, glass, and ceramics.

Furthermore, the industries can also be categorized as follows:

- Old industries located inside cities or very close to residential and/or commercial areas. This is considered an undesirable situation. In fact, the government has plans to re-locate these old industries to places outside the cities, which faces a delay due to financial problems. These industries have been causing many environmental problems to the public. The waste is important here so if possible make a general comment on that.
- New industries located outside the cities and sufficiently far from the residential and commercial areas. These industries pose less environmental problems, and the DOE has gained more success in term of meeting the related standards.
- Industries located in industrial complexes of the cities. Furthermore, the fact that many of these industries are located in the cities will compound the seriousness of the problem. As such, more efforts are essay to be undertaken to identify these "New" effluents, which may pose serious threats to the city dwellers living at the vicinity of these industries.

5.1.3 Generation

One of the difficulties encountered in Iran, especially in Tehran, is the identification of the amount of industrial non-hazardous and hazardous wastes generated by different industries and entities. Limited data is available on the types and quantities of hazardous waste generated by industries and other enterprises. This is also due to recycling of mono streams, packaging and emballage within their own boundaries.

Table 3.3 presents a general figure of the types of industries located in Tehran and their industrial wastes that are considered non-hazardous and hazardous. The estimation is based on the International Standards Industrial Classification (ISIC) that is generally applied in Iran.

Type of industry	number of employees	non-hazardous waste (tons/year)	hazardous waste (tons/year)	percentage of hazardous waste (%)
Food and beverage products	19.000	90.000	5.100	5,35%
Chemicals and pharmaceutical	14.500	700 ?	3.100	82,14%
Cardboard and Paper products	4.900	135.000	13.200	8,92%
Textile and leather products	19.600	12.400	1.600	15,17%
Basic Metal and fabricated Metal	25.000	12.000	6.200	33,92%
Non-Metallic products	28.500	23.600	3.100	11,60%
Electrical and electronic products	27.000	86.700	5.600	6,07 %
Oil and petrochemical products	?	?	?	43,75%
Transport & services	11.000	10.000	2.500	19,62%
Others	4.300	?	950	?
TOTAL tons/year (tons/day)	157.000	370.400 (1014)	38,685 (106)	

Table 3.3 - Non-hazardous and hazardous waste estimation based on ISIC for City of Tehran

The non-hazardous waste quantities in table 3.3 are based on quantities of hazardous waste multiplied with percentages of hazardous waste. This might result in an extrapolation that is not secure enough. The quantities obtained are not in line with the number of personnel in each sector. Since oil- and petrochemical waste quantities is not known at this moment (data gap) the total non-hazardous industrial waste generated is estimated at 1500 tons per day. See figure 3.1.

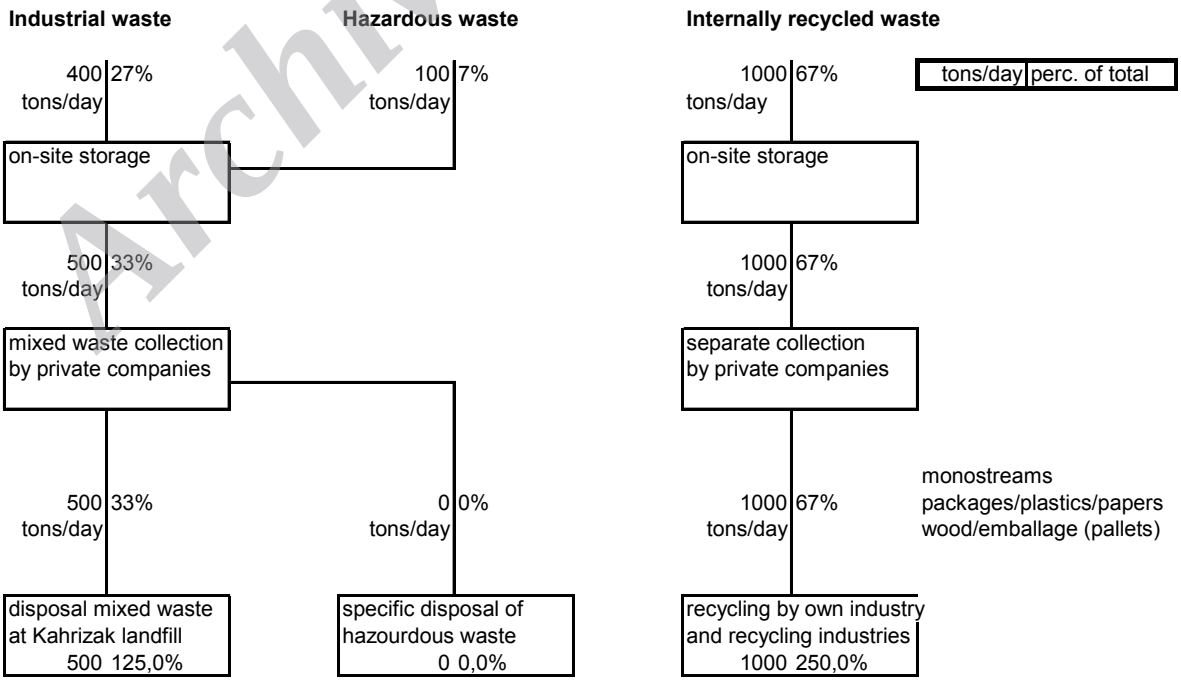


Figure 3.1- General scheme of Industrial waste stream

From the figure we can see that circa 1500 tons of waste is generated every day, 400 tons non-hazardous waste, 100 tons hazardous waste and 1000 tons of recyclable waste. Circa 500 tons per day is send to Kahrizak landfill, the rest is expected to be recycled within industrial boundaries.

5.1.4 Collection, transfer and transport

Non-hazardous waste collection
Depending of the size of industries, the general practices of handing, transport and disposal of hazardous wastes are different. In large industries where their economic conditions are more favourable than small and medium-sized industries, wastes are usually separated and stored for selling to traders. The remaining wastes are then separated, loaded on trucks and sent to landfill site. In other industries that are less interested in selling the usable wastes, these are piled together and send to landfill. Kitchen refuses and wastes from offices of large industries are usually separately collected and sent to landfill site.

Hazardous waste collection
In Tehran, limited number of industries has adopted proper measures for the management of hazardous wastes. Some large-scale industries have started to introduce waste minimization programs recently, and have achieved the reduction of the wastes as well. Not many of them are specifically designed for the above-mentioned wastes, however. This might be due to a general lack of knowledge of hazardous waste compounds.

In general, hazardous and chemical substances such as toxic materials, heavy metals, odorous organic compounds and inflammable products, as well as industrial wastes are not identified nor handled separately. No warning signs are posted on the transportation vehicles and in the plants. Furthermore, the mixing of ordinary industrial wastes with hazardous wastes increases the risk to the people living at the vicinity of the landfills and could have significant adverse environmental impacts. More alarming is the situation that some of the vehicles used for the transportation of hazardous wastes are used for the transportation of other ordinary wastes, as municipal and commercial wastes.

Following three categories from industries or manufactures collects the industrial wastes:
- Large industries/companies: transport directly to landfill site under own responsibility.
- Medium/small industries/companies: accumulate until enough volume, then transported by Motor Pool to Transfer Station and exchange to 20 tons trailers truck hauling to Landfill Site.
- Small entities/workshops/shops: mixed with municipal waste at streetlevel and collected together with household waste.

Moreover, in most cases, different types of wastes are collected by 5 tons truck, pick up trucks or semi-mechanical loading dump trucks. Motor Pool doesn't have special equipment for collection and transferring of industrial hazardous wastes.

5.1.5 Recycling

Recycling of mono stream industrial materials (metals, plastic, wood, paper) and packaging materials (pallets, cardboard, foils) with added value is fully executed by the industry itself. There is no clear view which companies are main players in this recycling field.

5.1.6 Disposal

In Tehran, there is no separate landfill site for the disposal of hazardous wastes. The waste should be collected at special trenches in the Kahrizak landfill site. However, this is normally not executed, since the hazardous waste is mixed with industrial on-hazardous waste when it comes to the landfill. Disposal of these hazardous wastes along with ordinary wastes could increase the level of risk to the people working in the areas, and workers working in their vicinity. The DOE has started a project to designate some areas for the disposal of known hazardous wastes and materials.

Table 3.4 shows total industrial wastes, which were directly disposed from 1999 to 2002 at Kahrizak Landfill Site.

	1999	2000	2001	2002
Industrial wastes (kg)	107,398,704	105,729,745	162,674,205	153,595,575

Table 3.4 - Disposed Industrial Wastes by OWRC at Kahrizak Landfill Site

Shortfalls

In summary, there is a general lack of proper management of hazardous wastes in Tehran. The current status of hazardous waste management in Tehran, including the processing, transportation and disposal, is summarized as follow:

- Hazardous/Industrial waste laws and regulation have recently established. However, the implementation of hazardous/industrial waste management regulations has not been inspected.
- Sources of hazardous/industrial wastes have not been adequately identified and categorized. Nature of these hazardous/industrial wastes and their quantities are yet to be adequately identified.
- Hazardous/Industrial wastes and chemical substances are usually disposed of together with ordinary municipal wastes in landfill sites.
- Hazardous and non-hazardous industrial wastes are often mixed at source and collectedm transported and disposed like municipal waste.
- Ordinary vehicles are often used for transporting hazardous and chemical wastes. Special trucks are required.
- Special marked vehicles are used to carry sludge from absorption pits of industrial areas, but they dispose of along with ordinary municipal wastes in the landfill site.
- Scavengers are looking for useful materials at the Landfill Site, which will increase their exposure to these hazardous/industrial wastes and chemicals substances.
- Unknown quantities of liquid hazardous, industrial and chemical wastes are being dumped in open wastewater channels daily.

Highlights

- About 70% of the waste materials are being recycled or reused by the industry itself which has resulted in the reduction of hazardous/industrial wastes.
- Most large industries and some medium and few small ones have their own waste and waste water treatment facilities. Most sludge from this industrial waste treatment plant is disposed off in municipal landfill site.
- There is still a lack of understanding and concern among managers in Tehran on the treatment of hazardous/industrial wastes from industries.
- Emission from hazardous/industrial wastes to the air is another major source for the air pollution of Tehran.

Needs for improvement

- Industrial waste management systems is a private sector (business to business) development where the public sector involvement is limited to regulation, stimulating, monitoring and enforcement.
- The issue of hazardous/industrial waste management is new to the country, as well as Tehran. DOE has initiated special programs for the promotion and implementation of hazardous/industrial wastes regulation in different enterprise. This should be further developed and fully implemented.
- Data to reflect the situation of industrial and hazardous waste related to environmental problems in Tehran should be further monitored and evaluated.
- Laws and regulations for hazardous/industrial waste management needs to be drafted and enacted and should be disseminated to each industry.
- Effort should be enhanced to design proper procedures and standardised methods and means for the handing, collection, transportation, and disposal of hazardous, industrial and chemical wastes.

5.2 Healthcare waste

Tehran generates 70 ton/day of waste traceable to one of the 310 major health facilities. Circa 40 % can be classified as risk waste. Health facilities are responsible for the adequate separation and collection and storage of their waste. The waste is transported by Motor Pool to mainly the landfill site at Kahrizak for disposal as mixed waste (10 tons/day) and hazardous waste (50 tons/day). A small fraction is treated in special auto-clave installations and small incinerations plants.

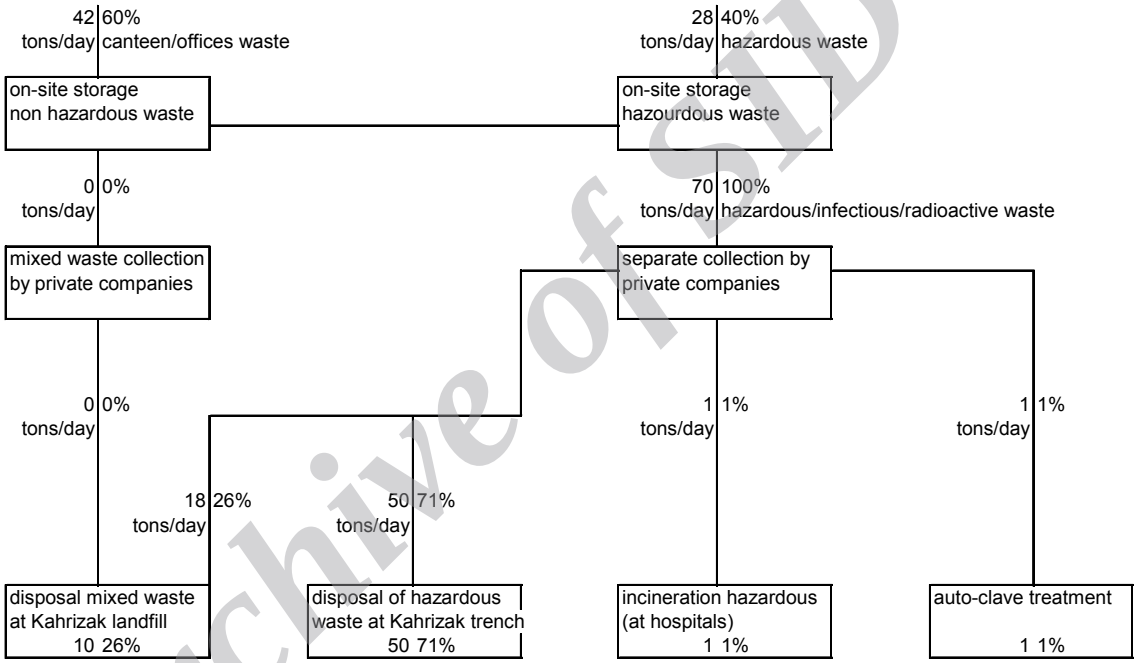


Figure 3.2- General scheme of Health Care waste stream

5.2.1 Generation

The Iran Ministry of Health defines Health Care or Medical Wastes as follows:

- A Infectious Wastes: Suspicious infected wastes: EG, physical/chemical culture materials, wastes discharged from isolation wards, tissues, wipe-off closes, tools & materials that contacted with infectious patients, secretions, human structures & liquids, body parts, blood & other liquids, fetus.
- B sharp wastes (needles, etc): needles, infectious tools & equipment, scuffles, knives, Lattices, broken glass and utensils.
- C medicines & chemicals Wastes, expired or no plan to use medicines, test and analysis reagents, film developers, expired or no plan to use disinfectants, others includes chemical wastes
- D semi-general wastes: non-risk infectious or general waste used in healthcare mostly same types as domestic hazardous wastes

The volumes of health care waste generated in Tehran over the past five years average 25,000 tons/year. The Municipality estimates that there were 20,350 active beds in Tehran in 2003, and that average healthcare waste production rates ranged from 2.5 to 3.0 kg/bed/day. This value is approximately two to three times higher than average healthcare waste production rates in other cities in the MNA Region, such as Cairo and Beirut, where generation rates are in the order of 1.3 and 1.1 kg/bed/day, respectively.

Year	1999	2000	2001	2002	2003
Amount of HCW disposed at Kahrizak [tone]	20,130	20,642	21,901	24,140	26,160
Percent increase in HCW disposed from previous year [%]	---	2.5	6.1	10.2	8.4

Source: Tehran OWRC

Table 3.6 - Health Care Waste generation in Tehran from 1999-2003

Over 60% of the waste collected at healthcare facilities is wrongly classified as risk waste. Data shows that approximately 70 tons/day of mixed healthcare waste are currently being collected from healthcare facilities in Tehran and being disposed at the Kahrizak landfill as risk waste. However, only a fraction of that volume is actually risk waste, while the remaining part has a composition similar to that of municipal waste. World Health Organization (WHO) estimates for developing countries that if waste produced in healthcare facilities is correctly separated, approximately 10% - 25% of it is risk waste and 75% - 90% is non-risk waste.

Type of waste	Percentage [%]
Compostable materials (from kitchen and garden)	45.8
Used dressings, injection needles	38.3
Household waste, administration waste	6.71
Others like cans, plaster, glass, ceramic	5.38
Others like old bread	3.32
Organs, amputated body parts	0.40
Old drugs and left over drugs	0.40
Chemical waste (*i.e.* laboratory waste)	0.02

Source: BC Berlin (1997)

Table 3.7 - Composition of hospital waste in Tehran (1995)

5.2.2 Separation in medical centres

- Healthcare facilities follow national guidelines for waste separation. Based on the field survey carried out in April 2004 for this Policy Note k[3], during which a total of 248 healthcare facilities were visited, 77.4% of the facilities are separating their wastes according to the national guidelines. Approximately 11.3% of the facilities surveyed did not follow separation procedures, and no definite answers were obtained from the remaining 11.3%.
- For separation at source a three-bin separation system is being used, in which risk waste is disposed of in yellow bags and general mixed waste is disposed of in black bags. Containers of risk waste are clearly labeled. Needles and sharps are being deposited in different types of rigid containers. Personnel at almost 86% of the facilities visited confirmed having received training on healthcare waste disposal practices and to follow MOHTME guidelines for waste management. Illustrated copies of the guidelines are typically posted in supply rooms or around waste containers. When asked if personnel were generally satisfied with the level of waste separation achieved at the facility, 70% of the staff answered affirmatively.
- Waste storage rooms are the weak point at healthcare facilities. Field visits to healthcare facilities showed that, for the most part, healthcare waste is being separated by floor staff and that guidelines are followed with minimum satisfactory separation performance (see Annex 5). However, there is generally a poor performance at the centralized waste storage rooms, which show significant variability between the different facilities. Separate waste bags are transported from the various hospital wards to the storage facility, where they are, in theory, stored in plastic bins. Yellow bags should be collected in yellow bins, while black bags should be put in blue bins. Approximately 66% of the hospitals visited claimed to be following adequate waste storage procedures, but this was not consistent with the conditions observed in some of the storage rooms surveyed. In many facilities, yellow and black bags were found mixed in both types of bins, along with boxes, oversized objects, and others. Bins are very often broken, their lids are missing, and do not look clean. Collection bins were typically insufficient, and as a result waste bags were seen scattered around the floors of storage rooms, particularly prior to collection time. Supervision of waste separation practices inside the hospital, in the different units, is typically carried out by nurses, who are widely recognized by the floor staff. In many of the hospitals surveyed, visits to the waste storage rooms were not allowed, and it was not always clear who supervised storage room operations.
- Well-trained managers are critical to performance in healthcare facilities. The field survey clearly identified that the performances in facilities did not depend on the type of hospitals (e.g. public versus private) or on their location within the city (e.g. wealthier district versus poorer areas), but rather good performance is directly related to the type of management in a facility. In those facilities where waste services were supervised by professionals with training or background in waste-related issues, healthcare waste management was typically satisfactory. Whereas in other facilities where managers have only general medical backgrounds and training, waste management performance was usually inadequate. In

[3] ISLAMIC REPUBLIC OF IRAN MANAGEMENT OF HEALTHCARE WASTE POLICY NOTE FINAL DRAFT – June 30, 2004 Water, Environment, Social and Rural Development Department Middle East and North Africa Region Section 2.4

general, healthcare waste management in most of the small clinics and laboratories was found to be of high quality.

5.2.3 Collection, transport and disposal

The Municipality of Tehran is organizing the operations for collection, transport and final disposal at a sanitary landfill. Collection and transport is delegated to Motor Pool. Motor Pull does not have the capacity to transport the waste separately in appropriate trucks. Motor Pool is partially privatized.

- Collection takes place daily during day hours, when trucks pick up the separated waste from healthcare facilities. However, both municipal and healthcare wastes are collected simultaneously in the same trucks. Fifty people are involved in the providing the service, including drivers and operators. The fleet used to collect healthcare waste is owned by the Motor Pool and consists of 25 trucks with capacities ranging from 1.5 to 8.5 tons. The number of vehicles is not sufficient to provide the service efficiently. A total of 18 collection routes have been set up to service the 22 districts of the city. Some collection vehicles are forced to go to the landfill more than once every day, in order to cover all of the stops in each route. As the age of collection vehicles ranges from 5 to 25 years, the trucks are in continuous need of servicing and a significant amount of the Motor Pool's resources are used to maintain the trucks.
- The system of separate waste collection of infectious and non-infectious waste is no longer functioning in the Municipality of Tehran. The collapse of the system, according to the Motor Pool, took place around the year 2000, because healthcare facilities were incorrectly separating their waste. Since existing waste separation guidelines were not being adequately followed, all waste generated by healthcare facilities is currently being collected in the same truck, and it is all disposed of as healthcare waste. Due of the presence of wet waste in the healthcare waste collection trucks, considerable amounts of leachate are generated, and only the larger trucks are equipped with leachate collection containers. Some larger trucks are also equipped with waste compactors. Although in principle compaction of healthcare waste collection is not permitted, it occurs often in larger trucks, further aggravating the leachate generation and leakage problem. Conversely, when healthcare waste is collected in smaller trucks, the leachate generated during transport spills out on the streets.
- Healthcare facilities sign contracts with the municipal agency for waste collection. Although the collection of general municipal waste is a daily service provided by the Municipality to the population of Tehran at no cost, healthcare facilities pay a fee for collection and disposal of their healthcare waste. Still, healthcare facilities are, in principle, not charged for the collection and disposal of their municipal waste. Healthcare facilities sign a contract with the Motor Pool for the collection of their risk waste, and payments are made directly. Collection fees are a function of the volume of healthcare waste collected, which is determined by the number of plastic bins picked up at each facility. The capacity of the different types of bins handled at the various facilities, and the respective cost of their collection is summarized in Table 3.8. Every day, at a specified time, operators of collection trucks load all storage bins in the storage area of the healthcare facility, under the supervision of a staff member. A log is kept of the number of bins collected per facility per day, and at the end of the month the Motor Pool charges each facility for the total number of bins collected.

Volume of bin [liter]	Cost of bin [Rial]	Typical mass of full bin [kg]	Cost of collection	
			[Rial/bin]	[US$/bin]
120	70,000	10-20	5,500	0.67
300	180,000 (Plastic) 260,000 (Fiberglass)	30 - 40	6,900	0.84
700	600,000	100 - 200	14,500	1.77

Table 3.8 - Characteristics of healthcare waste disposal containers and collection costs (Tehran)

- Cost-recovery for healthcare waste management services is below 50%. Monthly costs to the Motor Pool for providing the healthcare waste collection service are approximately US$130,000 per month. Fees collected from healthcare facilities only cover approximately 50% of the cost of the service. Healthcare facilities are frequently late with payments, and therefore, on average, payments only cover 25-30% of the service costs. The situation is becoming increasingly serious, as the costs of collection increase approximately by 15% every year and healthcare facilities are having progressively more difficulties in paying for the service.

5.2.4 Disposal

- Collection trucks transport the waste to Kahrizak, are weighted at the gate, and directed to the disposal location. The Motor Pool pays OWRC a gate fee of 14,500 Rials/ton (US$1.8/ton) for healthcare waste deposited in the landfill.
- The system of separate collection and disposal of healthcare waste is designed for separate healthcare cells excavated in a specific area of the landfill site. The design is individual unlined pits of 10m x 5m x10m that are excavated in rows. Healthcare waste is designed to be disposed of in the pits, which should be covered daily with lime and soil.
- During 2003-2004, landfill capacity reached critical levels and there was no additional room to excavate the specialized healthcare waste pits at the site. Waste collected from healthcare facilities was discarded along with ordinary municipal waste. Recently in mid-2004, in the specialized healthcare cells are being used again.

Current legal development

The World Bank has kicked off a process from beginning of 2004 to make an inventory of the hospital waste care practices in Iran. Tehran has been studied extensively as a preparation of a policy note issued by the World bank[4]. According to the *national policy note* on management of healthcare waste the joint treatment of infectious waste with general waste in Tehran is causing great concern regarding public health. At national level the policy note recommends to identify and learn from Iranian best practices. Stimulate best practices through pilot projects. Set up quality performance indicators to monitor progress. Focus on basic management systems to collect and dispose of infectious waste separately. Municipalities should gradually charge the real treatment costs to hospitals whist improving their services.

[4] Management of Health Care Waste Policy Note– June 30 2004 Worldbank - Water, Environment, Social and Rural Development Department - Middle East and North Africa Region

The policy note was issued and discussed with the representatives in Tehran on the 14 th of October 2004. A pilot project was proposed. At the time of writing funding was thought for phase zero of the pilot project. In this phase the collecting and transport is being mapped out. The objective is to better separate the infectious from the regular waste. After which the best treatment can be chosen. In the *land field preparation study*[5]. several options are proposed such as new land field cells, autoclave treatment systems and incineration.

The current situation is an environmental and public health liability uncontrolled contamination risked waste such as infectious is possible. A more detailed description of the current situation can be found in appendix 2.

Shortfalls and needs for improvement

- A main concern is the saturation of the capacity of the existing landfill at Kahrizak and the management of infectious medical waste.
- National and local government agencies have developed coherent and functional systems of separation at the source in healthcare facilities, and of collection and disposal of healthcare waste by municipality. Yet, over the past few years, several factors have contributed to the progressive deterioration of the system at all levels.
- The institutional responsibilities for the management of healthcare waste are currently shared between: (a) Ministry of Health, Treatment and Medical Education (MOHTME); (b) Department of Environment (DOE); and (c) the municipal governments. In the current structure the roles and responsibilities of the different government agencies are unclear, and no agency has overall control of healthcare waste management. This lack of leadership results in an absence of management priorities, lack of enforcement of guidelines, and undefined performance standards for efficiency and quality. The leadership role usually falls on municipal governments, who provide the specialized collection and disposal services for risk healthcare waste, as well as all the services for general household waste management.
- National guidelines developed by the MOHTME for the management of healthcare waste are applied. Significant efforts have been made by the MOHTME, universities, and Municipality to train healthcare staff in waste separation procedures. In spite of existing guidelines and training, the efficiency of waste separation procedures varies widely between facilities. On an aggregated basis, the performance of the overall system needs to improve, as waste generation rates in Tehran City is two to three times greater than those for comparable cities in the MNA Region.
- A survey of healthcare facilities conducted in Tehran shows that performance depends, to a large extent, on the knowledge level and daily 'hands-on' involvement of the facility's management. The handling of healthcare waste in facilities where managers have received specialized training for healthcare waste management was typically better than that in facilities managed by medical professionals.
- Separate collection and disposal system is progressively deteriorating in various cities around the country. The fleet of collection trucks typically has insufficient capacity for the

[5] Tehran Solid Waste Management Project Landfill Preparation Study, Annex to Part 2 – Design of Hospital Waste Cell , BC Berlin, aug 2004

needs of the healthcare facilities in each municipality, and the age of vehicles calls for constant maintenance. Moreover the separate designated locations at local landfills for the disposal of healthcare waste are often at or over capacity. As a result, the healthcare waste being collected is mixed with municipal solid waste for general disposal, rather than in separate designated disposal areas.

- Despite of practicing waste separation in Tehran City, workers in healthcare facilities are aware that healthcare waste is typically being collected and disposed mixed with municipal waste. Increasing the efficiency of waste separation procedures at healthcare facilities is thus difficult to promote, at present, since healthcare staff are not motivated by the performance of the overall system and feel that additional efforts to further separate waste would be in vain.
- Cost recovery fees charged by municipality to healthcare facilities are consistently insufficient to recover the associated operation costs. Current fees do not cover the costs of (i) operational and maintenance costs for the collection fleet, (ii) payment of tipping fees (also called gate fees) and (iii) depreciation on the collection equipment. Municipality is thus currently subsidizing healthcare waste collection and disposal, with cost-recovery rate around 40%.
- Municipal budget allocations for collection and disposal services of healthcare waste are not sufficient to sustain an adequate level of performance. Given the growing trend of urbanization in the IRI, an increasing strain continues to be placed on existing solid waste equipment and infrastructure, and the performance of healthcare waste service providers is significantly affected.
- Healthcare facilities pay municipality monthly fees only for the collection of their special waste, and are not charged for the collection of their non-special waste. The monthly fee, which is proportional to the volume of healthcare waste picked up, has not increased significantly over the past decade. This is leading to even less financial incentive to reduce the amount of special waste generated by each healthcare facility, as the fee level is already low and is not close to a full cost recovery level.
- The quality of healthcare waste management services in Tehran City is deteriorating by both the generators and the service providers. Making improvements to the existing system will involve improving the quality of collection and disposal services, as well as that of separation of healthcare waste at the source.
- Healthcare waste management is the responsibility of the health sector (Ministry of Health and other parties). Further elaboration on collection methods and treatment (centralized versus local auto-clave treatment and/or incineration) is subject for further study to the Ministry of Health.

5.3 Construction and demolition waste

5.3.1 Generation

According to OWRC[6], about 8.76 million tons per year or 24.000 tons per day of construction and demolition (CDW) waste is generated in Tehran. Most is directly transported to Ab Ali disposal site. This includes spoiled soil resulting from excavation works as well as demolition waste collected in mixed form by private sector contractors. The contractors are controlled by Office of cleanness of Tehran (supervised by OWRC).

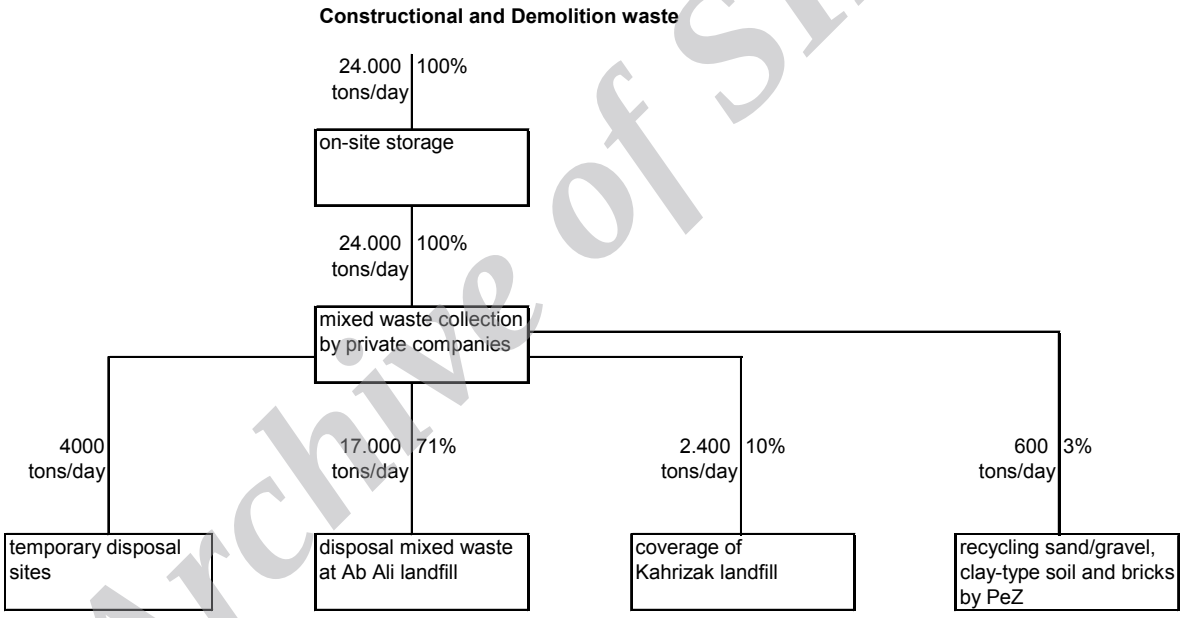


Figure 3.3- General scheme of Construction and Demolition waste stream

Generally about 60% to 80% of the CDW is transported to Ab Ali disposal site. In figure 3.4 the total tonnage is shown that is disposed to 7 locations in spring 2004. From this figure we can see that 70 % is disposed at Ab Ali, 3,7% at Kahrizak, 0,4 % at Ordib, 2,8 % at Tello, 0,1 % at Navab, 21% at Boroojerdi and 2,9 % at Shaheed Rajaee. Part of CDW is used as daily cover at Kahrizak landfill, the amount of which depends upon the request of Kahrizak landfill operator. A small part (circa 600 tons/day) is recycled by PeZ, the operator of Ab Ali.

[6] History of Ab Ali Waste Disposal Site, OWRC, Deputy of Research and Training, 2002

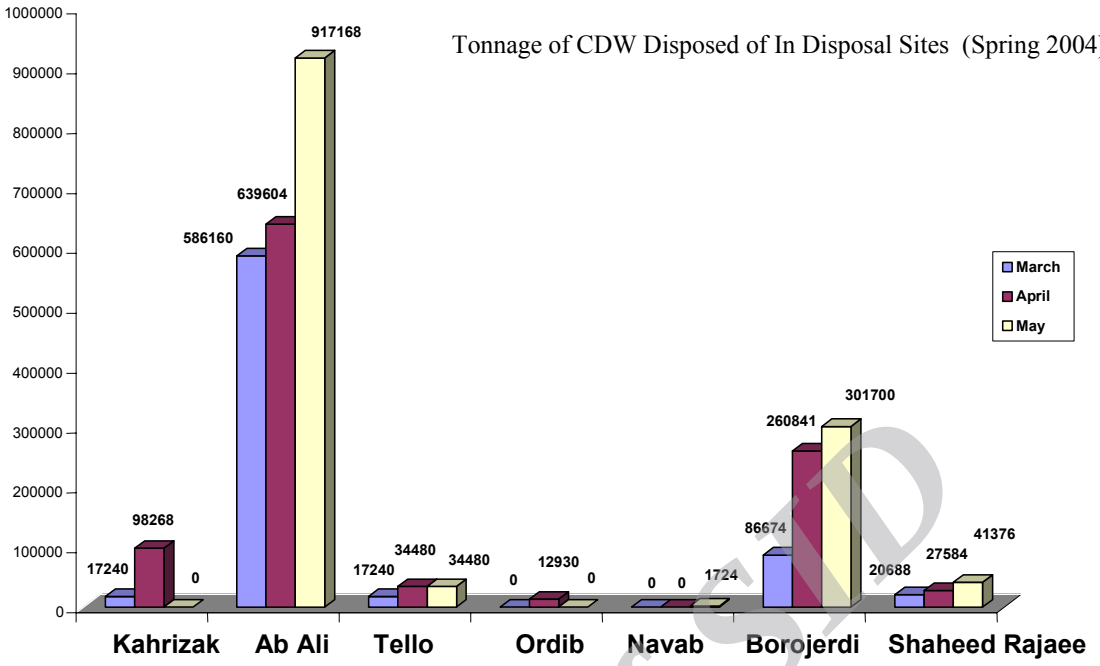


Figure 3.4- Construction and Demolition waste stream to several disposal sites

5.3.2 Collection, transfer and transport

The construction and demolition waste is mostly transported directly from construction sites to the landfill. Districts collect small quantities of household demolition waste and transfer this via the transfer stations to the landfill. According to OWRC circa 2.800 flat trucks are entering the landfill sites every day, which means an average truckload of 8,6 tons and circa 350 trucks per hour.

5.3.3 Recycling

It is worth noting that since 1999 operation of a sand and gravel producing factory named Hoveyzeh was started with a capacity of 600 tons per day.
PeZ is the company that currently processes the recycling factory and the CDW dumpsite(s).

PeZ identifies for marketing purposes three categories of products: (1) sand and gravel for construction application, (2) clay-type soil to be sold in agriculture, (3) concrete, bricks, asphalt, mosaics etc. Currently there is a market for categories 1 and 2 and these products are produced from screening soil material extracted from construction sites. The material that is normally called CDW is difficult to bring to market and mostly dumped. There is supervision at the site entrance to divert truck loads with 'clean' materials to the PeZ screening location. Additionally, PeZ operates a concrete plant. PeZ is fully private, rents the site from OWRC and has started its business without paying OWRC gate fees for the first 5 (or 7) years of operation. PeZ is looking for loans for further investments to streamline, extend and modernize their operations. A commercial loan would take 28% of interest with a maximum of 3-5 years.

5.3.4 Disposal

The Ab Ali site was used as the final disposal site for municipal waste generated in Tehran until 1990. After closure of this disposal site because of the problems associated with the generated leachate discharge to the nearby river (Jadj Rood River) which resulted in death of a considerable number of salmon fish, the site was used for only construction and demolition wastes being dumped over the previously disposed MSW.

Datagap
- It is currently unclear what is the remaining capacity of Ab Ali and other disposal sites.
- The number of truck services seems high: 350 trucks per hour is a large number of truckloads.

Shortfalls
- Ab Ali disposal site has become a heap of soil and construction debris which makes it difficult and unsafe for the drivers to operate in terms of high slopes (about 5% to 6%) and insufficient lighting at night time.
- Another important problem at this site is that the overburden pressure of the disposed CDW on the previously dumped MSW can increase the risk of accidents associated with the leachate and gas already generated.

Needs for improvement
- Modification of legislation and construction standards is deemed necessary to improve the share of recycled materials in construction works.
- Review whether all CDW landfill sites are necessary or only locations Ab Ali and Boroojerdi are sufficient. There are a lot of smaller sites that hardly receive any construction and demolition waste: Kahrizak, Ordib, Tello, Navab, and Shaheed Rajaee.
- Further elaboration on CDW recycling activities.

6 COLOPHON

Client :

Organisation of Waste Recycling and Composting

Project	:	Baseline review of Solid Waste Management chain
File	:	X8114 01 001
Length of report	:	119 pages
Authors	:	G. Erens, G. Simonis, P. Rupert, E. Safari, P. Henneman
Contributions	:	T.Aryan, I. Allahdadi, P. Moghimi, M. Riyahi, A. Salour, A. Barati
Project Manager	:	G. Simonis
Project Director	:	J. Kool
Date	:	19 November 2004
Name/Initials	:	JKo

APPENDIX 1 WASTE CHARACTERISTICS

Table I - Average waste composition in all districts in Tehran (summer 2003)

district / waste type	22	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Average
wet waste	61,7	76,56	50,82	76,91	58,14	78,54	81,09	74,59	79,52	64,64	60,15	60,84	63,44	60,04	71,00	71,75	65,75	64,1	60,26	69,26	75,19	**67,82**
bread	0,66	0,37	1,5	0,2	0,28	0,79	0,25	0,19	0,18	1,25	1,08	2,72	1,41	1,94	1,74	0,91	1,13	0,95	1,31	1,39	0,42	**0,98**
soft plastic	2,48	3,61	5,2	0,99	1,88	1,30	1,82	1,86	0,19	4,14	2,87	2,34	1,94	1,43	1,55	2,36	3,17	1,35	2,10	2,23	0,73	**2,17**
hard plastic	2,13	0,07	0,86	0,03	2,55	0,18	0,03	0,00	0,20	1,97	2,23	0,38	0,23	0,18	0,08	0,10	0,10	0,12	0,33	0,39	0,10	**0,58**
P E T	0,43	0,91	1,98	0,52	1,06	0,63	0,39	0,39	0,14	0,61	0,53	0,55	1,04	0,57	0,41	0,80	0,60	0,40	1,08	1,03	0,86	**0,71**
plastic bag	5,73	5,07	6,21	6,26	7,96	5,85	4,91	8,73	8,45	4,32	5,77	5,14	7,27	6,65	3,87	5,10	6,39	8,30	5,57	5,45	6,08	**6,15**
paper	3,43	1,75	3,01	4,37	5,11	3,14	1,11	1,80	1,26	4,29	6,12	5,43	7,30	7,12	5,49	6,47	5,50	4,60	6,64	4,90	3,74	**4,41**
cardboard	6,4	3,22	4,08	2	2,64	2,00	2,20	3,45	3,23	5,94	5,40	3,58	4,20	5,31	3,57	2,79	2,98	4,53	7,78	2,06	0,81	**3,72**
ferrous metals	0,81	2,95	4,47	1,1	1,22	0,00	1,89	1,93	1,62	1,36	0,96	1,56	1,89	1,74	1,13	0,90	1,39	1,22	2,39	0,95	1,00	**1,55**
non-ferrous metals	0,17	0	0	0,07	0,32	0,00	1,10	0,00	0,03	0,06	0,10	0,20	0,31	0,11	0,36	0,14	0,52	0,03	0,27	0,11	0,28	**0,20**
fabric	4,35	0,69	8,9	2,49	6,57	4,02	2,72	3,09	1,14	3,19	5,08	4,48	3,58	3,64	2,18	2,56	3,80	3,06	2,39	3,18	0,85	**3,43**
glass	3,89	2,66	4,81	1,23	1,92	1,20	0,48	1,79	1,76	3,01	2,26	4,74	2,54	2,46	2,01	1,12	2,49	1,57	1,66	3,69	3,15	**2,40**
wood	1,1	0,53	1,91	0	1,49	0,99	1,00	0,82	1,71	2,20	3,83	3,82	0,82	4,23	2,14	0,98	0,92	0,76	3,35	0,45	1,73	**1,66**
Tires	2,31	0,26	0,64	0,19	0,19	0,00	0,34	0,00	0,02	0,00	0,48	0,38	0,23	1,37	0,34	0,42	1,56	3,42	1,36	0,21	1,26	**0,71**
leather	0,17	0,56	3,54	0,21	1,31	0,66	0,06	0,26	0,13	0,14	1,22	1,53	0,30	0,49	0,16	0,29	0,77	0,28	0,14	0,12	0,61	**0,62**
dust&rubble(rest)	0,4	0,11	0,74	1,45	5,51	0,00	0,19	0,24	0,10	0,75	0,43	1,62	1,30	0,66	1,52	1,70	0,26	3,58	2,55	1,66	1,65	**1,26**
special waste	3,83	0,68	1,32	1,97	1,83	0,70	0,40	0,86	0,32	2,12	1,49	0,69	2,20	2,06	2,42	1,61	2,67	1,73	0,82	2,92	1,54	**1,63**
total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	**100**

Table II - Seasonal fluctuations in waste composition in Tehran

	Month	Bread	Wet waste	Soft plastic	Plastic bags	Hard plastic	Paper	Card board	Ferrous Metals	Non-ferrous	Fabric	Glass	Wood	Dust & Soil	Tires	Hazardous waste	Leather	Rest
Spring	20Mar-19Apr	1.06	67.17	1.86	7.32	0.07	3.48	5.11	1.63	0.04	3.28	1.97	1.24	3.18	0.31	1.64	0.51	0.13
	20Apr-20May	0.83	69.40	1.54	6.63	0.11	3.19	4.11	1.56	0.06	3.10	1.74	2.69	2.92	0.27	1.45	0.41	0.00
	21May-20Jun	0.92	68.70	1.81	3.43	0.14	4.23	4.31	1.81	0.07	3.71	1.97	2.04	3.81	0.32	1.67	0.39	0.67
Summer	21Jun-21Jul	1.14	69.87	1.67	3.48	0.10	5.13	3.44	1.80	0.09	3.45	2.01	1.72	3.30	0.39	1.59	0.48	0.35
	22Jul-21Aug	1.21	68.46	2.35	3.93	0.17	5.48	3.80	1.79	0.08	3.30	1.95	1.95	3.45	0.38	1.28	0.31	0.09
	22Agu-21Sep	1.37	69.99	1.71	4.25	0.08	4.83	3.76	1.59	0.06	2.93	1.93	1.47	3.39	0.65	1.63	0.35	0.00
Fall	22Sep-21Oct	1.46	70.12	1.72	4.59	0.07	5.18	4.76	1.24	0.06	2.98	1.89	1.38	2.60	0.18	1.65	0.13	0.00
	22Oct-20Nov	1.41	69.25	1.49	4.48	0.05	4.82	4.67	1.07	0.04	3.08	1.91	0.80	3.12	0.26	1.72	1.85	0.00
	21Nov-20Dec	1.83	71.95	1.66	4.38	0.04	5.27	4.48	1.31	0.04	2.13	1.63	0.64	2.04	0.50	1.70	0.38	0.03
Winter	21Dec-19Jan	2.06	70.52	1.56	4.80	0.04	5.52	5.00	1.42	0.04	2.68	1.97	0.58	1.62	0.16	1.81	0.26	0.00
	20Jan-18Feb	2.37	70.92	1.50	4.72	0.03	5.25	5.23	1.54	0.02	2.52	1.80	0.64	1.39	0.09	1.96	0.20	0.00
	19Feb-20Mar	2.10	69.53	1.77	4.27	0.04	5.93	5.46	1.69	0.02	2.78	1.86	0.56	1.61	0.48	1.78	0.19	0.00
	Average	1.48	69.66	1.72	4.69	0.08	4.86	4.51	1.54	0.05	2.99	1.89	1.29	2.70	0.33	1.66	0.45	0.11

Table III - Seasonal fluctuations in waste composition in Tehran

	Month	Bread	Wet waste	Soft plastic	Plastic bags	Hard plastic	Paper	Card board	Ferrous Metals	Non-ferrous	Fabric	Glass	Wood	Dust & Soil	Tires	Hazardous waste	Leather	Rest
Spring	20Mar-19Apr	1.06	67.17	1.86	7.32	0.07	3.48	5.11	1.63	0.04	3.28	1.97	1.24	3.18	0.31	1.64	0.51	0.13
	20Apr-20May	0.83	69.40	1.54	6.63	0.11	3.19	4.11	1.56	0.06	3.10	1.74	2.69	2.92	0.27	1.45	0.41	0.00
	21May-20Jun	0.92	68.70	1.81	3.43	0.14	4.23	4.31	1.81	0.07	3.71	1.97	2.04	3.81	0.32	1.67	0.39	0.67
Summer	21Jun-21Jul	1.14	69.87	1.67	3.48	0.10	5.13	3.44	1.80	0.09	3.45	2.01	1.72	3.30	0.39	1.59	0.48	0.35
	22Jul-21Aug	1.21	68.46	2.35	3.93	0.17	5.48	3.80	1.79	0.08	3.30	1.95	1.95	3.45	0.38	1.28	0.31	0.09
	22Agu-21Sep	1.37	69.99	1.71	4.25	0.08	4.83	3.76	1.59	0.06	2.93	1.93	1.47	3.39	0.65	1.63	0.35	0.00
Fall	22Sep-21Oct	1.46	70.12	1.72	4.59	0.07	5.18	4.76	1.24	0.06	2.98	1.89	1.38	2.60	0.18	1.65	0.13	0.00
	22Oct-20Nov	1.41	69.25	1.49	4.48	0.05	4.82	4.67	1.07	0.04	3.08	1.91	0.80	3.12	0.26	1.72	1.85	0.00
	21Nov-20Dec	1.83	71.95	1.66	4.38	0.04	5.27	4.48	1.31	0.04	2.13	1.63	0.64	2.04	0.50	1.70	0.38	0.03
Winter	21Dec-19Jan	2.06	70.52	1.56	4.80	0.04	5.52	5.00	1.42	0.04	2.68	1.97	0.58	1.62	0.16	1.81	0.26	0.00
	20Jan-18Feb	2.37	70.92	1.50	4.72	0.03	5.25	5.23	1.54	0.02	2.52	1.80	0.64	1.39	0.09	1.96	0.20	0.00
	19Feb-20Mar	2.10	69.53	1.77	4.27	0.04	5.93	5.46	1.69	0.02	2.78	1.86	0.56	1.61	0.48	1.78	0.19	0.00
	Average	1.48	69.66	1.72	4.69	0.08	4.86	4.51	1.54	0.05	2.99	1.89	1.29	2.70	0.33	1.66	0.45	0.11

Table IV - Seasonal fluctuation of waste quantity in Tehran (kilograms/month from march 1999-march 2000)

District	20Mar-19Apr	20Apr-20May	21May-20Jun	21Jun-21Jul	22Jul-21Aug	22Agu-21Sep	22Sep-21Oct	22Oct-20Nov	21Nov-20Dec	21Dec-19Jan	20Jan-18Feb	19Feb-20Mar	total in 1 year
district 1	8101370	9863140	9310250	9221470	9543090	9263650	8900650	9422370	9544600	8343850	9091550	9600060	110206050
district 2	10111950	11824090	10891990	10483210	10721840	10948540	11000790	11248720	10541330	10265150	10050280	11378140	129466030
district 3	13437850	13524270	11794100	12916360	13062040	12293170	11763900	11532900	10984590	10483710	10150680	11555720	143499290
district 4	18980430	19375450	19562790	20612530	18760870	24346090	23034510	20454110	19257330	19926060	17726940	18094530	240131640
district 5	9014470	10084160	9996640	10173930	10606030	11148830	12064330	12287980	11872480	10920260	10762600	12351980	131283690
district 6	7235975	9193785	8512790	6918980	8441612	7811209	8027120	9452300	8355100	8533260	9697685	7907500	100087316
district 7	8388140	8381460	5929040	5458080	5499940	5496460	5423420	5568130	5345670	4911020	4757820	5410000	70569180
district 8	7244400	8752880	8930800	8571470	8894610	8660940	8691940	8896590	8646100	8205770	8063710	9322870	102882080
district 9	6441270	7856870	7678590	7647140	7579490	7438650	7734050	8163420	7562210	7413520	7064960	8083080	90663250
district 10	5907970	6819230	7399260	7539880	7488260	6743130	6977830	7414870	6517920	6499100	5626170	7000140	81933760
district 11	5611510	6872180	6467632	6514105	6807445	6687505	6821055	7007120	6062880	5959610	6306920	6975715	78093677
district 12	6955285	7952260	8124088	9303990	8826653	11942196	9876255	8147140	7976880	7323380	7980835	9059935	103468897
district 13	6446770	6387170	6532840	5797260	6723020	6931060	6527130	6430000	6378180	6219330	6095290	7483160	77951210
district 14	6731990	7898835	7497660	7570850	7821900	7596850	7276120	7549800	7006150	6746500	6462950	8214040	88373645
district 15	10813600	12730995	12844000	12377930	13690340	13510455	13557575	13704285	12449270	11745450	11551720	12470980	151446600
district 16	6061840	6675564	6701291	7151350	7562390	7867645	8377250	7182405	6900080	6524075	6362400	7129250	84495540
district 17	5747040	6898340	7277660	6938010	7848850	7061550	8021020	8141370	9187350	8421250	9759550	11314710	96616700
district 18	4828000	5715220	6011870	5752310	6350350	6256350	6070000	6277380	5998690	4775520	4966050	6479310	69481050
district 19	5543950	4408326	4874789	4342310	4470860	3915605	4132170	4148005	4186960	4593845	4838570	6335400	55790790
district 20	6155990	6764530	6482560	6665680	6865810	6691550	6615990	7022220	6220980	5713360	5280090	6135880	76614640
Sum	159759800	177978755	172820640	171956845	177565400	182611435	180893105	180051115	170994750	163524020	162596770	182302400	2083055035

Table V - Number of traffic and quantity of discharged wastes in semi-trailer from different distinct in March 2004 (Farvardin 1383).

Waste weight (kg)	Traffic No.	Distinct	Transfer stations
8526120	6444	1	Darabad transfer station (1)
2137030	1140	3	
10663150	**7584**	**Total**	
12320865	8136	2	Zanjan transfer station (2)
3379320	2882	10	
15700185	**11018**	**Total**	
3404770	3353	3	Jahan-e-kodak transfer station (3)
3404770	**3353**	**Total**	
15705725	11841	4	Hakimieh transfer station (4)
15705725	**11841**	**Total**	
11212000	6504	5	Chitgar transfer station (5)
3066750	2026	9	
1394670	791	22	
15673420	**9321**	**Total**	
7696240	7651	6	Beihaghi transfer station (6)
6660385	6838	7	
3622805	2617	3	
17979430	**17106**	**Total**	
3954840	3290	4	Bany hashem transfer statio (6)
3954840	**3290**	**Total**	
4885471	4054	11	Shosh transfer station (12)
6909609	7705	12	
11795080	**11795**	**Total**	
4591370	3145	14	Azadegan transfer station (15)
11122330	9401	15	
4617310	3306	13	
20331010	**15952**	**Total**	
3267200	2032	9	Jadeh saveh transfer station (18)
4239650	3179	17	
5901190	3845	18	
1467410	1002	10	
14875450	**10058**	**Total**	
5851730	3791	16	transfer station (19)
5005075	3959	19	
10856805	**7750**	**Total**	
7522770	6091	20	Shahid aviny transfer station (20)
7522770	**6091**	**Total**	

Table VI - Number of traffic and quantity of discharged wastes in semi-trailer from different distinct in April 2004 (Ordibehesht 1383).

Waste weight (kg)	Traffic No.	Distinct	Transfer Stations
10149420	6924	1	Darabad Transfer Station (1)
2587260	1455	3	
12736680	**8379**	**Total**	
14881265	8876	2	Zanjan Transfer Station (2)
3940530	2930	10	
51395	44	3	
18873190	**11850**	**Total**	
1804708	1824	3	Jahan-e-kodak Transfer Station (3)
1804708	**1824**	**Total**	
19475390	13331	4	Hakimieh Transfer Station (4)
19475390	**13331**	**Total**	
13180210	7334	5	Chitgar Transfer Station (5)
3813810	2291	9	
1543560	778	22	
18537580	**10403**	**Total**	
9580707	9060	6	Beihaghi Transfer Station (6)
8111875	7400	7	
5851179	4464	3	
23543671	**20924**	**Total**	
4448520	3232	4	Bany hashem Transfer Station (6)
4448520	**3232**	**Total**	
5460225	4469	11	Shoosh Transfer Station (12)
9725395	10205	12	
15185620	**14674**	**Total**	
5939410	3467	14	Azadegan Transfer Station (15)
14154160	10730	15	
5109050	3326	13	
25202620	**17523**	**Total**	
3774760	2175	9	Jadeh saveh Transfer Station (18)
5271730	3480	17	
7102860	4509	18	
1782660	1029	10	
17932010	**11193**	**Total**	
6784795	4232	16	Transfer Station (19)
5875280	4249	19	
12660075	**8481**	Total	
9129470	6973	20	Shahid aviny Transfer Station (20)
9129470	6973	**Total**	

Table VII - Number of traffic and quantity of discharged wastes in semi-trailer from different distinct in May 2004 (Khordad 1383).

Waste weight (kg)	Traffic No.	Distinct	Transfer Stations
9820450	6948	1	Darabad Transfer Station (1)
2109420	1376	3	
11929870	**8324**	**Total**	
14356775	9033	2	Zanjan Transfer Station (2)
3592960	2925	10	
145940	75	3	
18095675	**12033**	**Total**	
17571515	12919	4	Hakimieh Transfer Station (4)
17571515	**12919**	**Total**	
12370700	7143	5	Chitgar Transfer Station (5)
3477960	2194	9	
1406840	867	22	
17255500	**10204**	**Total**	
9125695	9056	6	Beihaghi Transfer Station (6)
7508275	7046	7	
7324220	6180	3	
23958190	**22282**	**Total**	
3993998	3080	4	Banyhashem Transfer Station (7)
3993998	**3080**	**Total**	
4203980	3726	11	Shoosh Transfer Station (12)
8948060	9863	12	
13152040	**13589**	**Total**	
5404695	3442	14	Azadegan Transfer Station (15)
12741070	10178	15	
4752590	3329	13	
22898355	**16946**	**Total**	
3459550	2210	9	Jadeh saveh Transfer Station (18)
4986460	3581	17	
6725960	2858	18	
1572310	936	10	
16744280	**9576**	**Total**	
640200	4183	16	Transfer Station (19)
5774030	4247	19	
12176830	**8430**	**Total**	
8293430	6680	20	Shahid aviny Transfer Station (20)
8293430	6680	Total	

Table VIII - Number of traffic and quantity of discharged wastes in Transfer Stations from Industrial Cities in March 2004 (Farvardin 1383).

Waste Quantity (kg)	**Traffic No.**	Transfer Station
1145130	532	Darabad 1
51425	45	Zangan 2
534545	375	Gahan koodak 3
930540	221	Hakimeh 4
61875	120	Bany hashem 7
1322940	640	Chitgar 5
316630	323	Beyhaghy 6
171370	176	Shosh 12
843030	445	Azadegan 19
629910	220	Jadeh saveh 18
2385880	1793	Estgah 19
55710	30	Estgah 20
8448985	**4920**	**Total**

Table IX - Discharged waste from distinct and other Industrial Centers to Kahrizak Landfill Site in Spring (kg).

Total	**May**	**April**	Mars	**Distinct**
27442926	9549112	9878705	8015109	1
40900420	13901804	14635838	12362778	2
29100865	9071453	10131951	8897461	3
80019536	22907725	25023180	22088631	4
43977735	14992831	16186398	12798506	5
29061418	10108002	10451983	8501433	6
23013324	78599*64	8228528	6924832	7
24323180	8202120	8837600	7283460	8
23701869	8040957	8620198	7040714	9
29556822	9685385	10506668	9364769	10
20603340	7035305	7104962	6163073	11
29240506	10989226	10868150	7383130	12
17592081	5772047	6253433	5566601	13
29632086	9772925	11140730	8718431	14
52850076	18082637	19413472	15353967	15
21392621	7186356	7479097	6727168	16
26010528	8585063	9467042	7958423	17
22558672	7702367	8075032	6781273	18
16490145	5624580	5867096	4998469	19
32111093	10451004	11735923	9924166	20
4413191	1438372	1574026	1400793	22 m
612992434	206959235	221780012	184253187	City Distincts
6417940	**2315350**	**2361130**	**1741460**	**Hospital**
14855856	13803535	15604968	12447353	City (others)
3851230	1385840	1482470	982920	Industries
154880	56650	62240	35990	Pharmaceutical Wastes
665272340	**224520610**	**241290820**	**199460910**	**Total**

Table X - Statistics of transferred waste to Kahrizak Landfill Site during Mars 2004 (Farvardin 1383)

Different centers			Type of vehicle			Type of wastes			Place of discharge		
Type of waste		Properties	Type of waste		Properties	Type of waste		Properties	Type of waste		Properties
Weight (kg)	Traffic		Weight (kg)	Traffic		Weight (kg)	Traffic		Weight (kg)	Traffic	
166505070	9439	Stations	159699240	8479	Semi-trailer	160297470	8974	House hold waste	3797900	182	Kahrizak compost plant
26165870	4257	Distinct	1691030	360	Closed surface	1741460	550	Hospital waste	1742140	552	Hospital waste landfill site
4372830	1401	Organizations	1062980	223	Ghaltan?	5161000	703	Sewage	16720	101	Dog body landfill site
1018910	260	Factories	22693360	5285	RuBaz Tak?	3830260	464	Demolish	21110	9	Industrial waste landfill site
1398230	535	Others	14314300	1545	RuBaz Joft?	249390	78	Cut wood waste	171624630	13148	Hossein-Abad
199460910	15892	Total	199460910	15892	Total	28181330	5123	Others	22258410	1900	Trench No.64
						199460910	15892	Total	199460910	15892	Total
									6434223	513	Daily average discharged to Kahrizak

Table XI - Statistics of recycled materials in 2000 tons Compost Plant and Karco (kg), March 2004 (Farvardin 1383)

Compost	Drag	Foam	PET	Nylon	Sac	Iron Pack	Carton	Bone	Paper	Glass	Plastic	Dry bread	Wood	Process entrance	Total entrance	Place of discharge
332460	2392990	12360	9140	39850	840	43170	3750	785	16420	3110	4700	185	0	1269115	3797900	2000 tons C. P.
0	5670	0	4320	3690	420	5400	0	0	10090	910	820	440	690	0	21110	Industrial separation
332460	2398660	12360	13460	43540	1260	48570	3570	785	29510	4020	5520	2290	690	1269115	3819010	Total

Table XII - Statistics of recycled materials in 2000 tons Compost Plant and Karco (kg), April 2004 (Odibehesht 1383)

Compost	Drug	Foam	PET	Nylon	Ion pack	Carton	Bone	Paper	Glass	Plastic	Dry bread	Wood	Process discharged	Total discharged	Place of discharge
5530	4239250	27420	12840	92510	105630	2800	4215	35340	12460	19150	2480	0	4259605	8813700	2000 ton factory
0	0	0	0	0	0	0	0	590	0	0	0	690	17780	19060	Industrial separation
5530	4239250	27420	12840	92510	105630	2800	4215	35930	12460	19150	2480	690	4277385	8832760	Total

Table XIII - Statistics of recycled materials in 2000 tons Compost Plant and Karco (kg), May 2004 (Khordad 1383)

Compost	Drug	Foam	PET	Nylon	Iron pack	Carton	Bone	Paper	Glass	Plastic	Dry bread	Wood	Process discharged	Total discharged	Place of discharge
26740	4473190	31670	24670	76450	91190	1610	2525	43210	12930	25630	2830	2360	3797965	8586230	2000 ton factory
331400	162650	0	795	0	0	0	0	0	0	0	0	0	324095	487540	Carco
0	2310	0	8150	6850	6850	0	0	3320	4130	6230	0	1000	0	0	Disposal center sep.
0	0	0	410	790	790	0	0	1280	0	0	260	500	84510	93620	Industrial separation
358140	4638150	31670	34025	84090	84090	1610	2525	47810	17060	31860	3090	3860	4206570	9167390	Total

Table XIV - Statistics of discharged waste to Kahrizak Landfill Site during April 2004 (Ordibehesht 83)

Different centers			Type of vehicle			Type of wastes			Place of discharge		
Type of waste		Properties	Type of waste		Properties	Type of waste		Properties	Type of waste		Properties
Weight (kg)	Traffic		Weight (kg)	Traffic		Weight (kg)	Traffic		Weight (kg)	Traffic	
20110920	10811	Stations	192558640	9648	Semi-trailer	195266390	10321	House hold waste	8813700	405	Kahrizak compost plant
32313610	5257	Distinct	2270210	431	Closed surface	2361130	633	Hospital waste	2361800	636	Hospital waste landfill site
5713240	1598	Organizations	1584370	369	Ghaltan?	5232810	707	Sewage	91550	221	Dog body landfill site
1544710	401	Factories	27725090	6450	RuBaz Tak?	1002940	113	Demolish	19060	10	Industrial waste landfill site
1608340	639	Others	17152510	1808	RuBaz Joft?	336550	110	Cut wood waste	16235000	1204	Hossein-Abad
241290820	18706	Total	241290820	18706	Total	37091000	6822	Others	15462790	1271	Trench No.65
						241290820	18706	Total	16317330	1241	Trench No.58
									181989590	13718	Trench No.64
									241290820	18706	Total
									7783575	603	Daily average discharged to Kahrizak

Table XV - Statistics of discharged waste to Kahrizak Landfill Site during May 2004 (Khordad 83)

Different centers			Type of vehicle			Type of wastes			Place of discharge		
Type of waste		Properties	Type of waste		Properties	Type of waste		Properties	Type of waste		Properties
Weight (kg)	Traffic		Weight (kg)	Traffic		Weight (kg)	Traffic		Weight (kg)	Traffic	
185052710	10175	Stations	181142510	9472	Semi-trailer	181710140	9892	House hold waste	8586230	393	Kahrizak compost plant
31591460	5536	Distinct	1954050	417	Closed surface	2315350	650	Hospital waste	2315350	650	Hospital waste landfill site
5156000	1541	Organizations	1616140	362	Ghaltan?	4065210	657	Sewage	27370	198	Dog body landfill site
1442490	399	Factories	25351230	6366	RuBaz Tak?	2836920	398	Demolish	93620	50	Industrial waste landfill site
1277950	595	Others	14456680	1629	RuBaz Joft?	713380	203	Cut wood waste	487540	23	Hossein-Abad
224520610	18246	Total	224520610	18246	Total	32879610	6446	Others	204178570	16217	Trench No.64
						224520610	18246	Total	8831930	715	Trench No.58
									224520610	18246	Total
									7242600	589	Daily average discharged in Kahrizak

APPENDIX 2 REPORT ON HEALTH CARE WASTE

Healthcare Waste Management

in Tehran City

Current situation - regulations

By: Dr. Iraj Allahdadi

November 2004

CURRENT INSTITUTIONAL PERFORMANCE

- National guidelines delegate implementation to healthcare facilities and municipality
- There is an overall lack of clarity concerning institutional responsibilities

The three major central government stakeholders. The current Government structure for the management of healthcare waste in medium-to-large cities in the IRI is schematically shown in Figure 1. At the central level of the governmental administration, three major agencies are involved in issuing guidelines related to healthcare waste management: (i) Ministry of Health, Treatment and Medical Education (ii) Ministry of Interior, and (iii) Department of Environment.

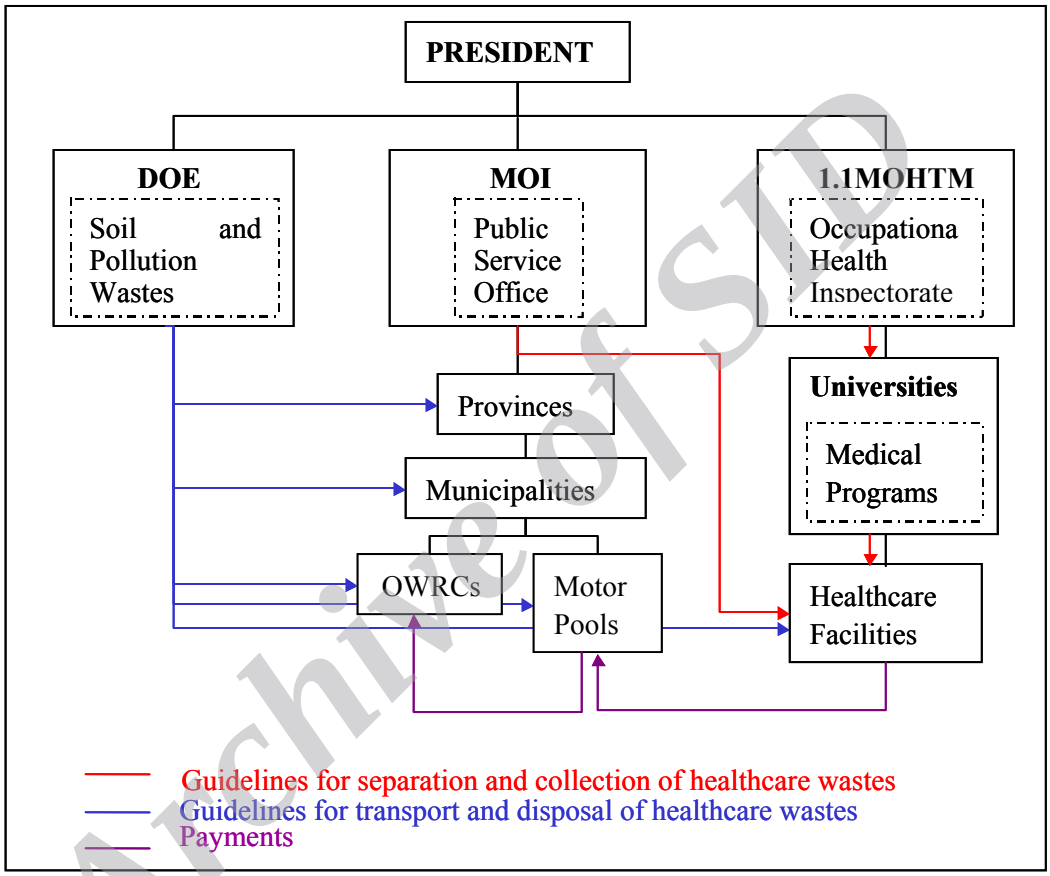


Figure 1. Current Government structure for healthcare waste management in medium-to- large cities

Ministry of Health, Treatment and Medical Education (MOHTME) is responsible for: (a) developing general guidelines for the handling, separation and collection of healthcare wastes for all facilities in the country; and (b) ensuring that all healthcare facilities follow these guidelines. The supervision of healthcare facilities is carried out through the medical universities who administer the Medical Programs, which in turn manage public healthcare facilities. The universities also oversee private health facilities. The specific guidelines for separation and storage of healthcare waste that apply to municipality are developed jointly between medical programs of the Municipality and MOHTME, based on the baseline guidelines issued by MOHTME.

Ministry of Interior (MOI) supervises and coordinates all provincial and municipal public authorities, which in turn are responsible of ensuring that procedures for the management of healthcare waste are consistently implemented.

Department of Environment (DOE) – While the MOHTME is responsible for limiting all incidents involving exposure or contamination by healthcare wastes within healthcare facilities, DOE's responsibility is to avoid any human and environmental impacts that could result outside healthcare facilities. DOE thus supervises and regulates issues related to healthcare waste treatment (including potential emissions from treatment performed by healthcare facilities), transport and disposal.

National Guidelines for Healthcare Waste Management

- In 1990-1991 the Occupational Health Inspectorate at the MOHTME developed the first set of national guidelines for the management of healthcare wastes, referred to as the National Hospital Infectious Waste Collection Plan. The National Plan provides a set of general guidelines for separation and disposal of waste at healthcare facilities, which were developed on the basis of World Health Organization (WHO) guidelines. Healthcare facilities are required to follow the guidelines concerning separation and storage, while the responsibilities of municipality consist in putting in place systems for the transport and disposal of healthcare wastes. Current MOHTME guidelines include the following:

Solid waste materials shall be collected in strong, black garbage bags, kept in a washable blue bin, collected and disposed of with municipal solid waste

Sharps shall be collected in special boxes and disposed of together with other dangerous wastes

Dangerous wastes shall be collected in strong, yellow garbage bags and kept in a washable and disinfected yellow bin, transported by the Municipality to the landfill and buried in special trenches, covered by lime powder

Radioactive wastes shall be collected separately, under the supervision of relevant personnel in charge of radiation hygiene. Waste shall be kept and disposed according to local rules

Cut limbs and organs (or disjointed parts of body and/or aborted fetuses) shall be collected separately, carried to a local cemetery and buried there according to local customs

Transport of hospital waste, especially infectious waste, must take place in special vehicles marked "infectious waste".

- Guidelines for separation and storage of healthcare waste that apply to each specific municipality are developed jointly between representatives from the MOHTME and members of Medical Programs from the municipality, on the basis of national MOHTME guidelines. The Municipality of Tehran, for instance, has three medical programs, housed at the University of Tehran, University of Iran and Shahid Beheshti University. All healthcare facilities are affiliated to one of the universities, where affiliation is determined by the geographical location of the facilities relative to that of the universities.
- Universities act as inspectors of the MOHTME, and regularly visit healthcare facilities to ensure that guidelines and procedures are being followed. Training of healthcare facility personnel is also conducted under the supervision of the university to which each specific hospital is affiliated.
- In 2003, MOI issued a second set of guidelines for the management of healthcare waste, which included improved procedures for separation, collection, transport and disposal. While the guidelines for waste separation and handling in healthcare facilities are consistent to those issued by the MOHTME, more detail is provided in relation to transport and disposal. The existence of these guidelines is largely unknown in the healthcare waste management sector, and their implementation is not currently being enforced. The complete guidelines are

included in Annex 2, but a number of articles, of relevance to the issues that will follow, are listed below:

Article 5 – Municipalities can charge fees to healthcare facilities for the provision of collection and disposal services of their waste.

Article 8 – Hospitals are allowed to operate incinerators, according to DOE standards, for the disposal of their healthcare waste and that of other hospitals. A contract must exist between hospitals.

Article 9 – All healthcare facilities should contract the services of a responsible waste collector for transport of their wastes to the final disposal destination.

Article 10 – Operators of waste collection trucks must ensure that leachate from the waste is not leaking onto the streets during transport.

Article 11 – Municipalities should dispose of healthcare waste in specified areas, separately from the disposal of municipal waste

Article 14 – Healthcare facilities should supervise the implementation of the guidelines.

- Healthcare facilities are responsible for the sound management of their waste. Healthcare facilities are required to follow MOHTME guidelines for separation and storage of healthcare waste. Hospital managers are responsible of ensuring that all healthcare waste management guidelines are followed in their facilities. University Medical Programs supervise the management and operation of all public and private hospitals, as well as all other healthcare facilities, and are thus responsible of ensuring that procedures are in accord with regulations from the MOHTME.

- Municipality is responsible for providing waste collection, transport and disposal services. The services provided by municipality under the MOHTME guidelines are different from city to city. In Tehran, separate agencies are exclusively dedicated to manage all types of solid waste:

Motor Pools – Motor Pools are municipal agencies that own the fleet of vehicles used for the provision of municipal services, including waste collection vehicles. Motor Pools often collect municipal solid waste, including healthcare waste. In the larger cities, Motor Pools are being progressively privatized, and now rent vehicles to the private sector rather than operating vehicles directly.

Organizations for Waste Materials Recycling and Composting (OWRC) – This municipal agency is primarily responsible for general household wastes, in particular the transfer, transport and disposal at landfills and compost plants. OWRC also support the modernization of waste management services through training, research and coordination of initiatives for separation and recycling of general household wastes

DOE regulates municipal collection, transport and disposal of healthcare waste. DOE has issued guidelines that address the handling and disposal of hazardous and special materials. Regional representatives from DOE conduct inspections of municipal vehicles and of the unloading at disposal sites, to ensure that operations are being conducted according to the guidelines. DOE may fine municipality if services are not in compliance with regulations. DOE also regularly monitors healthcare waste collection operations in the larger cities, in an effort to control illegal recycling of healthcare waste material (Table 4).

Table 4. Summary of articles in Waste management law of relevance to healthcare waste management

Type	Description	**Responsible Government Agency**	**Relevant Article**
National Guidelines	Provision of standards for quality and sanitation of recyclable materials, as well as for their authorized use.	Standard and Industrial Research Institute with the cooperation of the MOHTME	Article 3
	Adoption appropriate policies for recycling and disposal of wastes in accordance with: i) waste reduction regulations; ii) recycling policies and regulations; and iii) fees charged for recycling and disposal activities.	Waste generators	Article 4
	Develop plans for separation, recycling and disposal of ordinary wastes	MOI, DOE	Article 9
	Compilation of standards and methods for waste management, to be presented for approval by High Council of Environment Protection.	DOE *in cooperation with* MOHTME (medical waste[1]), Ministry of Mines and Industries, Ministry of Power and Ministry of Oil (industrial and mine wastes), and Ministry of Agricultural Jihad (agricultural wastes)	Article 11
National Implementation	Management of all wastes, excluding industrial and special wastes[2], within cities, villages and their borders.	Municipalities and rural governing	Article 7
	Development of instructions for organizing wastes management framework in municipalities, counties, and rural districts governing bodies	MOI	Article 10
	Supervision of implementation approved methods and standards for waste management.	DOE with cooperation from relevant Ministries, including MOHTME	Article 11
	Determination of adequate sites for waste disposal	MOI *with the help of* DOE and M. Agriculture	Article 12
	Development of Executive by-laws to waste management law, which will address ordinary and special residues	MOI, DOE, MOHTME, MOMines and Industries, MOAgricultural Jehad	Article 23
	Supervision and execution of waste management law	DOE	Article 24
Specific HCW Regulations	Managers are responsible for following the standards and regulations of the MOHTME, to provide healthy and safe working environments to personnel under their supervision	MOHTME	Article 5
	Mixing of medical waste[1] with other waste, its sale, use or recycling is prohibited	Enforced by DOE	Article 13
	Exports of residues will comply with guidelines of Basel Convention		Article 14

Type	Description	**Responsible Government Agency**	**Relevant Article**
	Parties responsible of contamination due to poor handling of wastes are required to stop polluting activities, to remove the source of pollution and to clean up environment		Article 18
Financing and penalties	Waste generators may be charged fees that cover the costs of waste management service provision. Tariff levels shall be set in accordance with instructions of the Ministry of Interior, determined by Islamic Councils	MOI, Islamic Councils	Article 8
	Storage, mixing, transportation, sale and purchase, disposal, exports and discharges of wastes in environment that do not comply with specific regulations will be subject to financial penalties	Enforced by DOE	Article 16
	Courts mandate extent of damage compensation to all parties affected by pollution caused by inadequate handling of waste	Enforced by DOE	Article 19

(1) Medical waste is defined as all infectious and harmful residues generated by hospitals, health and treatment centers, medical laboratories and other similar centers. Other harmless healthcare wastes are not included.
(2) Medical, hazardous industrial and agricultural residues are referred to as special wastes.

GUIDELINES FOR THE MANAGEMENT OF HEALTHCARE WASTE MINISTRY OF HEALTH, TREATMENT AND MEDICAL EDUCATION

Medical waste separation guidelines

The National Hospital Infectious Waste Collection Plan, developed by the MOHME, provides the following guidelines for separation and disposal of waste at healthcare facilities:

- Solid waste materials shall be collected in strong, black garbage bags, kept in a washable blue tank, collected and disposed of with municipal solid waste
- Sharps shall be collected in special boxes and disposed of together with other dangerous wastes
- Dangerous wastes shall be collected in strong, yellow garbage bags and kept in a washable and disinfected yellow tank, transported by the Municipality to the landfill and buried in special trenches, covered by lime powder
- Radioactive wastes shall be collected separately, under the supervision of relevant personnel in charge of radiation hygiene. Waste shall be kept and disposed according to local rules
- Cut limbs and organs (or disjointed parts of body and/or aborted fetuses) shall be collected separately, carried to a local cemetery and buried there according to local customs
- Transport of hospital waste, especially infectious waste, must take place in special vehicles marked “infectious waste”.

Specifications for temporary storage are as follows:
- Must have good access to other wards
- Follow procedures to minimize potential contamination
- Located far from other wards and kitchen
- Must be washed and disinfected regularly
- Designate separate areas for different types of healthcare waste
- Health and safety supervision should be conducted regularly

Injection equipment, blood packages, serum and contaminated instruments, should be collected and disposed in hazardous waste bins
Recycling of hospital wastes is forbidden.

Household waste (general hospital waste) includes:
Administrative waste
Kitchen waste
Linens

Hazardous wastes include:
- Waste from maternity and surgery rooms
- Waste from ICU and emergency rooms, injection and infectious wards, pathology laboratories, autopsy rooms, dialysis and isolation wards,
- Blood bank
- Bur unit
- All infectious wastes including all garments and sheets stained with blood, tissues used for bandages, samples of biopsies

- Plastic items such as gloves, urine bags, catheters, dialysis filters, etc.

It is required to collect all solid wastes (hazardous and semi-domestic) in separate bags in all wards. Semi-domestic waste should be collected in strong black strong bags and blue bins. Hazardous wastes should be collected on strong, yellow strong bags and later put in yellow bins. If there are no strong bags, two common bags may be used.

GUIDELINES FOR THE MANAGEMENT OF HEALTHCARE WASTE
MINISTRY OF INTERIOR

Medical waste separating/collecting/transporting and discharging guidelines

Article 1 – Description
Treatment and health centers include all hospitals, dental, and physiotherapy clinics, etc.
Medical wastes include: waste from treatment and health centers, as pointed out in Article A, which have the following specifications:
Uninfected wastes: involving waste from administrative and financial departments, kitchen and restroom wastes
Special wastes including the following three categories
Sharps – all types of needles, blades
Chemical and infected wastes – including waste from operating and emergency wards, nursery station, pathology and dialysis wards, blood banks, burnt unit, etc. Also includes used clothes, gloves, etc.
Radioactive wastes – all types produced at nuclear facilities

Article 2 – Separation and temporary containment
All production centers must separate and temporarily containing their medical wastes following the following procedures:
Not infected wastes should be collected in black bags and contained in blue washable containers
Sharps must be collected in red, marked boxes, and these should be contained in red metallic boxes
Chemicals and infected wastes should be collected in yellow bags and in washable containers that can be disinfected
Radioactive wastes should be collected and disposed of according to the Nuclear Energy Organization, and should be managed under the supervision of specialized personnel

Article 3 – Temporary containment
A designated place must be available, in all wards, with the following characteristics:

Not contaminated
Separate from the wards and from the kitchen
Washable
Supervised and safe
Isolated and marked (labeled)

Article 4 – All health and treatment centers should note the rate of medical waste they generate daily, according to the characteristics described in Article 1

Article 5 - Municipalities can charge medical centers the cost of collection and disposal services

Article 6 – Health and treatment centers should dispose of their wastes in the following ways:
Incineration – According to EMRO standards, in the absence of DOE standards
Following methods of reduction and treatment of special wastes
In sanitary landfills (according to Articles 9 and 11)

Article 7 – Wastes from incinerators should be contained in special boxes and disposed of as special waste

Article 8 – It is allowable for hospitals to incinerate their waste. There should be a contract between the hospital and the incineration facility

Article 9 – All the health and treatment centers should maintain contracts with service providers for the collection and disposal of their waste.

Article 10 – Collection and transportation trucks for special wastes should be marked. Leaking leachate should always be avoided

Article 11 – Municipalities, according to Article 9, should dispose of special wastes in specified areas, separately from municipal solid waste

Article 12 – Body organs must be collected separately and then transported to the cemetery for adequate burial

Article 13 – Discharges of chemical and infected wastes should be monitored by auditing committees. These committees include representatives from the healthcare center, DOE, industrial organizations and the Municipality

Article 14 – Healthcare centers should monitor implementation of guidelines

Article 15 – These guidelines involve 15 articles, which should be signed by person in charge at healthcare centers, and implemented accordingly.

SUMMARY OF HEALTHCARE WASTE TREATMENT TECHNOLOGIES

Several technologies are currently available for the treatment and/or disposal of healthcare waste. The main characteristics of the most widely used alternatives are summarized in Table 5.

Table 5. Available treatment and disposal technologies for healthcare waste

Type of technology	Characteristics of treatment	Advantages	Disadvantages
Designed landfill	Burial in lined pit Daily soil and lime cover	Relatively simple, known technology	Limited capacity (Low) potential contamination issues
Incineration	Combustion technology High temperature High circulation	Significant reduction of waste volume	Emissions must be closely controlled to avoid generation of dioxins and furans By products (ash) may need be hazardous and may need special disposal considerations Requires significant operator training and monitoring Costly to install and to operate
Steam sterilization (autoclaving)	Shredding of waste High temperature and pressure Disinfection	Sterilizes waste, which can then be buried as municipal waste	Limited types of waste may be treated Limited capacity Costly to install and operate
Microwave sterilization	Microwave strength Disinfection	Sterilizes waste, which can then be buried as municipal waste	Costly to install and to operate Requires significant operator training and monitoring

Source: World Bank, WHO

COMPILED DATA FROM TEHRAN SURVEY

MANAGEMENT OF HEALTHCARE WASTE

The following questions and conclusions are a part of study done in 248 healthcare facilities in Tehran, and interviewed Motor Pool drivers and landfill operators.

- Is HCW being separated at the various pick-up stations?

Certain HCW facilities separate waste	4
HCW facilities do not separate waste	14

- What are the conditions in the storage areas of healthcare facilities?

Good	3
Average	7
Bad	8

- Types of collection vehicles

Type of vehicle	Capacity [ton]	Number of vehicles
Benz Khavar	.	1
Benz Fuan	10	6
Khavar Fuan 808		8
Fuan 1924	.	2
Nissan	.	1
Total	**.**	**18**

- Is there a manual for HCW separation and disposal procedures that are followed in the facility?
Yes

- Are facilities following guidelines?

	Number of facilities	Percentage
Yes	212	85.5
No	12	4.8
No answer	24	9.7
Total	**248**	**100.0**

- Where did these procedures come from?
Ministry of Health

- Did personnel receive training on HCW management procedures?

	Number of facilities	**Percentage**
Yes	213	85.9
No	20	8.1
No answer	15	6.0
Total	**248**	**100.0**

- What is the involvement of the Ministry of Health in HCW separation and disposal procedures at the facility. Do inspectors visit facility on a regular basis?

	Number of facilities	**Percentage**
Yes	166	66.9
No	65	26.2
No answer	17	6.9
Total	**248**	**100.0**

- Types of HCW facilities visited

Type	**Number**
Clinic	59
Hospital	109
Laboratories	29
Others	51
Total	**248**

- Is HCW being separated from MSW in the different wards, laboratories, etc?

	Number of facilities	**Percentage**
Yes	192	77.4
No	28	11.3
No answer	28	11.3
Total	**248**	**100.0**

- Are separate containers used for healthcare and municipal waste in the storage room? Are they labeled adequately?

	Number of facilities	Percentage
Yes	170	68.5
No	42	16.9
No answer	36	14.5
Total	**248**	**100.0**

- Is leachate being generated in the HCW bags?

	Number of facilities	Percentage
Yes	26	10.5
No	192	77.4
No answer	30	12.1
Total	248	100.0

- Is facility personnel satisfied with separation and disposal procedures?

	Number of facilities	Percentage
Yes	174	70.2
No	36	14.5
No answer	38	15.3
Total	248	100.0

- Who does the healthcare facility pay for HCW management services?
Motor Pool

- How is fee established (*e.g.* volume or weight basis) and what does it cover?
Number and volume of bins collected

- Where is waste from HCW trucks being disposed? Are HCW cells being used to deposit the waste?
No

- Is HCW being mixed with MSW?
Yes

- Is waste being covered or stabilized?
No

Total Bed and Discharge Amount of infectious wastes

According to the statistic data of the Iranian Ministry of Health, as of 2002;

. Total bed in the City of Tehran: [24, 275 Beds]
. Infectious wastes discharged per bed per day: [4.7 kg per bed per day]

Accordingly, total discharge amount of Infectious Waste in Tehran is calculated as follows;

6,427 bed x 4.7kg/bed/day = 30,202.2 kg per day

Annual discharge amount is;

30ton x 365 = Approx. 11, 000 ton per year

Other infectious Wastes discharged from medical institutions

Data of other discharges wastes is not provided, however there are total 6,298 Medical Institutions in the great Tehran City. Other infectious Waste amount is 7,000 ton per year, if these institutions discharge 3 kg per institution per day,

6.298 x 3kg/day x 365 = 7,000 ton per year

Table 7. Number of Medical Facility in Tehran

Type of Medical Facility	No. of Facility
Poly Clinic	329
Doctor Office & Clinic	5,224
Physician s Lab	174
Radiology	107
Drug Store	407
Others	57
Total	**6,298**

Source: OWRC

APPENDIX 3 REPORT ON FINANCES

Integrated Waste Management Strategy & Implementation Plan of Tehran

Economic and Financial Framework

(Phase 1 Report)

By

Tayebeh Aryan

October 2004

Table of content

1-Introduction

Present system of Tehran solid waste management in established base on following organizations[7]:

1- Motor pool organization (see annex 1)
2- Organization of Waste Recycling and Composting (OWRC)

Reference to article 84 of municipality's regulation, principals of OWRC was approved with 35 articles and 13 remarks on 23rd October 1991 by ministry of internal affairs in order to fulfil following general policies Tehran Municipality:

- Internal financial independence of Tehran Municipality and related organizations and entities.
- Providing essential facilities and conditions for applying high tech systems for collecting urban solid waste and their recycling.
- Technical and hygienic disposal of non-recyclable solid waste materials.

Regard to article 4 of approved principles, OWRC is one of related organizations to Tehran municipality with independent legal individual and financial-administrative independence that must be managed base on approved principles.
It must be added that the organization is exempted from taxes base on part 1, article 2 of direct taxes code (approved on March 1987).

2- Costs

OWRC's costs are gathered during 6-year period of 1998-2003 (Table 2-1-2 Annex). Main items of these costs are as follow:

Landfill and relative costs of disposal and reclaiming waste: these costs can be considered as excavation of pits, excavation of semi pits and consumption of antiseptic materials.

Personnel costs: these costs can be considered as follow:
Salaries, wages and allowances,
Insurance costs,
Costs of allowances that must be paid for employees' annual work,
Food and other non-monitory allowances,
Work suit, security facilities and clothes

There were 420 employees (336 were official employees and 84 were contractor employees) in the organization. Contractor employees were mostly working in different field activities of Saleh Abad compost plant and Kahrizak complex.

[7] Other units are active beside above-mentioned organizations that play an important role in Tehran solid waste management. They can be considered as follow:

- Tehran municipal administration especially deputy of urban services.
- 20 municipal divisions of Tehran.
- Tehran sweeping and cleaning organization (SPNT) that is responsible for monitoring over demolition collecting, transfer and disposal (One of sub organization of OWRC.
- Private companies in the filed of waste transfer, delivery and recycling.
- Collectors of recyclable waste materials (private organization).

Contractors' costs for waste transfer.

Maintenance costs of stations.

Consumed materials.

Maintenance of fixed assets; It must be added that compost plant operation time from 1999 have increased costs of depreciation, water & electricity, equipment and maintenance of fixed assets.

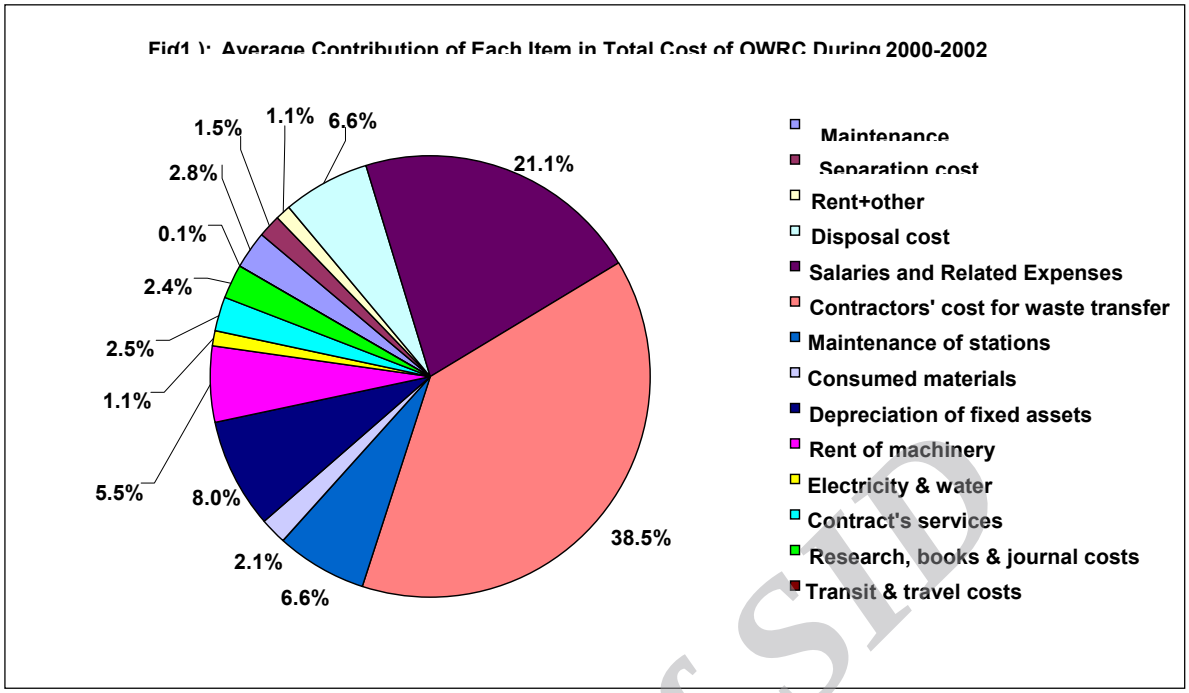
Depreciation of fixed assets.
Machines and vehicles fee.
Water and electricity.
Contractor services.
Researches books and journals.
Rents of landfill reclaiming areas and Kahrizak plant.
Development and maintenance of green yard area.
Transit and travel costs.
Costs of compost's Separation (Kahrizak)

Costs of compost's Separation and production (Karko): 2.1 dollars/ton were paid to contractors for doing following operation on one ton of waste materials at the plant complex:
Receiving, separation and arrangement of solid waste.
Manure comportment, manure processing and final separation of them.
Waste transfer for disposal up to 150 tons per day.

Totally 39895 tons of waste materials were entered in the area for above-mentioned activities.

Costs of compost's Separation and production (Hata): management duties of Saleh Abad compost production plant can be considered as follow (By contractors' commitment system);
Providing required Loader and personnel for separation process of waste and manure.
Transfer operation of waste and manure to the Kahrizak complex.
Manure comportment

Figure 1 present average share of each item in total costs during 2000-2002.



As it can be seen, transfer and delivery by 38.5% and personnel by 21.1% had the biggest contribution among all other items. By the way, disposal and required materials just covered 6.6% of costs.

There are some other costs that can be considered except the above-mentioned costs. These costs can be categorized as general, administrative and management costs. Their values are presented in table 2-1-3 of the annex table. Total shares of these costs among all other items during the years 1999-2002 were 21,16,10,11 and 13 percent of total costs.

3- Incomes

Tehran municipality must pay following expenses:

Waste collection and transport
Waste disposal and reclaim
Operation and maintenance of urban service stations
10% over head of OWRC commissions up to the approved ceiling in contracts

It must be mentioned that waste transfer and disposal operations beside operation and maintenances of stations are implemented base on contracts with 21 districts of Tehran municipality. So expenses must be paid by considering weight of waste on the one hand and tariffs and waste which are mentioned in the contracts on the other hand.

OWRC's incomes are gathered during 1998-2003 (Table 2-1-1 Annex). Main items of incomes are as follow:

1 - Waste disposal and reclaiming from Tehran 21 municipal districts, daily grocery market, Behesht Zahra Cemetery organization, motor pool organization, municipalities of other cities, Intentional trade fair. It must be said that 95% of incomes are belong to 21 districts of Tehran municipality and just 5% belongs to other resources,

2 - Disposal and reclaiming of industrial waste: It must be clarified that the incomes of each cubic meter industrial waste increased from 0.9 dollars/ton in 1999 to 1.1 dollars/ton in 2002.

3 - Disposal and reclaiming of construction demolition and debris: that categorized as issuing permission for excavation of demolitions in especial areas around Tehran and issuing traffic permission for proposed vehicles. Different rates and tariffs can be considered for these operations.

4- Incomes of waste transfer: Motor pool organization used to be responsible for waste transfer operation from loading site in districts and Kahrizak waste disposal center. But this responsibility was moved to OWRC from 2000to 2001. During this time , general tender was conducted for selection of contractor companies and Motor pool organization was one of those contractors which was responsible for waste transfer of some municipal districts .At present time , (beginning of year 2002) Motor pool organization is responsible for waste transportation and maintenance of stations .

5- Incomes from maintenance of urban services' stations

6 – Incomes of separating household waste: It means some fees, which are charged for issuing traffic permission for collecting dried bread remains. This operation is conducted by Tehran sweeping and cleaning administration. 9.3 dollars/ton were charged monthly as the determined tariff for each van during studying period (1998-2003).

7- Compost selling: tables (1) and (2) show compost selling and its price during 1999-2003.

Table (1) Compost Selling
Ton

Description	1999	2000	2001	2002	2003
Whole Buyer	7095	7490	6489	5884	4606
Districts	2067	1460	547	3200	2900
Other	1685	2176	1750	1860	1919
Total	10847	11126	8786	10944	9425

Source: Reports of independent auditor and organization observer

Table (2) Price of Compost

(us cent/Kg)

Description	1999	2000	2001	2002	2003
Main Buyer	0.23	0.23	0.34	0.46	0.57
Districts	0.57	0.57	.63-.86	.86-1.44	1.15-1.84
Other	.23-.57	.29-1.15	0.40-1.44	0.40-1.45	
Average	0.32	0.31	0.46	0.88	0.99

Source: Reports of independent auditor and organization observer

8- Paper selling: 112256 kilogram of Pakan Shahr company paper deposits was moved to OWRC after demolition of that company and the organization itself take the responsibilities of collecting and selling paper. Table (3) presents price and production of paper during 2001 and 2003.

Table (3) Production and Price of Paper

Description	Volume (ton)			Price (us cent /Kg)		
	2001	2002	2003	2001	2002	2003
Card Boards	788	1008	170	5.1	5.3	6.8
Mixed Paper	724	1285	350	4.9	3.2	5.9
White Paper	270	227	330	7.2	6.3	5.8
News Paper	213	751	---	4.5	4.0	0.0
Other	43	48	23	0.3	13.0	22.0
Total	2039	3319	873			
Average				5.1	4.4	6.5

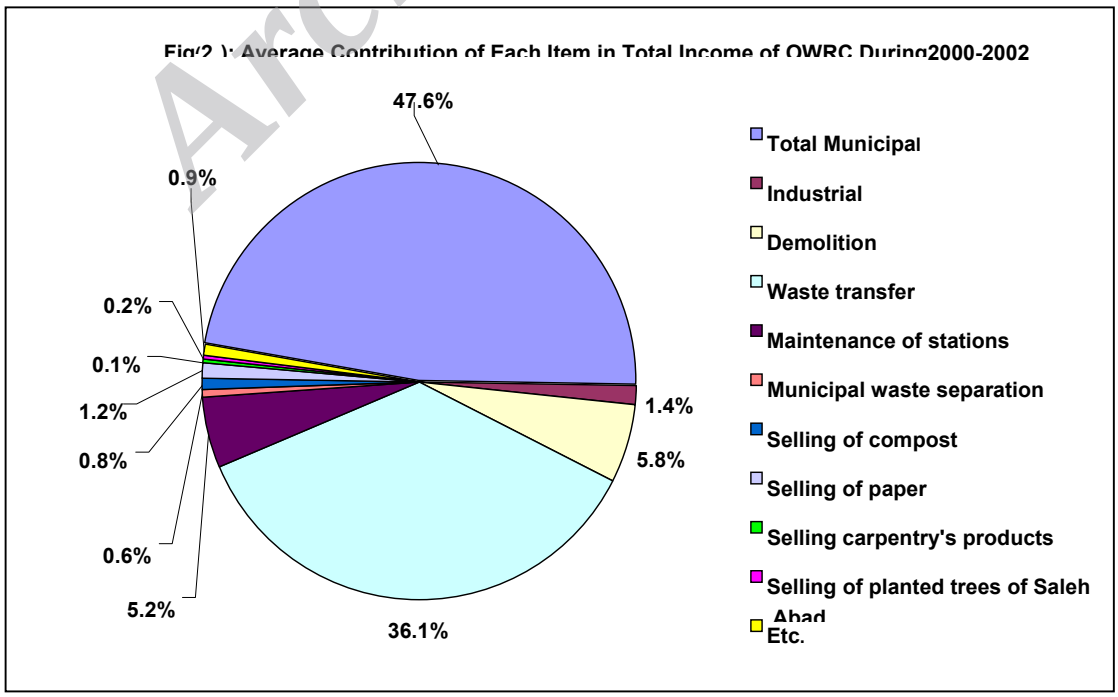
Source: Reports of independent auditor and organization observer

9-Carpentary products selling: carpentry branch of reorganization is in Saleh Abad plant. Products of this unit were increased from 2000 by the beginning of its operation. It must be mentioned that the area of carpentry unit was rented to other customers before the above-mentioned date.

10- Selling of planted trees of Saleh Abad

11-Other incomes: Incomes from implementation of contracts on design and construction of sample urban areas that consist of public health services.

Figure 2 present average share of each item in total incomes during 2000-2002.

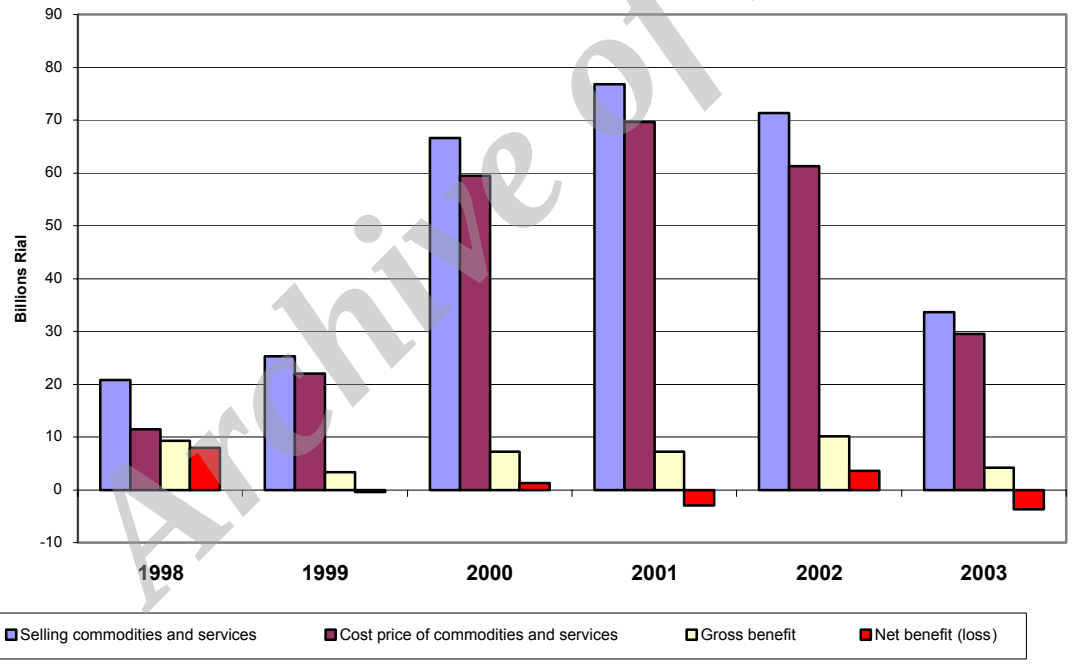


As it can be seen, Total Municipal by 47.5% and Waste transfer from stations by 36.1% had the biggest contribution among all other items. Demolition transfer and Maintenance of stations covered 5.8% and 5.2% of incomes respectively. By the way other incomes were less than 1% of total incomes.

4 - Profit and loss statement

Profit and losses are presented in annex table (2-1). Figure (3) presents variation trend of profits and losses in organization during studying periods (1998-2003). As it is clear on the table, gross net benefit of organization was positive (It means differences between incomes and costs of selling commodities and services). But by considering of other items (general, administrative and selling costs, net benefit of other incomes and costs, implementation profits and losses, net benefit of other incomes, other costs of non-implementation activities), net benefit of organization was positive in 1999 and then negative during 2000-2001. It changed to be positive in 2002and again negative in 2003.

Fig (3): Profit and loss statement of OWRC during 1998-2003

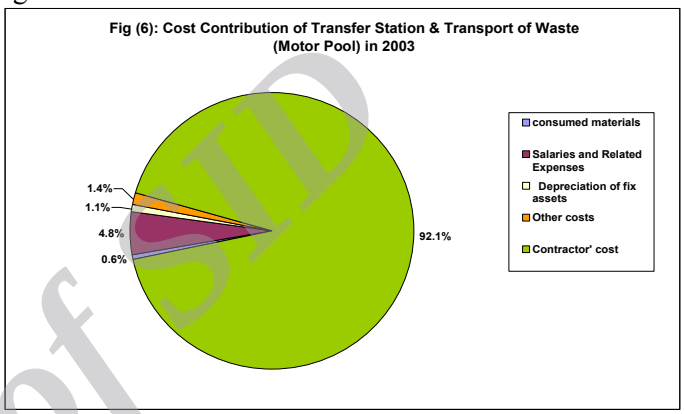


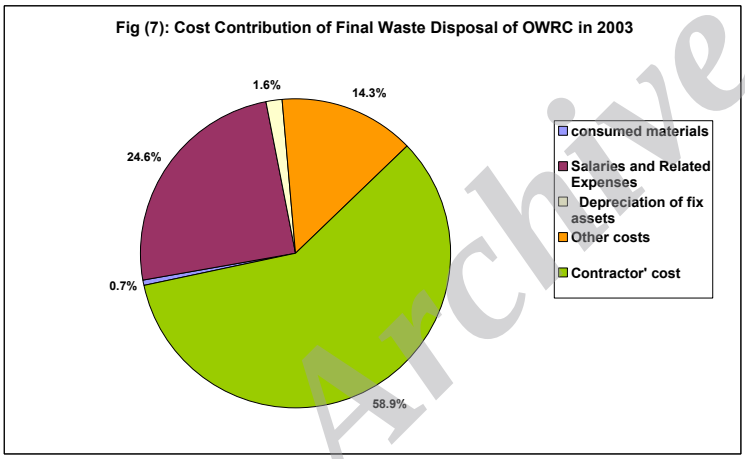
5- Summary and conclusions

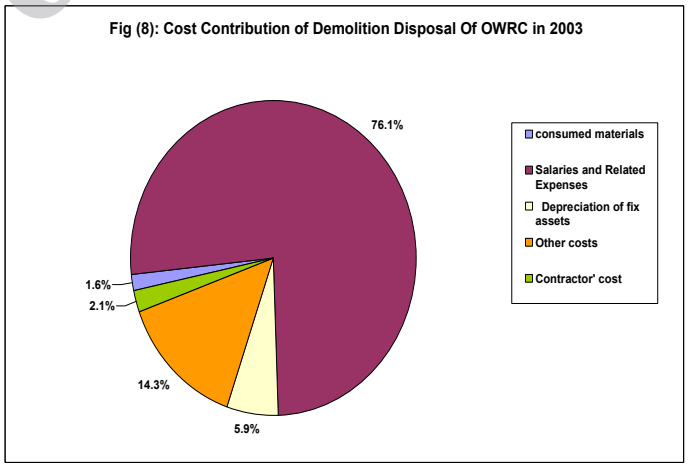
5-1- summary

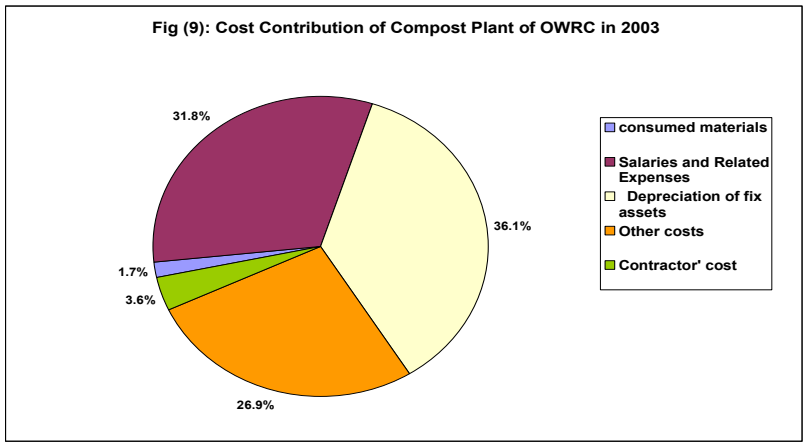
The Motor Pool is owned by Tehran municipality and has been partially corporatized, and thus acts as a private sector contractor by leasing tracks to other contractors. Except 3 years (200-2001), the Motor Pool is responsible for transfer and transportation (it means maintenance of stations and transportation of waste).
QWRC acts as a contractor for the municipality of Tehran by the process and disposal of waste (central Kahrizak landfile and Kahrizak compost plant).

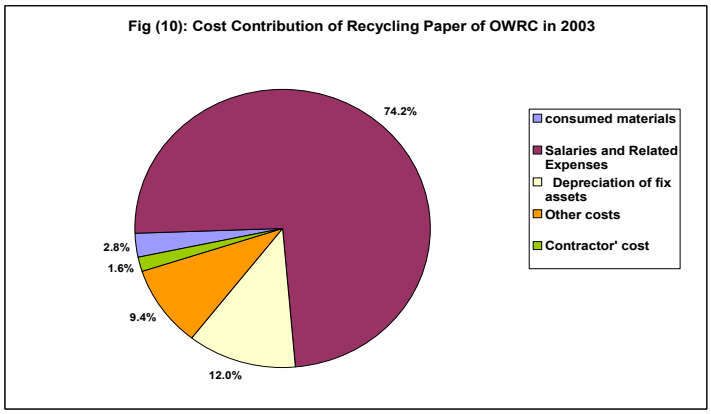
The OWRC financial aspects were discussed in details in previous sections.
Figures No. 4 to 10 show breakdown cost of main stage of SWM in 2003.











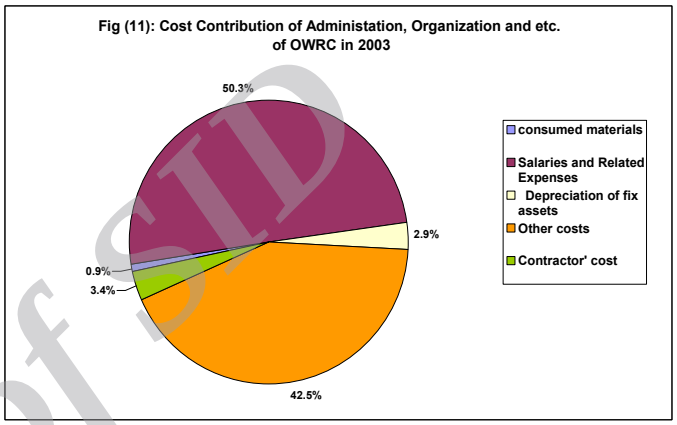


Table (4) shows the summary result of above figures. As it can be seen, the proportional of sub total cost in any stage of SWM is vary from each other. For example: Contractor' cost has the biggest proportional in Waste collection, Transfer station & transport and Final waste disposal. In the other hand the Salaries and Related Expenses has the biggest percentage in Demolition disposal and Recycling of paper. Compost plant has a higher depreciation cost in comparing with other component (because of old machinery).

Table (4) Main items' breakdown cost of SWM Figures: (%)

Description	Waste collection	Transfer station& transport	Final waste disposal	Demolition disposal	Compost plant	Recycling (paper)	Admin,Org. and etc.
Consumed materials		0.6	0.7	1.6	1.7	2.8	0.9
Salaries and Related Expenses		4.8	24.6	76.1	31.8	74.2	50.3
Depreciation of fix assets		1.1	1.6	5.9	36.1	12.0	2.9
Other costs		1.4	14.3	14.3	26.9	9.4	42.5
Contractor' cost		92.1	58.9	2.1	3.6	1.6	3.4
Total		100	100	100	100	100	100

5-2-conclusions

Figures No. 11and 12 show the contribution share of main item in cost and income of WSM in 2003.

Fig (11): Contibution of Main Item in Total Cost of Waste Management

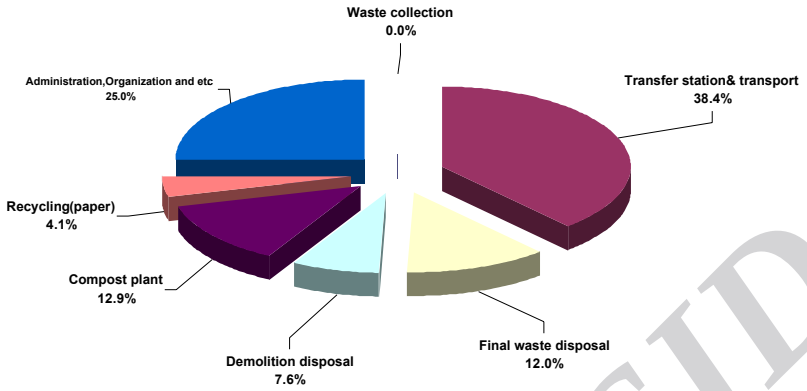
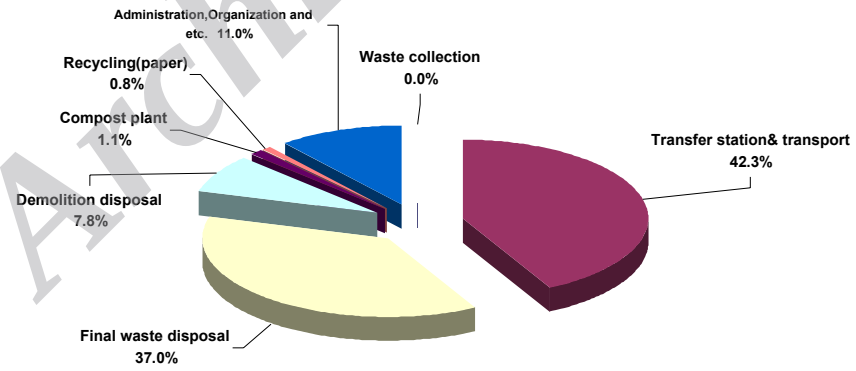


Fig (12): Contibution of Main Item in Total Income of Waste Management in 2003



It should be noticed, there is a large informal sector that is collecting and recycling all types of wastes in Tehran, which their information is not available.
General Future of Financial Framework of Tehran Waste Management is given in table (6).

This table shows:

- Positive balance between cost and income of Transfer and Transport
- A noticeable shortcoming in the composting system (the compost's revenue can cover only 8% of total cost) and paper recycling (the revenue of paper covers 20% of its cost).
-Considerable net income of waste disposal.
- Shortcoming in other costs and income (about 66%).
- Considerable differences between total cost and income of Tehran waste management, in other word, the formal income of waste only cover 52% of total cost.

Table (6): General Future of Financial Framework of Tehran Waste Management

Description		Responsibility	Total Cost (million US$)	Total Income (million US$)	Net Benefit (million US$)	US$/ton	
						Cost	Income
Collection							
- excl. street sweeping		Municipality's	10.8	0.0	-10.8	4.6	0.0
- incl. Street sweeping		urban services	21.6	0.0	-21.6	9.2	0.0
Transfer and Transport*		Motor pool	3.8	5.5	1.6	1.9	2.6
Reuse and Recycling	**Compost**	OWRC	1.1	0.1	-1.0	118.9	9.9
	Paper		0.4	0.1	-0.3	406.8	79.4
Disposal			1.0	3.2	2.2	0.4	1.3
Other			2.2	0.9	-1.2	0.9	0.4
Total							
- excl. street sweeping		Municipality	19.3	9.8	-9.5	7.6	3.9
- incl. Street sweeping			30.1	9.8	-20.3	12.0	3.9

The exchange rate: 1US$ = 8700 rials

Annex 1 – Motor pool organisation

Tehran municipality Motor pool organization

This institution is one of big organizations of Tehran municipality that is established in 1961 by the name of "Transfer Company". This company was in charge of very clear and limited affairs. But this administration changed to Motor pool organization in 1977 by Tehran rapid grow and much more demand for services to citizens.
This organization changed to an independent organization in 1991 by commercial system.
Tehran municipality Motor pool organization is facilitated with following capabilities that provide urban services 24 hours a day:

- 2101 light, semi heavy and heavy vehicles.
- Especial automatic vehicles for transfer of hospitals & clinics' waste.
- Expert staff.

The organization provides services for 21 districts of Tehran municipality and relative institutions, units and branches base on organization manifesto. Although providing vehicles and transfer of waste are main activities of organization for Tehran municipality, following activities can be considered for organization that is expanded gradually:
- Implementation of projects and providing services for private entities out of organization.
-Implementation of civil and development projects for 21 districts of Tehran municipality and relative institutions.

Organizations' vehicles that are working in municipal services can be divided in to 2 main categories:

Vehicles that are indirectly active in municipal services and can be considered as civil vehicles. This vehicles are mostly applied for following activities:

Transfer of soil and demolition.
Transfer of asphalt.
Transfer of slime.
Transfer of building debris and demolition.
Transfer of agricultural soils.
Construction highways, streets and roads.
Irrigation of green yard areas.
Destruction of non-residential buildings and constructions.

2- Vehicles that are devoted to urban services and provide especial demanded services to citizens.

Motor pool organization always delivers 7000 tons of solid waste from 21 districts of Tehran municipality to waste disposal areas by the help of vehicle facilities.

This section of organization has provided its services to hospitals and clinics from 1994. At the first step, organization established some copy examples of hygienic reservoirs from some foreign samples. These reservoirs can be evacuated automatically by especial machines. It was the first time that such project was implemented in Iran. So, lots of activities have been conducted at the first phase back to the importance and wide range of the operations and 125 hospitals and clinics were covered by services in 1994. Now a day, 310 hospitals are covered

by this new system of waste material control that means more healthy and hygienic loading and delivering hospital waste materials.

Annex2 – Tables

Table (2-1) PROFIT AND LOSS STATEMENT OF OWRC (US $)

Year	1998	1999	2000	2001	2002	2003
Selling commodities and services	2,388,054	2,902,295	7,661,904	8,825,190	8,204,784	3,867,329
Cost price of commodities and services	1,316,442	2,523,716	6,834,054	8,002,225	7,038,614	3,390,197
Gross benefit	1,071,612	378,579	827,849	822,965	1,166,170	477,132
Administration Organization and etc. costs	341,974	482,517	744,967	943,314	1,021,384	1,150,986
Net benefit of other implementation incomes and costs	57,398	-91,995	63,808	-505,383	-142,707	228,004
Implementation net benefit (loss)	787,036	-195,933	146,690	-625,732	2,079	-445,850
Non implementation net benefit (loss)	1,467	141,594	-7,189	283,155	405,326	20,130
Net benefit (loss)	907,502	-54,339	139,501	-342,576	407,405	-425,720

Source: Reports of independent auditor and organization observer

Table (2-1-1) INCOME OF OWRC (US$)

Year	1998	1999	2000	2001	2002	2003
District	1,971,752	2,417,455	2,982,709	3,218,391	3,441,490	2,873,563
Others						
Daily grocery market	0	17,442	19,939	23,620	33,277	36,416
Behesht Zahra Cemetery	4,131	5,555	6,142	6,254	6,150	8,590
Motor pool organization	50,639	55,919	116,005	111,580	117,861	162,706
Bagher Shahr municipality	10,375	18,664	23,776	31,737	24,986	19,955
Babol municipality	0	0	34,556	0	0	0
International Trade Fair	0	516	3,011	0	0	0
etc.	0	0	0	0	59,721	23,946
sub total	65,146	98,096	203,429	173,191	241,994	251,613
Total Municipal	2,036,898	2,515,550	3,186,138	3,391,581	3,683,484	3,125,176
Industrial	51,864	59,462	83,435	110,618	103,203	76,300
Demolition	212,885	237,083	331,520	543,236	397,800	444,595
Waste transfer	0	0	3,310,124	3,823,753	3,266,400	0
Maintenance of stations	0	0	636,607	605,351	388,829	0
Municipal waste separation	59,148	54,601	41,746	39,659	29,007	59,936
Selling of compost	15,863	35,136	34,411	40,180	96,210	93,082
Selling of paper	0	0	27,939	104,394	144,910	56,543
Selling carpentry's products	11,396	463	9,984	7,395	4,655	8,248
Selling of planted trees of Saleh Abad	0	0	0	21,093	25,631	0
etc.	0	0	0	137,931	64,655	3,448
Total	2,388,054	2,902,295	7,661,904	8,825,190	8,204,784	3,867,329

Table (2-1-2) Cost WORC **(Us $)**

Year	1998	1999	2000	2001	2002	2003
Disposal cost	289,689	121,354	355,438	720,307	423,800	432,143
Salaries and Related Expenses	596,654	869,428	1,439,696	1,628,863	1,607,028	1,615,862
Contracts' cost for waste transfer	0	0	2,728,527	3,295,092	2,546,956	0
Maintenance of stations	0	0	390,866	592,934	499,075	0
Consumed materials	69,835	84,971	143,340	151,991	167,302	47,295
Maintenance of fixed assets	34,998	81,071	130,200	162,597	126,385	162,920
Depreciation of fix assets	71,153	551,099	585,323	651,004	548,475	505,807
Rent of machinery	166,302	343,894	579,430	341,857	285,130	222,520
Electricity & water	16,890	66,289	72,354	79,263	98,567	96,843
Contract's services	37,700	38,964	15,725	235,689	323,260	117,923
Research, books & journal costs	49,086	53,218	145,197	87,112	279,251	65,965
Rent of land for Kahrizak compost plant	0	0	0	8,621	8,621	8,621
Maintenance of Kahrizak green area	13,710	24,257	39,214	65,712	104,372	73,643
Transit & travel costs	10,844	4,081	7,959	12,689	3,208	4,495
Separation cost of Kahrizak compost plant	0	0	0	85,692	100,328	123,081
Separation & production cost of Carco compost	0	85,276	41,301	0	0	0
Separation & production cost of Hata compost	0	76,285	107,450	0	0	0
Others	42,549	50,005	54,490	60,902	107,295	66,529
Total	1,399,412	2,450,193	6,836,509	8,180,324	7,229,051	3,543,649
Correction	0	0	0	-145,988	-101,865	-85,302
Deposits of compost at the beginning of year	200,162	233,692	129,423	107,875	164,353	175,427
Deposits of carpentry's products at the beginning of year	5,659	3,710	3,710	1,884	1,884	8,637
Deposits of paper at the beginning of year	0	0	0	3,540	38,690	8,005
Buying paper	0	0	19,163	74,397	79,021	25,644
Deposits of compost at the end of year	-233,692	-129,423	-144,457	-164,353	-175,427	-258,725
Deposits of carpentry's products at the end of year	-3,710	-3,710	-1,884	-1,884	-5,756	-8,114
Deposits of paper's products at the end of year	0	0	-3,540	-38,690	-8,005	-6,773
Cost of consumed compost by the organization and cost of free compost	-42,561	-6,418	-4,718	-6,909	-149,719	-1,036
Cost of consumed carpentry's products by the organization	-8,828	-121	-152	0	-7,481	-7,084
Cost of consumed transheh by the organization	0	-24,207	0	0	0	0
Cost of consumed paper by the organization	0	0	0	-7,971	0	-4,133

Cost of consumed horticulture product by the organization	0	0	0	0	-26,131	0
Total	1,316,442	2,523,716	6,834,054	8,002,225	7,038,614	3,390,197

Table (2-1-3) Administration Organization and etc. costs

(US $)

Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Personal expenses	160,368	231,267	439,878	473,110	571,255	794,032
Consumed materials	12,845	16,575	16,504	14,622	14,632	16,019
Maintenance of fixed assets	11,820	16,586	22,670	28,021	25,135	27,732
Depreciation of fixed assets	22,323	24,267	18,251	21,313	33,418	22,223
Advertisement (for education of waste separation)	14,778	37,904	46,348	110,952	60,433	24,549
Post and communications	4,208	5,941	6,876	7,820	9,099	9,433
Electricity & water	3,219	4,177	4,466	6,070	7,616	14,577
Contract's services	17,382	29,608	49,975	74,235	96,998	105,394
Hospitality cost	7,016	11,103	10,680	14,550	13,718	8,101
Transit & travel costs	11,430	11,854	14,696	30,491	14,303	1,037
Exercises	50,988	54,945	57,395	11,290	0	0
Grants and gifts	10,080	17,647	24,980	29,220	12,345	5,981
Auditing remunerations	5,023	5,575	6,437	7,126	8,046	8,621
Others	10,492	15,070	25,813	40,644	52,521	27,986
Official overhead	0	0	0	73,850	101,865	85,302
Total	341,974	482,517	744,967	943,314	1,021,384	1,150,986

Source: Reports of independent auditor and organization observer

Table (2-1-4) Net benefit of other non implementation incomes and costs

(US $)

Year	1998	2001	2002	2003
Approved net benefits of investments stocks in Hamshahri	28,736	27,586	57,471	0
Renting incomes of 2 storage in Saleh Abad factory and one hall	0	0	0	0
Renting incomes from Saman Zist co. of 2 apartment	4,686	5,931	6,621	0
Renting incomes of carpentry workshop in Saleh Abad factory	0	0	0	0
Benefits of selling buildings and lands	82,740	325,830	419,662	1,379
selling metals	0	6,782	323	0
Benefits of selling fixed assets	2,573	4,472	770	30,256
Others	6,162	20,974	98,682	67,903
Total	124,897	391,574	583,529	99,538
Non implementation cost	0	-102,916	-173,906	-76,400
***Surplus cost over renting assets**	-4,430	-5,503	-4,296	-3,008
Net benefit	120,467	283,155	405,326	20,130

* Depreciation is subtracted

Source: Reports of independent auditor and organization observer

Table(2-1-5) Breakdown cost of SWM (US $)

Year	2002	2003
Waste collection	0	0
Consumed materials	0	0
Salaries and Related Expenses	0	0
Depreciation of fix assets	0	0
Other costs	0	0
Contractor' cost	0	0
Sub total	0	10,849,152
Transfer station& transport		
Consumed materials	21,588	0
Salaries and Related Expenses	160,761	0
Depreciation of fix assets	35,247	0
Other costs	46,408	0
Contractor' cost	3,073,027	0
Sub total	3,337,031	3,837,586
Final waste disposal		
Consumed materials	33,438	6,935
Salaries and Related Expenses	215,286	256,052
Depreciation of fix assets	20,674	16,430
Other costs	309,209	148,905
Contractor' cost	601,716	613,350
Sub total	1,180,322	1,041,672
Demolition disposal		
Consumed materials	13,537	10,443
Salaries and Related Expenses	473,127	500,018
Depreciation of fix assets	26,058	38,607
Other costs	56,173	94,254
Contractor' cost	49,035	13,706
Sub total	617,930	657,029
Compost plant		
Consumed materials	64,497	18,683
Salaries and Related Expenses	286,363	356,071
Depreciation of fix assets	438,057	404,766
Other costs	258,701	300,988
Contractor' cost	147,174	40,464
Sub total	1,194,792	1,120,972
Recycling (paper)		
Consumed materials	27,084	10,008
Salaries and Related Expenses	167,069	263,522
Depreciation of fix assets	41,544	42,483
Other costs	106,219	33,500
Contractor' cost	67,779	5,564
Sub total	409,695	355,077
Administration, Organization and etc.		
Consumed materials	34,599	20,375
Salaries and Related Expenses	1,030,101	1,091,614

Depreciation of fix assets	63,631	62,164
Other costs	652,431	922,898
Contractor' cost	103,789	73,985
Sub total	1,884,550	2,171,036
Other income	0	0
Total		
Consumed materials	194,742	66,444
Salaries and Related Expenses	2,332,707	2,467,277
Depreciation of fix assets	625,210	564,451
Other costs	1,429,142	1,500,546
Contractor' cost	4,042,519	747,068
Total	8,624,320	20,032,523

Islamic Republic of Iran, Municipality of Tehran
Organisation for Waste Recycling and Composting

Report on Phase 2

Tehran Solid Waste Management

Integrated Waste Management Strategy and Implementation Plan

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EXECUTIVE SUMMARY

Introduction

The Tehran Solid Waste Management Strategy is being developed, starting with the current situation in Tehran on the waste handling, the current organisational structure and the current operational practices. The OWRC organisation is the organisational spill in waste management and has in the past initiated various projects related to public awareness, composting etc.
In order to come to a long term cost effective, sustainable and social/political acceptable solid waste managements system, the strategy was developed. The municipality has already defined some high level strategic goals like the 3-R approach.

In addition the following statement is proposed as main view:

"Development of an environmentally and socially sound solid waste management system in a cost effective and sustainable manner, for greater Tehran"

The development of the strategy has been done starting from the vision and resulting in a final implementation plan of the required actions.

As a result of the strategy development the following strategic targets for the period 2004-2014 are defined:

1. Institutional, financial and legal strengthening of SWM organisations
2. Separation of dry waste plus hazardous waste at source: 20% of total waste flow
3. Separation of wet waste at source: 50% of total waste flow
4. Realization of private composting industry: 5000 tons/day
5. Realization of private dry recycling industry: 2000 tons/day
6. Realization of required infrastructure for collection, transfer, sorting of dry waste and transport of all Municipal waste.
7. Realization of new sanitary landfill at Hooshang Abad.

Institutional strengthening of SWM organisations

The reform of OWRC into an organisation where the responsibilities, tasks and resources that are associated with the command/control function, are separated from the role as an active participator in the physical waste processes like collection, treatment and disposal. The three main organisational parts are OWRC for management, policy making initiating etc., the Tehran Municipal Waste Services as an organisation that controls the waste flow through logistics and exploitation and as third the Motor Pool in the role of leasing company.

The restructuring of OWRC is one of the main issues in the strategy and is considered as a basic requirement. The development of the detailed organisational plan and the Financial Management and Information system is high priority.

On short term the organisation should find its shape through, organisation charts, staffing plans etc

On medium term the OWRC should initiate an inspectorate in order to enforce and control the legal requirements and operational procedures in stakeholder groups but also in the operation of collection and transport/transfer system.

The Motor Pool activities can be summarized as 'leasing'. This implies administrative and financial activities but also technical activities like (preventive) maintenance. The current operational efficiency of equipment can be improved and a target of 80% up-time (currently 50%) should be set.

Most important is the institutional setting that is needed to create an organisational structure that can fulfil the requirements for financial structure, data collection and information analysis, know how on issues like technical, logistics, marketing and financial. To optimize finance, to minimize environmental impacts and to come to a sustainable development the strategic goals are: minimize tonnage to the landfill, increase recycling and composting effort and promote recycled products. Reduction of waste generation at source is an additional action which requires multidisciplinary timely efforts of various stakeholders. The main issues to be addressed are the product supply and consumption state. This should be addressed in the coming 10 years through cooperation of the related industries and the public awareness campaigns.

Quantity of waste

Domestic waste is the largest waste stream generated and shows a steady increase in line with an increased population from about 8 million in 2004 to 9.5 million in 2014. It is projected that the total waste flow will grow from 7.700 tons/day in 2004 to 10.000 tons/day in 2014, consisting of 9.300 tons/day of domestic waste (incl. informal sector), 600 tons/day of industrial waste and approximately 100 tons/day of health care waste.

Separation at source in wet and dry waste

In this strategy study it was considered whether to focus on separation at source of dry recyclables or on separation of wet (organic) waste. Separation at source in dry waste ánd in wet waste is most in line with the strategy of waste reduction:

- Separation at source in a dry component and a wet component is most clear to households: they understand in which bag to put what kind of waste. This will improve public participation.
- Separation of wet and dry components directly at source will result in better quality of both dry recyclables and pure organic waste. Hazardous waste is collected together with dry waste which will strongly reduce the risk on contamination of the organic fraction.
- Users of recycled products (farmers, households, public and private organizations) will prefer to buy products (i.e. compost) if they know the waste is coming from a separated source (pure input material). It will result in a better market price for the incoming waste to these industries.
- The alternative process of collecting dry recyclables and mixed waste and separation mixed waste at transfer station or land fill (pre-treatment), is expected to result in less quantity and quality of dry and wet recyclables and in additional sorting costs (more sorting lines required to handle all mixed waste).

In order to optimise waste reduction it is of strategic importance to move the sorting effort in the coming 10 years from sorting at the end of the SWM chain (pre-treatment) to sorting at the front (separation at source). The success of this strategy will depend on the participation of the inhabitants of Tehran.

Dry recycling: up to 20%

Increase of the dry recycling up to a 20% of the total produced household waste in 10 years time is the target that can be reached by: source separation in dry/wet waste and the required public awareness. In order to achieve this target it is proposed to implement a combination of collection systems either based on incentives (get a small return for the recyclables) and on easiness for the households (just put the separated waste outside the door). There is a strong role for OWRC to ensure that the awareness programs are (re) initiated and scaled-up, to ensure that an adequate logistic system is available and that there are sufficient downstream private recycling industries developed. The OWRC policy should find a proper way to handle the ongoing reduction of 'recycle value' of the waste as more recyclables are coming into the market. Market stimulation should be addressed by promoting the usage of recycled products to households, public and private organisations.

The current 8% of recycled waste is for the major part realised by the informal sector. The combination of the informal sector and the formal sector into a consistent recycle structure must be considered as a medium term goal. The recycling market requires more analysis in the near future, on the priority of recycling initiatives related to specific components like electro-waste, tires, hazardous waste etc.

Composting: up to 50%

One of the points in the waste reduction strategy is the composting of the separately collected wet/organic household waste and other high quality sources from e.g. fruit & vegetable markets. The strategic position of composting is targeting on maximizing the available composting material. The projected wet fraction from household waste is estimated on 50% or 5.000 tons/day in 2014 resulting in approx. 1.800 tons/day compost. The results of composting efforts so far have to be taken into account when assessing the risks of composting investments. Three main points of concern are identified: the adequate wet/dry separation, the composting technology and the compost market. Initiatives are already being developed to enhance the composting capacity. The increased role of the private sector should be developed parallel to compost standards to stimulate clear market positions and to reduce environmental risks.

Recycling infrastructure

The approach towards the introduction of separation at source is taken into account the structure of the 22 districts and 130 sub districts (population density, logistics, etc) and the required size in relation to type and amount of recyclables. The long term goal is to have per sub-district a place to bring recyclables ('*recycle shops*'), covering on average 60.000 inhabitants. The *recycle shops* will receive recyclables directly from individual households or small shops and enterprises and from the face-to-face collection system (replacing the current informal system). One of the approximately 5 *recycle shops* per district can have an enhanced function as '*recycle*

centre' The *recycle centres* will receive recyclables from other recycle shops and from a 'door-to-door' collection system using coloured bags for wet and dry waste. The infrastructure for shops and stations can also be developed for receiving electronic-waste and other types of "coarse" household waste (furniture, carpets, etc.).

In addition to the relative small-scale recycling shops on sub-district level and recycling centres on district level, it is optional to introduce about 4 large-scale *transfer station*s equipped with sorting lines for dry recyclables. The transfer stations will be multi-functional and open for receiving demolition waste, hazardous waste and special waste from small enterprises (e.g. from car repair sector: oil, batteries, brake pads, brake fluid). One of the problems that the Municipality faces is finding good locations for these enhanced transfer stations.

New Landfill

The development of the new Houshang Abad sanitary landfill site is not optional but a must, knowing the situation that the current landfill is full in 2006. The waste flow to the land fill will reduce from 6000 tons/day in 2004 (86 % of total waste) to approximately 3000 tons/day in 2014 (30% of total waste), depending on the results of the waste reduction strategy.

Healthcare

In the current healthcare waste disposal there are various problems identified of which the main one is an adequate disposal of what is called 'infectious hospital waste'. In fact the used definitions for characterisation of healthcare waste and subsequently the procedures for separation need to be clarified. Having better procures will optimize a needed capacity for autoclaving. The current practised procedure to mix e.g. body parts in household waste to be disposed to the landfill, needs reviewing and plans for source separation and waste labelling should be re-initiated. On short term the separation process should be optimized and the options for special locations on the new landfill for the approximately 30 tons/day 'real' hospital waste, should be investigated. For longer term the options of incineration should be studied.

Industrial waste

Industrial waste is for the major part recycled, reused in a business to business system. Of the net produced 550 tons/day, approximately 15% can be considered as dangerous.
On medium term the programs for a higher recycling effort and source reduction should be stimulated in cooperation with the industry. The use of a landfill facility for the most dangerous waste is a long term option for reducing environmental risks.

Costs

It can be expected that any sophistication of the waste control system will lead to an increase of the overall costs. Control of cost allocation is therefore important. The *polluter pay principle* should especially for industries and healthcare sectors be effectuated in order to have a cost recovery. The development of a tariff system based on a clear characterisation of the waste streams should be started.

The agglomeration of financial data shows that for the future development, two basic options are apparent: one option where the focus for recycling is with the private sector, so risks and revenues are pushed to the private sector. The other option is a more pronounced role of the government in the recycling business and thereby having more direct control. Consequently however the risks for the government increases and the governmental organisation to handle it all has to be available. The current calculated costs for waste management are 30 million $/year and if based on a realistic basis the costs are estimated on 50 million $/year. If developments are not controlled and consequently the landfill will be the focal point, the costs will rise to 75 million $/year in 10 years time. If cost recovery is increased by stimulation of private sector activities, the cost are estimated on 60 million $/year. If however the municipality will participate in waste treatment and increase cost recovery by higher prices of the waste, the costs will be reduced to 45 million $/year. The downside of the yearly lower costs are higher risks and the requirements for investments and organization.

Implementation of the strategy

The implementation of proposed actions should be put in an order that presents more ore less a critical path. Adding up all suggested actions will create an enormous task for OWRC. Source reduction and waste

It requires a clear set of priorities in order to work consistently on reaching the goals and targets. The main short-term emphasis should be put on the restructuring of the institutional system. The organisational basis should not be disputed and an effective decision making system with clear responsibilities of the various fields of expertise is needed.

In this respect it is vital to have the consent of the highest level in the municipality. This will assure a consistent implementation for the coming 10 years, needed to have the full results.

1 INTRODUCTION

The Tehran Solid Waste Management strategy is an important step to come to an integrated waste management that has a solid structure with respect to organisation, technical issues, community involvement and finance.

The strategy action and implementation plan will define short, middle and long term activities in a coherent way and some of the activities are already in preparation or ongoing.
In this respect the Adaptable Program Loan (APL) is the framework for the development assistance of the World Bank.
The APL frame work covers a two phased approach for institutional, recycling, health care/ industrial waste management and landfill/composting. For these four focal points or main project components, more detailed activities have been listed in the APL framework document.

The SWM strategy and the APL framework should be aligned and consistently be developed.

Sustainable development of the socio-economic and environmental conditions in Iran is the point of focus in the five year programmes of the government of Islamic Republic of Iran. There are a wide range of issues which need to be enhanced in achieving socio-economic development targets among which protecting and improving the living environment of residents can be a major concern.

The growing trend of population and consequently waste generation necessitates a more integrated and practically doable SWM system. Although almost all the waste generated in the greater Tehran is collected, yet the basic problems encountered in the treatment and disposal schemes are of growing concern.

Generally the problems with waste management lie in the needs for cost recovery and/or institutional (and legal) aspects. These could simply result in deficiencies and inappropriate operational features throughout the overall waste management components.

Development of a Municipal Solid Waste Management strategy which is a major practical issue for a city like Tehran of about ten million residents will necessarily need a clear definition of the vision.

The vision is in fact based upon the priority policies of OWRC as the sole waste management body of the municipality of Tehran. The main waste management policies have been established by OWRC through identification of the problems with the existing conditions as well as the opportunities/capacities of the current system.

Waste reduction through recycling and composting can be considered as crucial constituents of an integrated waste management system in this regard. Promotion of the waste recycling and composting could also lead to generation of additional income and improved cost recovery. This can consequently provide the municipality to develop gradually towards sustainable waste management scheme through a cost recovery program.

Strategic Vision for Tehran SWM:

"Development of an environmentally and socially sound solid waste management system in a cost effective and sustainable manner, for greater Tehran"

The Tehran SWM strategy is then established in order to achieve the so defined vision. The current SWM system needs a series of improvements in order to build the required capacity for achieving the overall goal defined in the vision.

A number of strategic options are introduced through a strategic framework. The strategic options cover the whole range of TSWM components including, institutional, operational and financial and cost recovery aspects as well as public awareness and private sector participations. The strategic options are then compiled to a number of implementation plans in terms of short, medium and long term investment projects.

This report covers a review on the existing SWM system in Tehran as discussed in details in the Phase 1 report followed by the strategy development. The main strategic options are introduced and assessed in terms of the associated sustainability. Accordingly a practically achievable implementation/action plan is prepared defining the required outsets and the gradual improvements and modification of the major tasks.

2 BACKGROUND

The components of the current SWM system in Tehran were reviewed in terms of efficiency and potential rooms for further development in operational, institutional and financial aspects. The main objective is set to achieve sustainability in every component of the system. The Domestic (household) waste was considered to hold the outmost priority and importance in developing the strategy. Healthcare and industrial wastes as well as specific waste were also included in the overall strategy development scheme as part of the integrated SWM system.

A number of shortfalls and bottlenecks were identified through studying the baseline conditions of the current SWM system. The main problems in this regard can be categorized into operational, institutional, financial and public awareness/participation components of the SWM system.

2.1 Operational aspects

2.1.1 Household waste

Following is a list of the most important shortfalls identified in the existing SWM scheme:

- Environmentally and socially unfavourable landfilling
    - Kahrizak landfill at almost full capacity
    - Extensive environmental and social pollution caused by current waste dumping practice
- Inefficiency of collection system in terms of:
    - Truck size
    - Waste handling time
    - Labour conditions
    - Public participation
- Shortfalls of transfer and transport system
    - Small size of the transfer stations
    - Relatively inappropriate transfer station locations and layout
    - Inappropriate waste volume reduction schemes
    - Transportation fleet needs for frequent repair
    - No provisions for environmental control
    - Very limited (if any) provision for workers' health control
- Recycling
    - Small recycling industries
    - No capacity for recycling larger volumes
    - Limitedly known and unstable market
- Composting
    - Low quality of final product
    - Technical and financial shortcomings
    - Limitedly known and unfavourable market

The operational problems stated above result from two main limiting factors of management and finance. The management unit or better to say the institutional configuration of the governing systems (i.e. OWRC, motor pool and the districts) seems not to have provided the required capacity for maintaining and developing the SWM system with respect to the growing needs associated mainly with the population and consequently waste generation growth.

2.1.2 Healthcare waste

Healthcare waste mainly generated at hospitals and medical centres is currently inappropriately managed in terms of source separation of infectious and non infectious wastes and the ultimate disposal. In fact apart from the general categorization of the HCW into infectious and non-infectious wastes, other constituents such as used and/or expired drugs, chemicals, radioactive waste and body parts should be taken into consideration.

Generally source separation of the infectious and non-infectious wastes has been and is currently practiced based on regulations provided by the MoH. The efficiency is evaluated to be practically low.

The so unfavourably separated HCW is collected and disposed in a mixed form. Disposal of the mixed HCW in a separate trench at the existing landfill site (i.e. Kahrizak) gives rise to the public health concerns and environmental contamination.

Separation of the HCW at source can be considered the main point of concern which is legally (i.e. based on the recently approved solid waste law) the responsibility of the MoH. Decentralized disposal of at least the infectious waste using incinerators have been experienced and failed in most the medical centres.

A pilot project is currently ongoing to determine the overall scheme required for the HCW management. Meantime the separation at source is considered to play a vital role through the course of HCW management. The final disposal option of HCW remain to be determined through evaluation of the feasible options including but not limited to introducing source autoclaves and sanitary landfilling or centralized/decentralized incineration.

Cooperation of the responsible organizations namely the municipality and the MoH seems also not to have been efficient in terms of establishing a sustainable HCW management system.

2.1.3 Industrial waste

The main part of the industrial recyclable wastes such as metals is recycled through ann internal business to business scheme. In other words many industrial plants use the wastes or by-products of other factories in their production processes.

The remaining part of the industrial waste which normally covers a range of materials not being capable recycling is transferred to the existing landfill site and disposed of together with the municipal waste. This part of the industrial waste can potentially comprise the hazardous materials either in form of solid wastes or semisolid wastes such as industrial wastewater

treatment sludge. Therefore the current disposal scheme is considered to pose highly adverse environmental impacts.

Lack of definition, categorization as well as handling procedures within the industrial units restricts the opportunities for safe collection and disposal of this waste. Separation at source in an uncontrolled manner has been and is currently being experienced by the industries. This is by law the responsibility of the MoI. The safe disposal of specially the hazardous materials generated at the industries seems to be totally lacking in the overall SWM system.

2.2 Institutional aspects

Concerning the SWM legislation, the recently approved law having still unclear points lacks the executive agenda. In fact the agenda was supposed to be prepared six months after the approval of the law by the parliament. This has not taken place even though more than six months is left behind. Lacking the executive agenda of the WM law as well as the required standards and guidelines, the development of a sustainable SWM system can be considered practically unachievable.

At a district level where the private companies are involved in urban services including city cleansing and waste collection, the main problem is identified to be the short term (1 year) contracts offered to a number of limitedly experienced private companies. This has led to a lack of interest within the private companies to make investments for longer terms. The typical contract encounters detailed tasks and requirements which are not met by the contractor nor supervised by the district.

Relatively unstable management setup of the municipality and consequently OWRC as the main organization responsible for SWM in Tehran has led to such a situation where the system can be generally considered unsustainable. Almost frequent changes of the management system both leads to some significant changes in the overall operational and budgetary practices. This indicates the lack of (or ignoring if any) firmly established legislations, municipal ordinance and organizational schemes. Accordingly no certain planning is carried out by the responsible organizations to overcome and enhance the existing system.

The management system is in deficiency of experienced and well educated staff that could assign solid tasks and to supervise and monitor the assigned tasks. Furthermore, OWRC plays also an operational role mainly including operation of the existing landfill and compost plant.

2.3 Financial aspects

The lack of a cost recovery component was observed within the SWM system and all costs are recovered through the municipal budget. This is partly because the Polluter Pay Principle is not implemented.

Lack of an appropriate (if any) information exchange system within the waste management scheme leads to unclear allocation of waste management functions to related organizations. In

other words the financial information chain is not covering all stakeholders and is mainly restricted in a district level.

Multiyear budgeting as a basic prerequisite of strategic planning and integrated SWM is absent throughout the responsible organizations (mainly the Ministry of Interior).

2.4 Public awareness and participation

Pubic awareness can be considered as a basic requirement for achieving a sustainable SWM system. Concerning the basis of OWRC policy which is focusing on waste reduction, public have been recognized to be the main component of a successful waste reduction plan. As stated earlier localized efforts have been and are made to enhance public awareness through a series of public awareness campaigns. Such efforts have partly been successful in a sense that the public awareness was enhanced in a certain locality. However these localized and lowly supported plans have not shown practical success since the downstream facilities are very limited (if any).

In addition inconsistency in the decision making process within different layers of the municipality including the districts and OWRC as well as lack of longer term planning has led to the fade of such activities.

On a contractual basis, the private contractors are to implement waste separation (mostly on a dry/wet) basis through offering a multi-bag system to the public. This is neither controlled or supervised by the district nor implemented by the contractor.

2.5 Conclusion

In summary, it can be stated that the existing SWM system in Tehran lacks the required infrastructure/capacity to achieve the goals and targets of a sustainable SWM system. The required capacity can be tracked from the highest level of decision makers of the field to the implementation and operational units.

A SWM strategy based on which a longer term planning could be achieved is absent in the current system. A first priority could be building the required capacity in terms of institutional rearrangement of OWRC, financing and information systems, marketing and operational infrastructure. Public awareness needs to be developed in a objective oriented manner to take fully into account the downstream consequences. Appropriate capacities for investment of private sector in SWM system can be considered to be of potentially high significance.

3 STRATEGIC FRAMEWORK

3.1 Vision

The strategic approach to the SWM system in greater Tehran covers a range of issues partly being the necessities of the system which are currently lacking as well as the requirements for a sustainable SWM system.
The overall goal of Tehran Municipality can be defined as the vision of the strategy as defined earlier. The vision as introduced before "***Development of an environmentally and socially sound solid waste management system in a cost effective and sustainable manner, for greater Tehran***" serves as the basic principle for the development of the strategy.
The main points of concern in the so defined vision are:

- Environmental and social acceptability
- Cost effectiveness
- Sustainability

3.2 Waste management policy

The policies of OWRC have been introduced in the Phase 1 report. The policy is objected to achieve a sustainable management of the waste streams in Tehran which is recognized to be absent currently. An environmentally and socially sound WMS while being well organized in terms of cost recovery and financing.

The current policy of the municipality as well as OWRC lies mainly in reduction of the waste streams to the landfill. Although a sanitary landfill is required inevitably as a significant component of the overall waste management scheme, waste reduction is considered to play an important role in terms of the sustainability of the SWM system.

The policy of the municipality is partly based upon mitigating and/or eliminating the problems with the current SWM system mainly associated with the current waste disposal scheme. The other and still the main feature of the policy lies in developing a sustainable SWM system where none of the problems identified in the current situation are present.

3.3 Waste streams

The waste streams covered in the strategy are;

- Municipal Solid Waste
    - Household waste
    - Commercial waste with similar composition to household waste
    - Street sweepings
    - Wastes from the fruit en vegetable market(s)
- Industrial waste

- Healthcare waste
- Special waste

Although the responsibilities of other organizations are taken into account in the course of developing the strategy, the possible relationships and coordination arrangements between the responsible organizations should be clarified.
However the priority waste stream will be the household waste which is generally regarded as the waste of highest generation rate being directly the financial responsibility of the municipality.
The responsibility of the industrial and healthcare wastes is by law with the ministry of industry and the ministry of health, treatment and medical education respectively. Special waste or hazardous waste which can be part of the industrial as well as healthcare wastes is not defined clearly in the law. The municipality can however play a major role in providing services for the responsible organizations to manage these types of wastes.

Strategic time frame
The strategy is to be developed for he following time frames:

- Short term (1 to 2 years)
- Medium term (2 to 5 years)
- Long term (10 to 20 years)

Overall strategic framework
The main points of focus in the strategic framework can be categorized as follows:

- Institutional framework
- Operational features
- Financial sustainability
- Public awareness and participation

The strategic framework comprises the following activities:

- Reviewing the shortfalls and problems identified in the baseline condition
- Reviewing the policies of the municipality
- Developing strategic options in compliance with the current policies
    - Institutional options
    - Operational options
    - Financial/cost recovery options
    - Public awareness and participation options
- Characterizing the strategic options through required activities/alternatives
- Defining certain indicators or criteria for comparison of the options
    - Environmental and social sustainability
    - Cost recovery and financing
    - Implementation timeframe
    - Required capacity building effort
    - Need for public awareness/participation
    - Need for private sector involvement
- Comparison of the strategic options

- Agglomeration into one consistent strategy
- Preparing the action/implementation plan
- Task breakdown of the implementation plan
- Preparing the investment plan
- Setting monitoring and upgrading mechanisms for the implementation plan

The strategic framework covers the whole range of involved groups mainly including but not limited to the municipality, OWRC, districts and motor pool.

The approach for the Integrated Waste Management Strategy is outlined in Figure 1.

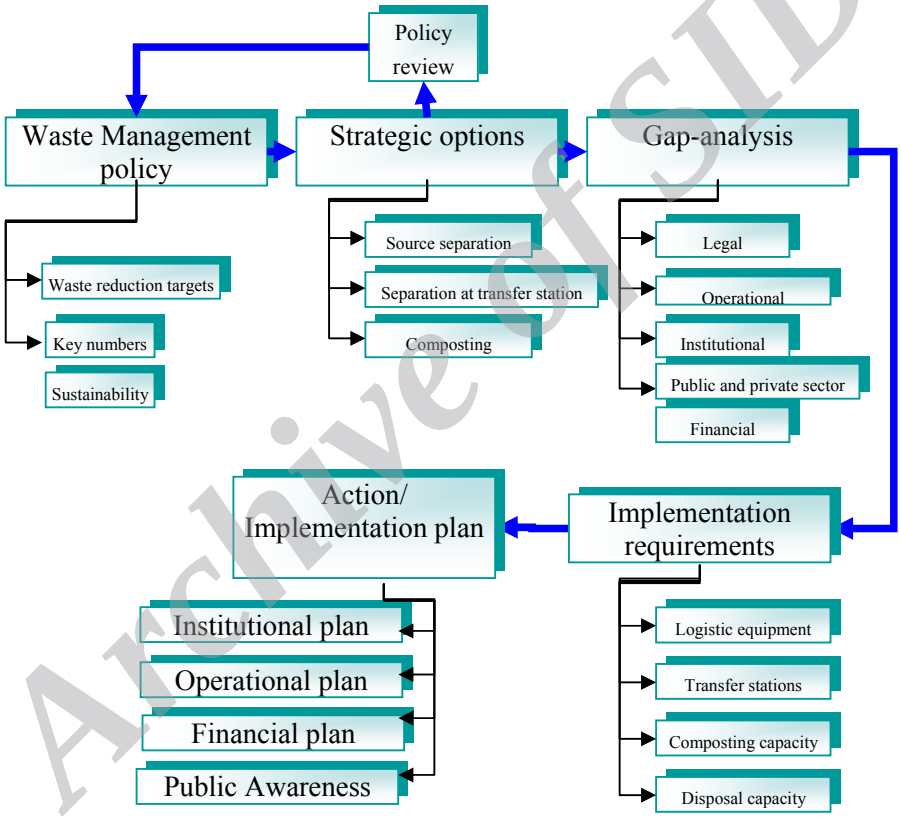


Figure 1 Strategic Framework

In the first part of the project the focal point has been the analysis of the existing situation. In the Phase 2 report, the focal point will be the Strategic Framework. The framework will be developed from the waste management policy until cost recovery and institutional requirements to support the investment.

3.4 Development of strategic options

The strategic options are set out in compliance with the current policies of the municipality. The overall objective which is reflected also clearly in the vision is to achieve a sustainable SWM system. Generally two main strategic options are taken into account as follows:

- Option 1: Sole sanitary landfilling
- Option 2: Waste reduction

Strategically waste reduction can be considered as the overall objective in line with the current policies of the municipality. Meantime a sanitary landfill is however required since a significant portion of the waste stream to various reduction schemes would not be capable of being composted, recycled or reused. Sole landfilling of waste streams (mainly domestic waste) in a sanitary landfill which is already designed (BC Berlin, 2004) can provide a reasonable sustainability in terms of environmental and social impacts. This option is relatively costly because of the level of environmental protection as well as the required improvements in transfer and transportation scheme.
Waste reduction can provide the highest level of sustainability while requiring a significant effort behind to develop all required capacities. Starting from the generation of waste at the predefined waste streams, ending to composting, recycling and sanitary disposal, every part of the waste management structure mainly public awareness and participation, institutional strengthening, operational scheme and financial sustainability should be focused significantly. In other words waste reduction will require actions which are totally or partly absent in the current SWM system. The strategic options are introduced and discussed in proceeding chapters.
On the highest level the main strategic option/decision focuses on waste reduction. Waste reduction can be achieved through a number of strategic alternatives as follows;

- Option 2-1: Source reduction.
- Option 2-2: Composting recycling.
- Option 2-3: Pre-treatment and landfilling.

The option represents a decreasing complexity of solid waste reduction.

The strategic options are categorized as operational and institutional options. The institutional strategic options are considered as the basic requirements to achieve certain operational option.

Each operational strategic option is evaluated based on a number of criteria as mentioned above. The best operational option is selected and the corresponding institutional rearrangements and improvements are set out.

It is worth noting that cost recovery options which should clearly reflect the financial sustainability of the operational and the consequent institutional options are taken into account. Every option can be analysed in terms of the associated costs and the financial resources available or anticipated. A correlation of the costs (and the availability) with the risks of every option will demonstrate the suitability of the option.

In addition to the domestic waste which can highly be considered as the major concern of the municipality, industrial and healthcare wastes are also taken into account in developing the strategy. Generation and source processing of these wastes are considered to be the responsibility of the related organizations. The municipality can play a significant role in providing services for the responsible organizations in terms of sustainable collection and disposal. This can be considered as a potential option for cost recovery in the SWM system of the municipality.

3.5 Gap-Analysis

A sustainable SWM system which is provisioned for the greater Tehran is characterised by a set of certain requirements at every components of the system. Gap analysis will lead to a clear view of the shortfalls and bottlenecks in the existing system as well as the needs for improvements. The major part of the gaps lies in the basic capacities in terms of legislation of the SWM system, awareness and expertise of the stakeholders, public and authorities and the financial structure.
The main gaps identified and stated in phase 1 report are summarized in **Error! Reference source not found.**.

SWM Component	Main gaps
Legislative aspects	- Unclear definition and categorization of the waste streams - Lack of by laws for the recently approved waste management law - Lack of an efficient (if any) enforcement mechanism - Lack or deficiency of SWM guidelines
Institutional aspects	- Lack of municipal ordinance - Ignorance of articles of associations of OWRC - Weak cooperation scheme between the stakeholder organizations - Deficiency of expertise within the SWM system including OWRC, districts, motor pool and private contractors - Lack of (long term) planning - Frequent change in management in terms of the overall decision making process
Operational aspects	- Environmentally and socially unsound waste disposal system - Inefficient compost plant - Limitedly known and controlled markets for the compost and recycled material - Incompatibility of the collection, transfer stations and transportation fleet with a sustainable SWM scheme
Financial sustainability	- inadequate accounting system in terms of consistency and transparency
Public awareness and participation	- Limited and temporally and spatially inconsistent efforts made to enhance public awareness on source separation and recycling
Private sector involvement	- Lack of incentive for the private companies to make investments resulting from a 1 year contract offered - Lack of expertise of the private companies

	- Private contractors are not requested by the municipality to meet the typical requirements stated in their contracts

Table 1 Main gaps of existing swm system in Tehran

3.6 Implementation requirements

Some difficult decisions will need to be made during preparation of the Implementation/Action Plan. The Plan can have major political, institutional, technical and financial implications, all of which must have been addressed clearly and effectively if it is to be agreed, adopted and implemented.

The main areas of attention required to be focused in the implementation/action plan can be categorized through the SWM system components as follows:

- Institutional
  - Institutional framework
  - Improving organization and management
  - Improving private sector involvement
- Operational
  - Waste treatment and disposal technologies
  - Environmental and sanitation aspects
  - Improving service levels
- Financial
  - Improving financial planning
  - Investment needs
  - Improving cost recovery
  - Improving accounting
- Public awareness and participation

The implementation/action plan provides the basis for sustainable SWM in Tehran taking into account all political, financial, operational and institutional aspects. It will cover the basic requirements for improvement of the existing SWM system as well as the needs for further and sustainable development of the system.

The needs are translated into a series of actions and activities through the course of the strategy timeframe in form of operational activities and the related and required institutional and financial actions. The operational part covers the whole range of activities required to perform the selected options.

A proper implementation will result in requirements for hardware, finance and organisation. The requirements comprise the number of logistic units, the number of transfer stations and the operations performed (separation, compaction), composting capacity, landfill capacity etc.
In addition attention will be paid the investment planning, acknowledging the fact that it will take a time span to realize investments and making installations operable.

3.7 Development of the Action/Implementation plan

In the implementation plan, the results are presented in a consistent way, covering all relevant aspects on institutional, staffing, legal, investment; cost recovery, public awareness etc.
It is essential to ensure that the Action/Implementation Plan is realistic and can be implemented in practice. As stated earlier in this chapter, preparation of an Action Plan/Implementation will involve pre-feasibility studies of short-listed technical options. Pre-feasibility studies should be sufficiently detailed to allow decisions to be made on options to be pursued. More detailed feasibility studies will, however, is required to pursue the selected options into implementation.

4 INSTITUTIONAL STRATEGIC OPTIONS

4.1 Development of an institutional framework

The development of a new institutional framework has to be based on the general principles of rationalization of roles and responsibilities (core business activities, avoiding conflict of interests), transparency for all stakeholders and accountability (poor performance) in order to achieve cost efficiency and effectiveness.

The key elements for such re-organisation are:

Organisational

- Tasks and responsibilities of stakeholders should be clearly defined (accountability)
- Capabilities of stakeholders should be clear (transparency)

Operational

- Waste collection especially from households preferably at lowest municipal administrative level in order to enhance public participation (Sub District)
- Transfer/treatment/transport/disposal preferably at metropolitan level in order to achieve economy of scale (Municipality)
- Private sector participation as it might result in cost efficiency through competition (collection, transport, treatment/recycling, disposal)

In addition to the above mentioned organizational/operational aspects it is also important that the proper legislation and rules and regulations (National and Municipal level) are developed in order to introduce the adequate working environment and to introduce a control and monitoring framework. However these aspects are not taken into account in the option evaluation as they are applicable for all options.

In Table 2 Analysis of existing situation, the institutional options are presented. The recommended responsible organisations and /or structures are underlined.

	GENERATION	COLLECTION	TRANSFER/TRANSPORT	TREATMENT	DISPOSAL
HOUSEHOLD WASTE	*Legislation*: Department of Environment/ministry of interior *Executive responsibility:* Municipality	-Municipal level -District level -Sub district level -public and/or private	-Municipal level -District level -Public and/or private	-Public -Private	-Municipality -Private
HEALTHCARE WASTE (INFECTIOUS)	*Legislation*: Department of Environment/ministry of health *Executive responsibility*: Hospitals	-Municipal level -District level -public and/or private	-Municipal level -District level -Public and/or private	-Public -Private -Hospital	-Municipality -Hospital -Private
INDUSTRIAL WASTE (MANUFACTURING)	*Legislation*: Department of Environment/ministry of industry *Executive responsibility:* Industry	-Municipal level -District level -Public and/or private	-Municipal level -District level -Public and/or private	-Public -Private -Industry	-Municipality -Private -Industry
SPECIAL WASTE	*Legislation*: Department of Environment/ministry of interior *Executive responsibility*: Municipality	-Municipal level -district level -Sub district level -Public and/or private	-Municipal level -District level -Public and/or private	-Public -Private	-Municipality -Private

Table 2 Analysis of existing situation

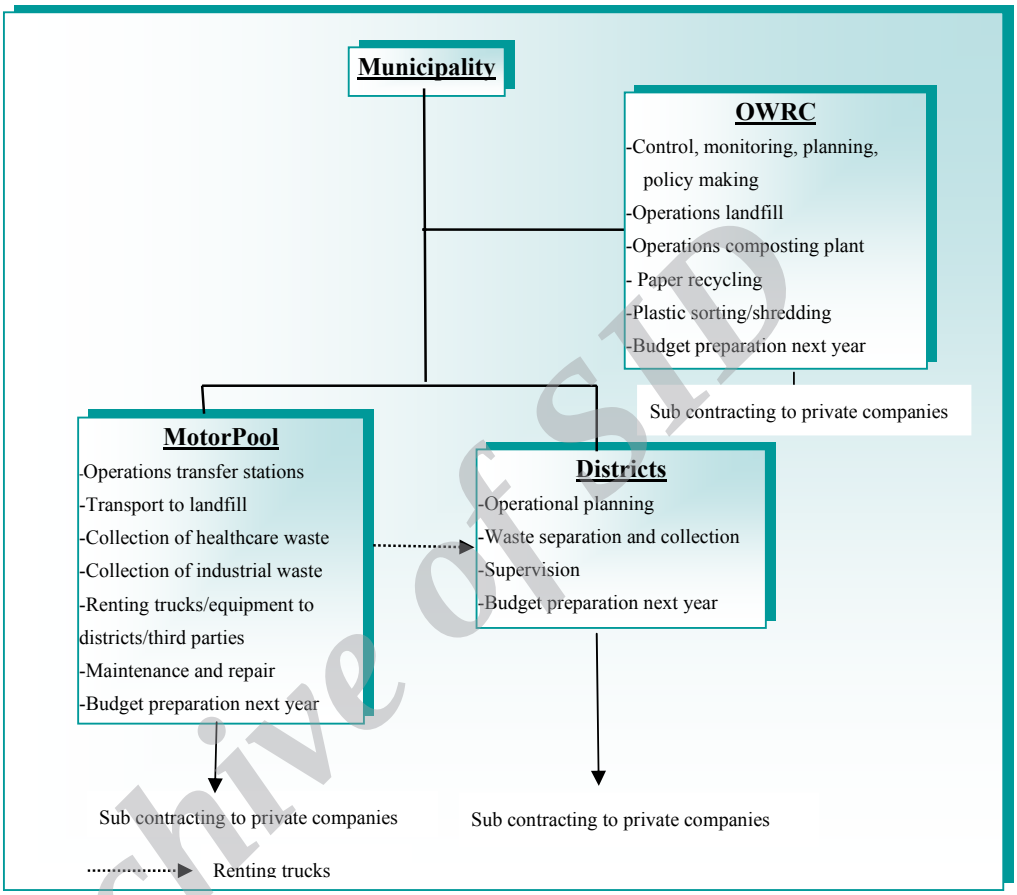


Figure 2 Overview institutional existing situation

Advantages

- One organization at District level for waste collection (District office)and one organization at Municipal level for Metropolitan services (Motor Pool)
- One organization for planning, strategy development, control and monitoring (OWRC)

Disadvantages

- No Municipal Ordinance (By-Law) defining the tasks and responsibilities of all stakeholders (inhabitants, District, waste collectors, recyclers, Municipality)
- No multi- annual Waste Management Strategy Plan at Municipal level and no annual Waste Action Plan at District level
- Combination of conflicting tasks in one organization (e.g. control/monitoring and operational activities in OWRC and thus no accountability for poor performance)

- No dedicated waste management department at District level and thus no experienced staff working on specific waste management aspects. No public awareness campaigns due to lack of budget resulting in poor public participation
- No real expertise is built up within Municipal and District organizations as most operational services are sub- contracted to private companies. This results in a fragmented waste management system as most contracts are on an annual basis.
- Staff within Municipal/District organizations is moved frequently between departments and organizations. Senior management is appointed for 2-3 years and they are normally "generalist" and not always familiar with waste management practices and they lack experience. Consequently training can only become effective if "moving around" is stopped.
- Sub- contracting to private companies for waste collection and operations is mostly on annual basis. Thus no motivation for private companies to improve services in view of investment risks and to built up trained staff(prolongation of contract)
- Contractors are mostly hiring in labour and trucks and thus contractor is becoming more a manager than a specialized waste collection company. Selection criteria for contractors are not always transparent and mostly based on price than on experience and expertise. The reasons for decision should be open before the public so it can enjoy the support of the public.

4.2 Introduction of reviewed options

4.2.1 Analysis Option 1

Institutional Set Up Waste Management- Option 1

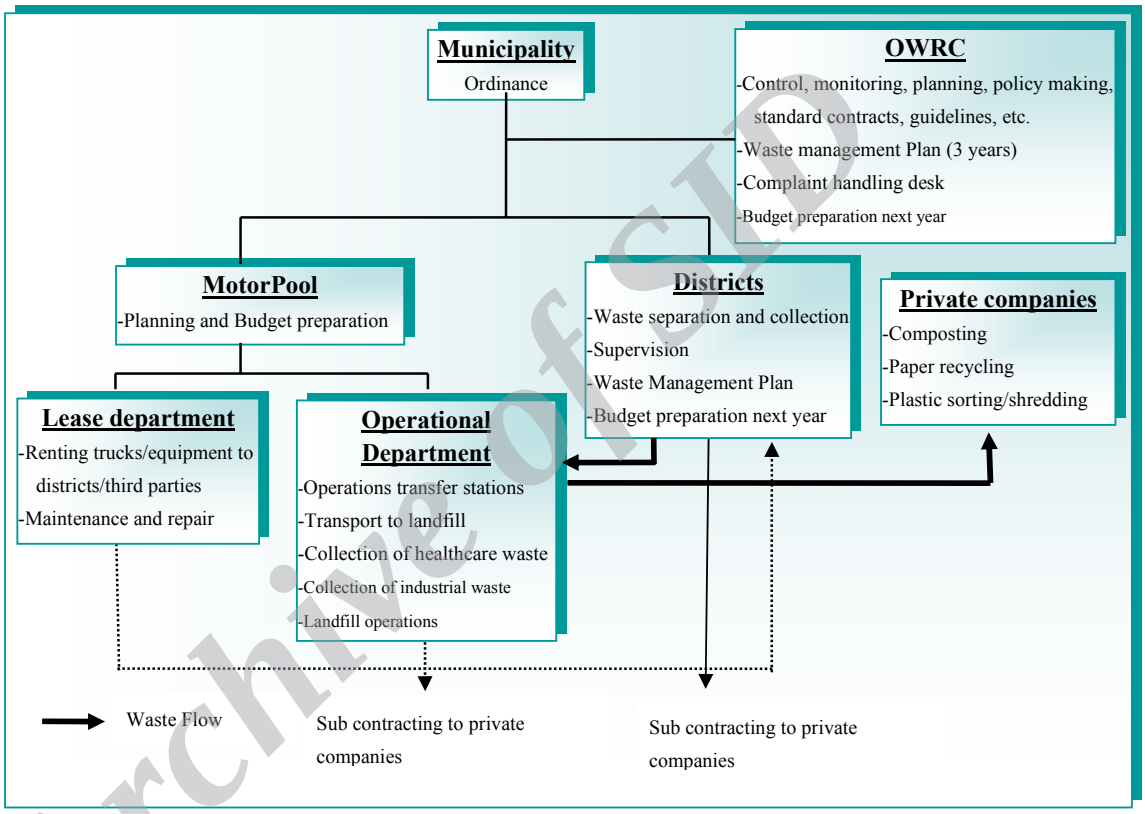


Figure 3 Institutional option 1

Advantages

- Activities of OWRC are restricted to its core business i.e. planning, policy making, monitoring and control, etc. There is no combination with operational activities (landfill, recycling). OWRC can concentrate on preparation of draft Ordinance, Municipal Waste Management Plan, etc.
- Recycling activities (heavily loss making in case of composting and paper) are privatised so there is no chance for conflict of interest between Municipal waste management services and private business development is promoted
- All operations on Municipal level are combined in one organization (Motor Pool)
- Districts get more autonomy in the field of waste planning and policy development through establishment of a waste management department

Disadvantages

- Motor Pool has combination of tasks i.e. leasing/renting/maintenance of equipment and operational waste collection/ transport activities. This might give a conflict of interest concerning rent/lease costs and maintenance priority for equipment to be used by own operational department or by Districts/private contractors.
- Motor Pool has no experience with landfill operations and thus staff of OWRC should be transferred to Motor Pool.
- Size of Motor Pool (i.e. number of employees, variety of activities and the number of sub contracts with private companies) could make it a difficult to control/manage organization. This might result in inefficient and non transparent operations.
-

4.2.2 Analysis Option 2

Institutional Set Up Waste Management- Option 2

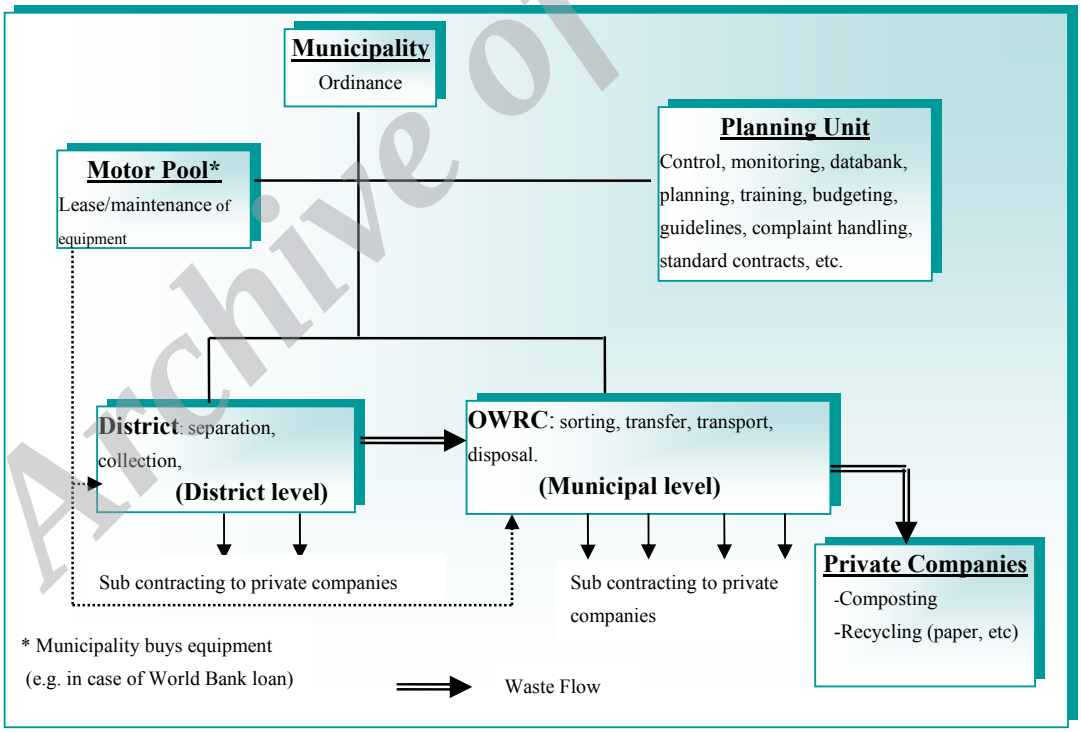


Figure 4 Institutional option 2

Advantages

- All planning, policy making, monitoring and control, etc activities are concentrated in one new organisation. They can concentrate on the preparation of a Draft Ordinance and

the Municipal Waste Management Plan. There is a strict division with any operational activity
- All logistic operations on Municipal level are combined in one organisation (OWRC) except for recycling activities as this might create a conflict of interest
- Districts get more autonomy in the field of waste planning and policy development through the establishment of a waste management department
- Motor Pool will concentrate on lease/renting/maintenance of equipment offering services to the Districts and OWRC

Disadvantages

- OWRC activities will be extended (transfer stations, transport, collection) and staff from Motor Pool has to be transferred (back again) to OWRC. This might create a confusing situation
- OWRC has not the management capability to deal with the operational aspects taking into account the present staff (number and qualifications). This is also reflected in the management of the existing recycling operations which are heavily loss making operations.
- Making OWRC responsible for operations at Municipal level will involve substantial re-organisation and transfer of personnel which might result in considerable confusion with the present staff.

4.2.3 Analysis Option 3

Institutional Set Up Waste Management- Option 3

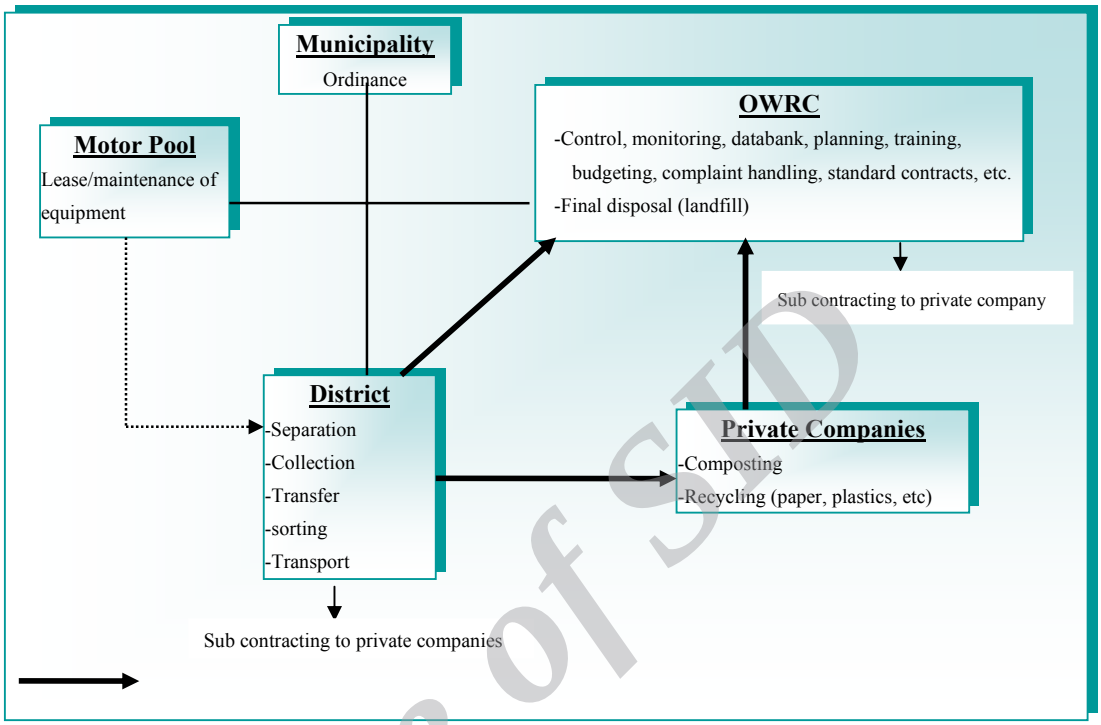


Figure 5 Institutional option 3

Advantages

- Large autonomy for the Districts to arrange for collection, transfer and transport through competitive bidding. This might result in more efficient and effective services as private companies will play a major role
- Motor Pool will concentrate on its core business i.e. lease/renting/maintenance of equipment
- OWRC will concentrate on planning, policy making, etc. For landfill operations a Public Private Partnership will be set up i.e. acceptance of waste by OWRC and landfilling, covering, extensions by a private contractor
- Recycling activities are privatised which is in line with the private waste collection services

Disadvantages

- Districts lack the management capability and staff to take over full responsibility for all waste management tasks on the short or medium term. Substantial training and time is needed.
- Higher costs might be involved due to lack of economy of scale at Metropolitan level

4.2.4 Analysis Option 4

Institutional Set Up Waste Management- Option 4

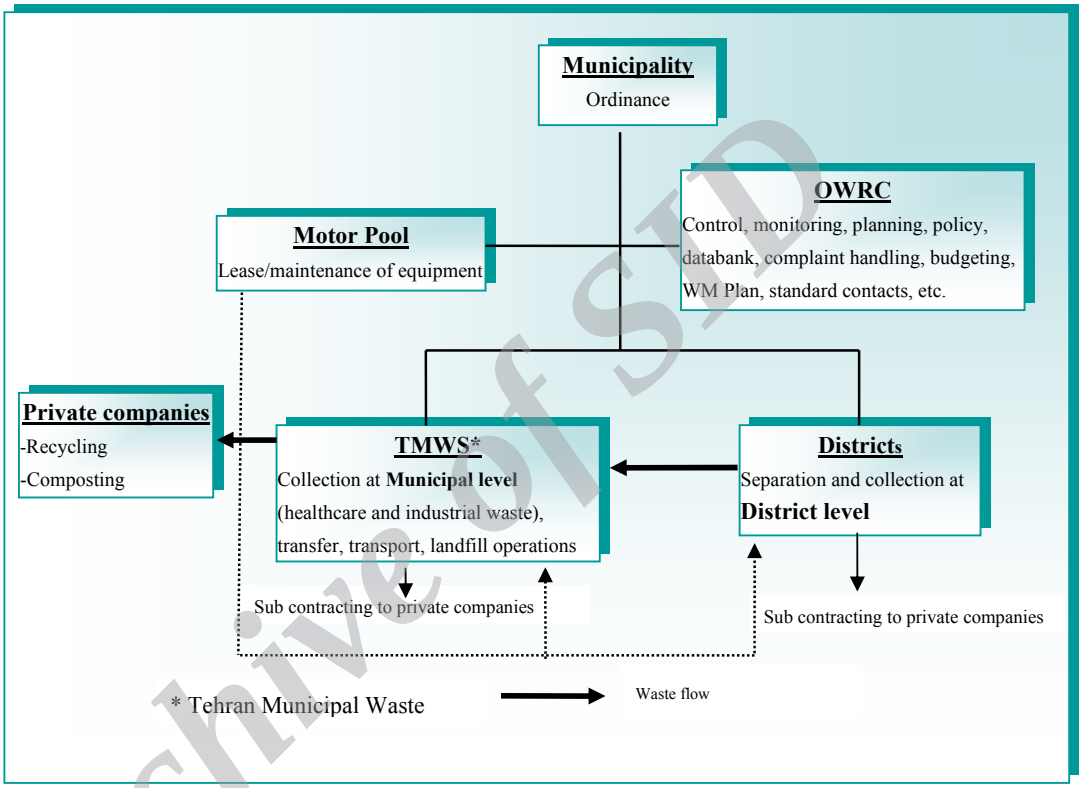


Figure 6 Institutional option 4

Advantages

- Activities of OWRC are restricted to its core business i.e. planning, policy making, monitoring and control, etc. There is no combination with operational activities (landfill, recycling). OWRC can concentrate on preparation of draft Ordinance and Municipal Waste Management Plan
- Motor Pool will concentrate on its core business i.e. lease/renting/maintenance of equipment
- Recycling activities are privatised so there is no chance for conflict of interest between Municipal waste management services and private business development is promoted
- Districts get more autonomy in the field of waste planning and policy development through the establishment of a waste management department
- A new operational company will be established (Tehran Municipal Waste Services-TMWS) combining the operational waste management staff from OWRC and Motor Pool. Sub-contracting of activities should be critically reviewed in order to build up operational experience and expertise inside the new company

- TMWS should operate as a "commercialised" company as it can generate income from selling recyclables and rendering collection services to industries and healthcare facilities. Payment system to Managers and staff should include incentives for good performance.

Disadvantages

- Setting up of a new company will require re-organisation of existing organisations (OWRC and Motor Pool) and transfer of staff. This might create confusion with the employees for some time as in the past many re-organisations and transfers were carried out.

4.3 Selection of preferred option

The options are analysed and based on assessment of the advantages and disadvantages, the preferred *Option 4* is worked out in more detail (see Table 2). It is believed that this option will result in:

- More transparency in company/organization skills and experience, resulting in higher professional standards
- Clear division of responsibilities and the introduction of accountability and avoiding conflict of interests
- Division of the various waste management services into municipal and district level
- Promotion of private sector participation in waste collection and especially in treatment/recycling

In Table 3 an overview of the preferred institutional option is outlined for the main 4 types of waste.

Waste type*	Responsibility	Collection and transport	Proposed financing
Domestic			
(i)Household	(i)Municipality	(i)District through contracting to private company	(i)Phased implementation of a differentiated tariff system (e.g. based on size of house).
(ii)Dry Recyclables	(ii)Municipality	(ii) District through contracting to private company	(ii)From revenues of selling the sorted fractions.
Healthcare			
(i)Household/recyclables	(i)Municipality	(i)District through contracting to private contractor	(i)Cost recovery basis
(ii)Infectious	(ii)Healthcare	(ii)Municipality(TMWS) or	

	facility	licensed private contractor	(ii)Tariff to be negotiated on basis of: -pre treatment by hospital, or -incineration or autoclaving by Municipality at landfill
Industrial (i)Household/recyclables	(i)Municipality	(i)District through contracting to private contractor	(i)Commercial basis (tariff to be negotiated)
(ii)Manufacturing	(ii)Industry	(ii)Municipality(TMWS) or licensed private contractor	(ii)Commercial basis (tariff to be negotiated depending on volumes and type of waste)
Special(hazardous) (i)Fridges/freezers (ii)Computers, screens, etc (iii)Batteries (iv)Small chemicals from households(medicines, etc) (v)End of live vehicles (vi)Tyres (vii)TV sets (viii)Lighting (fluorescent) (ix)Bulky (furniture, etc.)	Municipality is responsible for the special(hazardous) waste	Presently most of these types of wastes are collected by the informal sector for repair, re-use or dismantling and recycling. No complaints are received from the households as the collection system apparently works smoothly. However the Municipality should develop a strategy plan on the goods having a hazardous component (CFC in fridges or lead in TV screens)	On a national level the discussion should be started to introduce the Producer responsibility i.e. the manufacturer or the importer should pay a fee for putting the goods on the market and the fee will be used for recovery. Otherwise the Municipality will be responsible for collection, disposal and payment thereof.

Table 3 Overview of waste stream management in preferred institutional option

5 OPERATIONAL OPTIONS

5.1 Operational alternatives

In Chapter 3 the strategic objectives for Solid Waste Management for the coming long term (10-20 years) are defined. The following main options are considered:

- Option 1: land filling (continuation of existing situation)
- Option 2: waste reduction

Looking at the strategic options as discussed in Chapter 3, we come to the following main alternatives for waste reduction.

Option 2-1: source reduction and re-use

- public awareness campaigns on source reduction and usage of recycled products.
- emballage re-use by business-to-business industries
- bottle refill by retail shops and consumer industries
- introducing producer responsibility on packaging

Option 2-2: waste recycling and composting

2-2.1 separation organic waste and composting

2-2.2 separation dry recyclables and recycling

Option 2-3: pre-treatment and land filling

2-3.1 treatment of organic component in mixed waste in order to reduce weight and volume before land filling.

2-3.2 treatment of dry component in mixed waste and make RDF (refuse dry fuel) as fuel for cement ovens and other industrial ovens.

In the coming paragraphs operational alternatives for generation, collection, transfer, transport and final treatment are analysed for domestic waste, healthcare waste, industrial waste and special waste.

5.2 Criteria for comparison of alternatives

In Chapter 3 the strategic objectives for Solid Waste Management for the coming 10-20 years are defined. These objectives are translated into criteria which can be used for the assessment of alternative options and plans. The principal objective of any plan for municipal solid waste management is to ensure safe, efficient and economical collection, treatment and disposal of wastes and to ensure that the system is reliable now and for the foreseeable future.

The following 5 criteria for comparison of alternatives are specified:

1. **3-R strategy (reduction, re-use and recycle)**: to minimize the amount of solid waste generated, to maximize the re-utilization of products, to maximize the recycling of waste, to maximize energy recovery from disposed waste.

2. **Economic Viability**: to minimize costs, subject to other (often conflicting) objectives and constraints.
3. **Technical Reliability**: to ensure that the solutions are proof, safe, flexible, and maintainable under local conditions
4. **Environmental Impact**: To minimize the energy usage for collection, transfer, transport and recycling. To reduce health risks, nuisance and environmental pollution risks associated with the collection, treatment and disposal of municipal solid waste.
5. **Socio-Political Acceptability**: maximum degree of understanding and acceptance of the direct affected (public, companies, organizations). Ensure a long term legal and institutional strengthening. To maximize the number of jobs created.

The criteria are described for each alternative and provided with a qualitative score: + = positive qualification, 0 = neutral qualification and - = negative qualification. The scores are used to compare the alternatives and come to a selection of preferred operational options.

5.3 Domestic waste

Looking at the strategic options (Option 1 and Option 2) a major effort for the coming 10 years will be in starting up Option 2-2: separation at source of dry recyclables and/or organic waste and realizing a strong recycling and composting industry. This will be the main focus in this paragraph.

5.3.1 Separation: Dry or Wet?

An important question for waste separation and recycling (Option 2-2) is: focus on separation of dry recyclables, or on separation of organic waste? Two main categories can be defined:

1 **Separation of valuable dry recyclables**: door-to-door collection of valuable dry recyclables (paper, plastic, metals, glass, dry bread) from households in residential areas and from shops/restaurants/offices. This is circa 20% of total waste flow.

2 **Separation of wet and dry waste** : door-to-door collection of two bags, one with wet waste, one with dry waste (paper, plastic, metal, glass, fabric, wood, foam, leather, dry bread, hazardous waste) coming from households and shops/restaurants/offices in residential areas.

In Table 4 a comparison is made of advantages and disadvantages of these strategic options.

	1. Separation of dry recyclables	2. Separation of wet / dry waste
3-R strategy	0 Three main components make out 20% of total waste, and future growth in waste quantity will be in these components.	+ 70% of total waste volume is potential for composting, 30% has valuable dry recyclables that need further sorting and recycling.
Economic Viability	0 Neutral to positive costs-benefit ratio: only separation of materials with good market value, but more waste has to be (pre-treated and) land filled.	0 Neutral to positive costs-benefit ratio: depends on processing costs and market for composting and on sorting costs and market for dry recyclables.
Technical Reliability	+ Technically no problems. Additional capacity of trucks required.	+ No technical problems. Collection trucks with leachate storage are required for organic waste.
Environmental Impact	- Residue contains hazardous components and is not easily to use as compostable material. - Residue will be of low quality for composting.	+ Hazardous waste can be collected together with dry waste and separated at a sorting facility. - Risk of leakage of leachate on curb site/in streets during collection.
Socio-Political Acceptability	0 Households need good information what should be separated. - Informal sector focuses on same components	+ It is clear to households what is wet waste and what is dry waste. + Most households already separate wet waste in kitchen (using bins).

Table 4 Overview advantage/disadvantage of separation dry recyclables or wet/dry waste

Separation at source in dry waste and in wet waste is most in line with the strategy of waste reduction:

- Separation at source in a dry component and a wet component is most clear to households: they understand in which bag to put what kind of waste. This will improve public participation.
- Separation of wet and dry components directly at source will result in better quality of both dry recyclables and pure organic waste. Hazardous waste is collected together with dry waste which will strongly reduce the risk on contamination of the organic fraction.
- Users of recycled products (farmers, households, public and private organizations) will prefer to buy products (i.e. compost) if they know the waste is coming from a separated source (pure input material). It will result in a better market price for the incoming waste to these industries.
- The alternative process of collecting dry recyclables and mixed waste and separation mixed waste at transfer station or land fill (pre-treatment), is expected to result in less quantity and quality of dry and wet recyclables and in additional sorting costs (more sorting lines required to handle all mixed waste).

Based on the advantages and disadvantages described above and following the strategy to reduce the total quantity of waste, the Consultant proposes to choose for option 2: *separation of wet waste / dry waste*.

5.3.2 Basic operational options for wet / dry separation

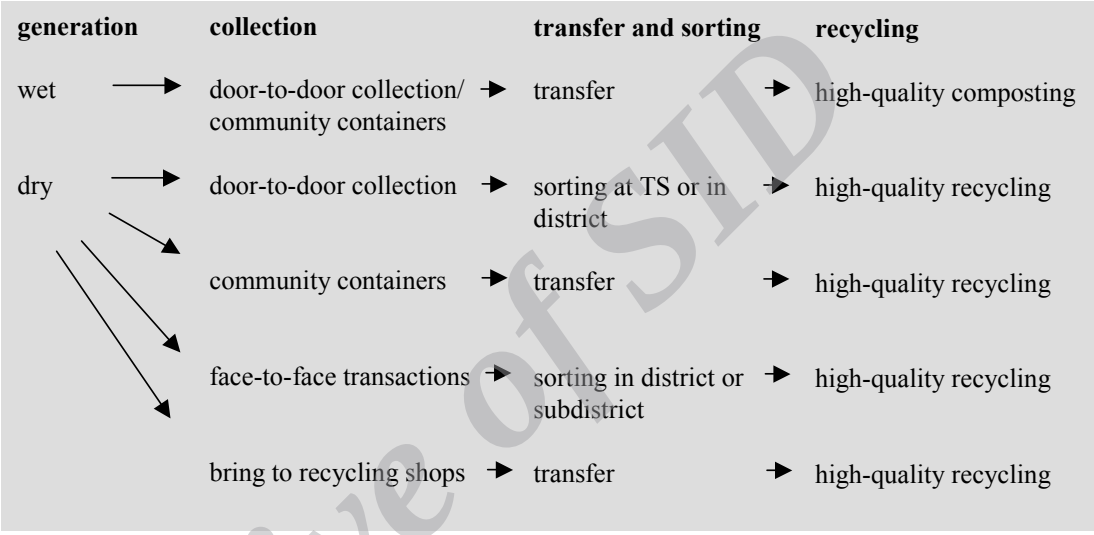


Figure 9 Basic operational options

In Figure 9 Basic operational options the basic operational options for separating wet waste (Option-2.1) and dry waste (Option-2.2) are shown, which is in line with the strategic objective of waste reduction. The alternatives for wet waste and dry waste are further detailed in the following paragraphs.

5.3.3 Separation and recycling of wet waste

Separate collection of wet waste

For wet waste there are two main options for separate collection:

1. door-to-door collection of bags from the curb side with a high frequency (preferably 7 days per week).
2. community containers located in the district (1 container per 100 households to obtain a high density of containers) or at fruit- and vegetable markets.

	1. door-to-door collection in bags	2. community containers
3-R strategy	+ People can easily dispose their organic waste with high frequency. This might result in high quantity and quality of	0 People have to do more effort to dispose their waste.

	organic waste.	
Economic Viability	+ Positive costs-benefit ratio: low collection costs, maybe special (biodegradable) bags required for composting.	- Neutral to negative costs-benefit ratio: investments in containers, high cleaning costs for containers.
Technical Reliability	+ No technical problems, but it requires collection trucks with leachate storage.	+ No technical problems, but it requires collection trucks with leachate storage.
Environmental Impact	- Risk of cats eating from organic waste in bags and leachate leakage.	- Community containers will get dirty and attract cats, mice and flies. - People might also put residue waste in containers.
Socio-Political Acceptability	- Socially people might have problems with bags with organic waste (leachate leakage)	- Not in my backyard (NIMBY) effect. No household wants a container in front of their house.

Table 5 Analysis separate collection

Based on above criteria we propose to choose for collection of organic waste in special strong bags for households. These bags can be made of biodegradable materials on the long term. For fruit- and vegetable markets usage of large containers will be more beneficial, but this requires good maintenance and cleaning of containers to reduce health risks and allocation on a concrete floor with waste water outlet.

Transfer and transport of wet waste

For transport of wet waste we propose to use the existing but improved infrastructure with transfer stations and direct dump in semi-trailers. The semi-trailers have to be located on a water tight concrete floor with waste water outlet. The semi-trailer has to be water tight (good working rubber frame around the backside door) and has to have a collection system and tank for leachate.

The semi-trailers can have an optimum load of maximum 30 tons\truckload (10 tons per truck axle). This required number of trailers will depend on the distance to the future location(s) for the composting industry. Considering the distance to Kahrizak , the required number of trailers and tractors will be reduced to 22 tons/30 tons = 73 % of the current total. This number will be further reduced if dry waste is transported in bales using normal flat trailers in stead of semi-trailers.

Composting of wet waste

Producing quality compost for most of agricultural and horticultural industries requires establishing standards, close supervision and quality control from the beginning to end of the composting process, including raw materials.

Unacceptable compost is almost as costly to produce as quality compost but there is little market for it, while the agricultural and horticultural market for quality compost has yet to be saturated (The Ministry of Agriculture is proposing the use of 500.000 tons of compost per year). The use of low quality compost is generally limited to reclaiming disturbed soils, capping landfills, improving crop land for non-food crops and dumping in landfills.

Marketing an odorous improperly-composted product can result in complaints, total rejection and bad publicity, as it is the case now in Iran.

It is difficult to establish uniform agricultural standards for all composted products, because composts are made from numerous raw materials and come from different sources. However since compost is made from organic products and by products it should be comparatively uniform, providing that additives such as metals are within approved limits. Also according to some sources the reduced impact of heavy metals in soil due to insolubilization effects, depending on the soil types, and the relatively small assimilation by the plants should be taken into account.

The factors which influence the quality of compost most are, improper composting methods, compost particle size, contamination in raw materials etc.
If compost is going to be used to grow a wide variety of plants, it must be ready to use, in means of ripeness and maturity of the compos, and its pH must be adjustable.
Composts also have to meet the requirements of epidemiology hygiene.

For example nurseries, greenhouses, home gardeners and farmers require a premium quality compost. Field grown nursery plants can use a medium grade of compost for their applications. And low grade compost can only be used for land reclamation and landfill caps.
Good composting can make a major contribution to recycling. The agricultural and horticultural industries are ready to utilize compost, which fulfils the quality standards.

As analyzes have shown (ref. **Error! Reference source not found.**), the compost which is produced now in Tehran with new methods is a ready to use compost which fulfils all the necessary requirements. Its quality is within the EU-range and better waste separation will improve the existing quality to obtain a product with export quality, since there are valuable markets outside Iran in neighbouring countries.

	Present situation	**EU-Range**
pH	6.9-7.5	6-9
EC (ds/m)	8-18	
N %	0.8-2.2	0.5-2
P %	0.3-1.3	0.3-1
K %	0.4-1.6	0.5-2
Pathogens	ND	ND
Heavy metals: mg/Kg		
Lead	110-600	70-1000
Cadmium	2-7	0.7-10
Zinc	200-1200	210-4000
Copper	80-800	70-600
Nickel	6-50	20-200

For the production of good quality compost, there are different physical, chemical and microbiological characteristics which have to be taken into account. For example the pH, the EC, the C/N ratio, the content of macro elements like N, P, K, Ca, Mg, S and microelements like Zn, Mn, Fe, Cu. Compost should be free of any pathogens for man, animal and plants and also free of weed seeds. Also the heavy metal concentrations should be tested and controlled, in addition different factors like soil type and structure, soil pH, the water content for example

determine the uptake of some elements like Cd or Pb into plants. Analyses done on the compost produced from household wastes in Tehran, showed that the concentration of heavy metals are within the EU range for these elements, so that there are no limitations on its usage.

For wet waste there are several options for producing of quality compost:

1 Wind-row composting (comparable to current Kahrizak plant).
2 Bio-mechanical composting.
3 Other composting processes like vermi-composting.

A third method is the vermin-system which produces high quality compost from the wet fraction of MSW. Limiting for the system is the maximum capacity of about 50 tons/day. The most common and applicable processes relevant for Tehran are 1 and 2. These are analyzed in Table 6.

	1. Wind-row composting	2. Bio-mechanical composting
3-R strategy	+ High effects on reduction, reuse and recycling 0 Low-med.-high quality compost can be produced, depending on the conditions	+ High effect on reduction, reuse and recycling + Medium-high quality compost can be produced
Economic Viability	- High investment costs (about $ 3 Mio), medium operation costs (about $4/Mg)	+ Med. Investment costs (about $ 450.000), low-medium operation costs ($3/Mg)
Technical Reliability	- Medium-high complexity of technology 0 Medium reliability 0 Medium capacity (400-500 Mg/day)	+ Low-medium complexity of technology 0 Medium reliability + High capacity (800-1000 Mg/day)
Environmental Impact	+ Relatively good, in open-air systems with some problems, depending on the conditions	+ Relatively good, adapted to open-air conditions and climate of Tehran
Socio-Political Acceptability	0 Medium-high acceptance, depending on operation and conditions, general problem is to improve the acceptance for the product, the compost	0 Medium acceptance, needs time, general problem is to improve the acceptance for the product, the compost

Table 6 Comparison of main composting systems

Composting is a good option for processing of wet waste, especially if the percentage of organics is around 70% or more. The biomechanical system needs about 50 ha land for the treatment of 1.000 tons waste per day. Both methods can be used simultaneously.
Main goal is to produce qualitative compost to be economically proof. The quality of MSW compost is strongly depending on the quality of incoming wastes. Therefore pre-sorting or separation at source is necessary to obtain compost with high quality. The sooner in the system we start with the pre-sorting the better it is.

The national market price for fine compost is about $5/ton for uses in Parks and about $10-20/ton for agricultural usage. Enriched and formulated compost can be sold for about $20-60$/ton. International market prices are higher, depending on the country and their needs but the transport costs have to be taken into account.

In some cases even it can be seen just as a pre-treatment method for organic components in mixed waste in order to reduce weight and volume before land filling.
(ref. Annex 3)

5.3.4 Separation and recycling of dry waste

Separation of dry recyclables
Four main systems can be used for collection of dry recyclables:

1. **Door-to-door collection**. Door-to-door collection of dry recyclables in colored bags (yellow bag for dry recyclables and black bag for residual waste (organic plus non-valuable dry waste). The waste is collected during 3 (up to 7) days per week. Special 2-compartment trucks are used, or the collection truck drives the same route twice (first recyclables, second residual waste). It is optional to introduce a special recycling bin for households in stead of a recycling bag, but this requires that the inhabitant has to go outside twice to pick up his (own) recycling bin. It is also optional to add another colored bag for hazardous components.

2. **Face-to-face transactions**. This is the system as is currently started by OWRC in all districts. In day time dry recyclables are collected directly from households (ringing door bells) and shops (face-to-face transactions). Every district is giving a contract to 1 collection company to organize the informal sector. It is not allowed to put dry recyclables directly in the street. The households get paid or receive a little incentive for the recyclables they give. Especially applicable from regular clients with large volumes of dry recyclables (shops, offices).

3. **Community containers**. Households have to bring their dry recyclables to a central container location within walking distance. Here containers are located for paper and glass and optionally for metals and plastic. The latter one is difficult because of the high volume of plastics. Experience in the Netherlands learns that a container density is required of circa 3.000 people per container. For all of Tehran this would mean 2.800 container locations. Containers should be located strategically near areas with high-housing density and with high visiting frequency (shopping streets and centres, mosques, schools). Containers have to be emptied 2 to 7 times per week, depending on the practical experience on overflow of materials.

4. **Central recycling shops.** Households can bring their dry recyclables to a central collection point or recycling shop in their sub-district, situated strategically near main shopping centres. To promote the usage of the recycling shops people get an incentive for their recyclables. It is proposed to use 1 central collection point per sub-district (circa 60.000 inhabitants), or 130 central recycling shops in all of Tehran. This is comparable to experiences in The Netherlands and Germany regarding number of inhabitants per collection point (50.000-80.000). The recycling shop can also be used as receiving desk for hazardous waste and for parts of the special waste fraction (computers, TV's, refrigerators), The recycle shops also can be used as a temporarily storage place for face-to-face collected dry recyclables.

Ad 4: basic lay-out of recycling shops

A general basic lay-out of a recycling shop for dry recyclables is shown in Figure 10. Dimensions are based on a capacity of 7 tons of dry recyclables per day (brought by households and from face-to-face collection). A building is required with –minimal- dimensions of 9 x 5 m and an external storage area with shed with dimensions of 5 x 5 m for bales and short term storage of certain wastes fraction like refrigerators, etc..

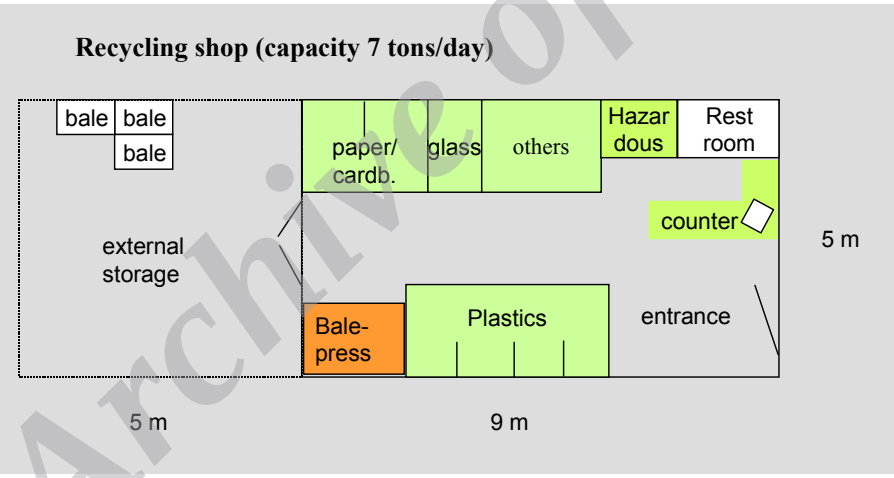


Figure 10 Basic lay-out recycling shop

Required dimensions of storage boxes in recycling shop: paper/cardboard (box lxwxh=2,5x1,5x1,5m), for glass (container lxwxh=1x1,5x1,5 m) and plastics (box lxwxh=4x1,5x1,5m), others (box lxwxh=2,5x1,5x1,5 m) and hazardous (closed cupboard).

In Table 9 an analysis is made of advantages and disadvantages of these operational options.

	1. door-to-door collection	2. face-to-face transactions	3. community containers	4. recycling shops
3-R strategy	+ high quantity (10%) of dry waste will be collected because of good combination with mixed waste collection	0 It will be difficult to achieve 10% extra waste (face-to-face: people have to be at home)	0 Lower quantity and quality (more mixed) than door-to-door collection	- 2-3% quantity (large distance) + Combination with bring point for special wastes
Economic Viability	+ collection costs circa $ 15 / ton for dry waste and $ 10/ton for organic waste	- collection costs circa $ 40/ton (labor intensive) for dry recyclables	0 collection costs circa $ 20 / ton, due to investments in containers	+ Costs $ 30/ton, including sorting and storage of waste in the recycling shop
Technical Reliability	+ usage of normal collection trucks - Glass requires separate system.	+ Waste can be more easily separated per component, no large sorting is required.	- Storage of only two components: paper and glass	- System is not working stand alone (together with option 1 or 2).
Environ-mental Impact	+ Dry recyclables only short time on the curb-side.	+ Dry recyclables not on curb-side (only direct hand over).	- Risk on overflow and pollution around containers	+ No health risks, low impact on neighbourhood
Socio-Political Accept-ability	+ High service rate (3 up to 7 days per week, door-to-door) - Discipline to use the right (colored) bags or bin.	0 Medium service rate (have to be at home and not all people are costs oriented. + households can receive small incentive for recycl. - It might be difficult for contractor to organize the informal sector.	0 Medium service rate (24 hrs per day, but walking distance to container) + Positive and promotional way to show recycling. activities in district. - Risk that scavengers pick out valuables.	- low service rate (14 hrs per day, long distance) + Households receive an incentive for their recyclables.

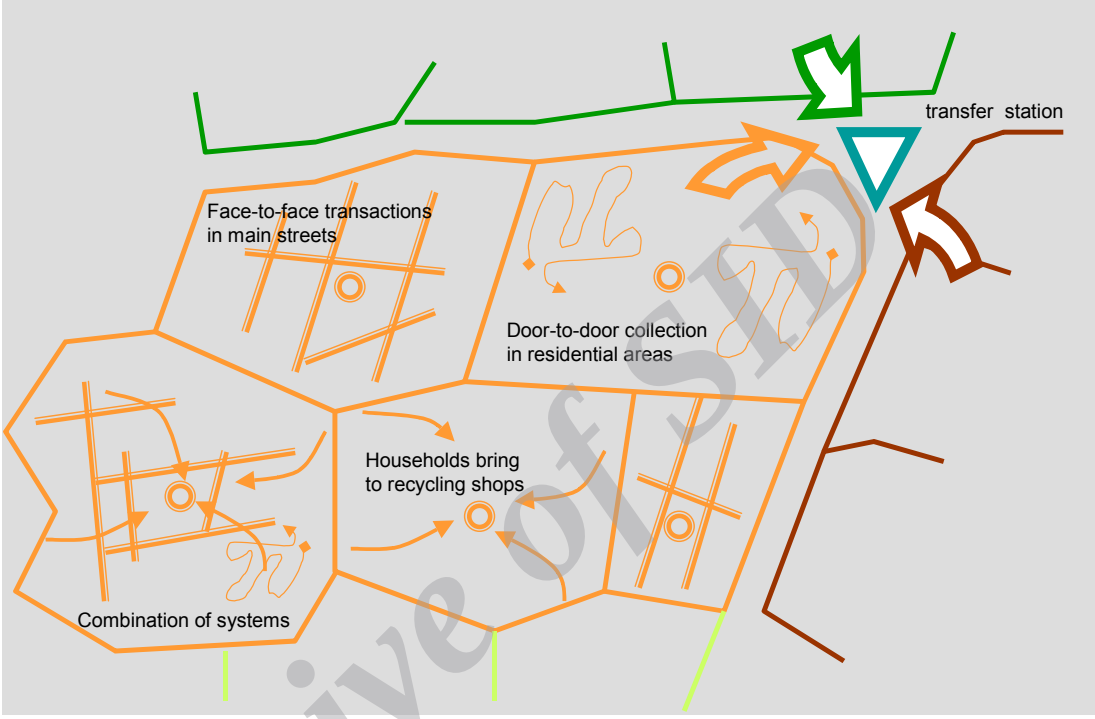
Table 7 Comparison of collection systems

Based on the advantages and disadvantages described above, we propose to choose for a combination of collection systems:

- door-to-door collection of wet and dry waste in two separate bags (using coloured bags), in order to achieve a good recycling volume. Recycling target: 30 % of dry waste, 50 % of wet waste.
- face-to-face transactions for shopping streets, offices, large producers (with incentive system). Recycling target: 25 % of dry recyclables (compare current informal sector).
- Introduction of 130 central recycling shops for households (with incentive system). Introduction of recycling shops has the advantage that other waste streams (hazardous waste, refrigerators, TV's, etc) also can be brought to these shops and it can be combined with face-to-face collection. Recycling target: 10 % of dry waste.

In Figure 11 is shown how the collection systems can be combined.

Figure 11 lay out sketch district



Every (sub)district can choose the most preferred systems with best socio-demographical fit. These systems will be implemented as main system, based on pilot projects and characteristics of the residential and shopping area.

An additional system that can be introduced is collection of dry recyclables by schools, mosques, NGO's. For these public organizations it is interesting to collect paper and cardboard to earn income for social activities. Either parents/children can be asked to bring paper/cardboard from their homes, or recyclables can be collected door-to-door after starting a local public campaign.

Transfer and sorting of dry recyclables

An important issue is how the dry recyclables are transferred, sorted and transported to the recycling industries, since the dry material is very voluminous and requires a lot of transport.

There are two basic options:

1. **Transfer and sorting at 9 transfer stations**, where also mixed waste is transferred. Referring to 2.000 tons of recyclables per day and 9 transfer stations, the capacity should be approximately 225 tons/day. If also part of the mixed waste has to be treated, an extra line can be introduced. Advantage is that organic waste and dry recyclables are transferred at the same location, which makes the usage of 2-compartment collection trucks possible.

2. **Transfer and sorting at 22 districts**. Referring to 2.000 tons of recyclables per day and 22 districts, the capacity of each sorting installation should be approximately 90 tons/day. Advantage of these sorting installations is that they are close to the districts, which reduces voluminous transport with collection trucks.

Ad 1: Sorting line with capacity of 225 tons/day.
The sorting plant will have 1 sorting line with a capacity of 225 tons dry waste per day. The basic layout consists of a receiving floor – shovel – conveyor belt – handpicking large particles – bag cutter - sorting platform with 6 x 2 manual handpicking stations – magnet – bale press. In below figure a basic layout of the sorting line is shown including dimensions for building (lxwxh=65x30x9m). On the front side a logistics area is required of 65 x 14 m.

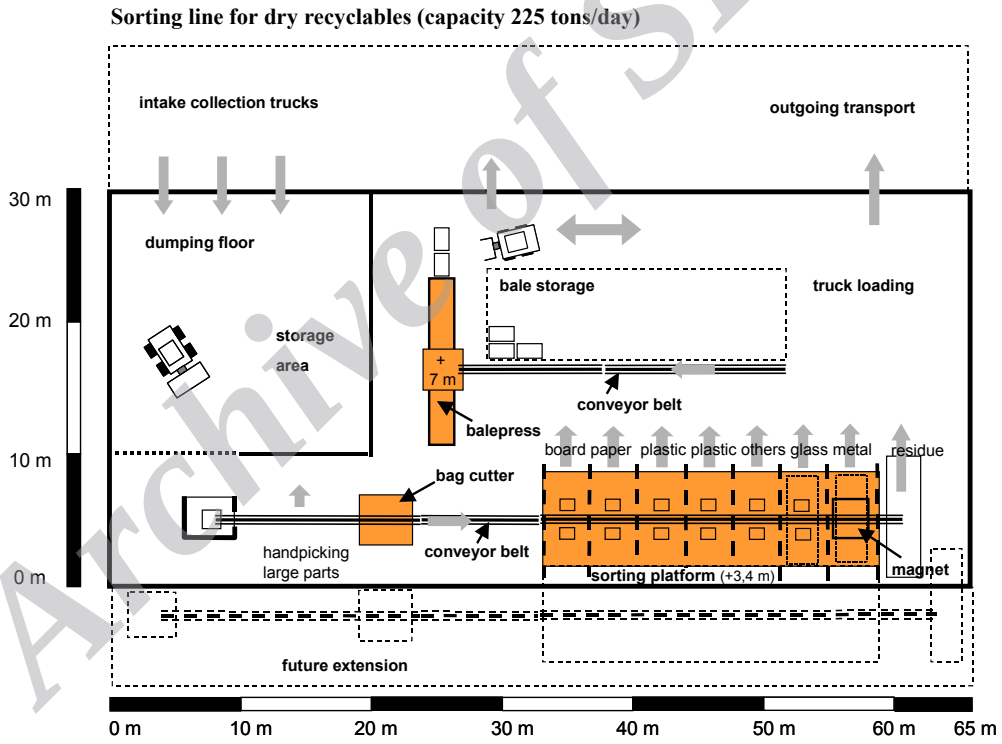


Figure 12 Lay out of Sorting line of 225 tons/day

The dumping floor has a storage area with dimensions of 20 x 10 m. This is sufficient for temporarily storage of 200 tons of dry recyclables (1 day work load, waste is collected at night and sorted in 2 shifts in day time). Under each platform station boxes are provided for cardboard, paper, plastics, and others. For glass and metals 30 m3 containers are provided. The residual waste is collected in a semi-trailer. The separate recyclables are loaded on a conveyor belt by a combined forklift/shovel. The conveyor belt goes up to a level of + 7 m and disposes the waste in a bale press with a capacity of 30-50 tons/hour. The fork lift truck picks up the

bales (dimensions lxwxh=1,5x1x0,7m) and puts them in the storage area. Regularly the bales are loaded in a transport truck and transported to the recycling industry.

Ad 2: Sorting line with capacity of 90 tons/day.
At district level it is possible to set up a highly manual dry recycling sorting line with a capacity of circa 90 tons/day. There The basic layout consists of a receiving floor – shovel – conveyor belt –manual bag cutting - sorting line with 8 manual handpicking stations – semi-automatic bale press. In below figure a basic layout of the sorting line is shown including dimensions for building (lxwxh=40x25x6m). On the left side a logistics area is required of 14 x 25 m.

Sorting line for dry recyclables (capacity 90 tons/day)

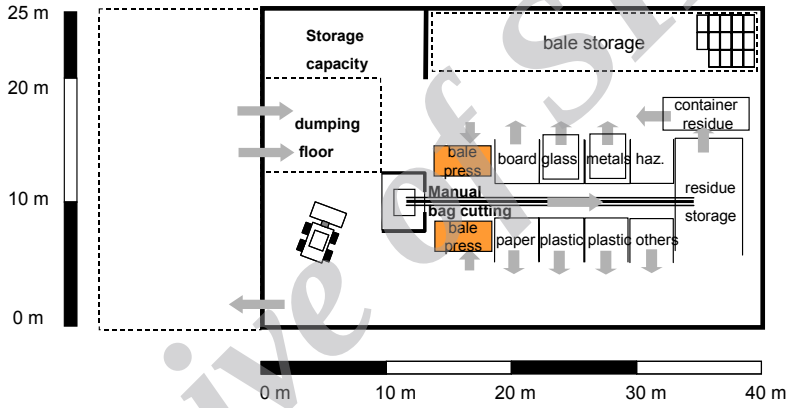


Figure 13 Lay out sorting line of 90 tons/day

The dumping floor has a storage area with dimensions of 13x7 m. This is sufficient for temporarily storage of 90 tons of dry recyclables (1 day work load). On each side of the sorting line boxes are for cardboard, paper, plastics, others and hazardous. Glass and metals are directly stored in 1100 litre roll containers. The residual waste is collected in a storage box and can either be loaded by shovel in a container or it can be compacted in the bale press (depending on the type of residue). There are two semi-automatic bale presses provided.

A comparison of both sorting lines is presented in Table 8.

	Sorting at 9 transfer stations	Sorting at 22 district sorting plants
3-R strategy	+ separation of dry waste in high value components and hazardous waste	+ separation of dry waste in high value components and hazardous waste
Economic Viability	+ expected investments ca. $ 2,5 million per sorting plant, operational costs $ 12-14/ton, sorting line has high through-put of recyclables	0 expected investments ca. $0,8 million per sorting plant, operational costs $ 14-16/ton, sorting line is simple and costs effective, but requires more space than alternative 1.
Technical Reliability	0 it is a one-line system, requiring good maintenance and cleaning of mechanical equipment (bag cutter, conveyor belts, bale press).	+ it is a one-line system, but having 2 semi-automatic bale presses. No other mechanical installations.
Environmental Impact	+ low impact on neighbourhood (incoming trucks), combination possible with collection of mixed waste (2-compartment truck). - longer transport distance to districts for collection trucks with voluminous dry recyclables (no hand carts).	+ low impact on neighbourhood (few incoming trucks) + nearby or central in district to reduce transport (plus hand carts). - more locations have to be found, larger building is required with more surrounding neighbourhood.
Socio-Political Acceptability	+ combined implementation for 2 or 3 districts.	+ single implementation for 1 district, who is clearly having the benefits and costs for dry recycling.

Table 8 Comparison of sorting line capacities

Based on the comparison in Table 8 it is difficult to decide what alternative is best for large-scale introduction in Tehran. Possibly a combination of both systems is required: some districts want to work together and have enough free space on their nearby transfer station for realizing a sorting building, other districts prefer to have their own sorting building.
It is an option to outsource transfer and sorting to a private company. The municipality can provide an empty building and leave all installations and activities to a local entrepreneur.

5.3.5 Improvement of mixed waste

Collection of mixed waste
Several alternatives for collection units and for collection trucks are reviewed.

Collection units
Alternatives for collection units for mixed domestic waste are presented below.

1 door-to-door collection using plastic bags
2 door-to-door collection using 120 or 140 litre mini-containers
3 bring system using 720 litre community containers
4 bring system using 16 m3 open containers

A comparison between the four collection systems is presented in Table 9.

	plastic bags	140 litre mini-containers	720 litre community containers	16 m3 open containers
3-R strategy	0 not resulting in extra waste reduction.	0 not resulting in waste reduction.	0 not resulting in extra waste reduction.	+ resulting in little waste reduction due to larger walking distance.
Economic Viability	+ no investment costs, operational costs for households	- relatively high investment costs ($ 50 / household)	- relatively high investment costs ($ 30 per h.h.)	0 relatively low investment costs ($ 30 per h.h.)
Technical Reliability	+ no technical problems	+ few technical problems, container is privately owned. - only applicable for households with gardens.	0 risk on technical problems because public ownership.	+ few technical problems, simple container - difficult to implement on large scale due to required space.
Environmental Impact	+ only waste on curb-side for short period	+ only waste on curb-side for short period	- frequently there is pollution around containers	- not a nice view in residential areas
Socio-Political Acceptability	+ widely accepted, although it gives rubbish due to scavengers and cats.	- people don't want to use garden space for their container.	+ system is accepted for areas with small alleys and shopping centres	0 not easily accepted, not in my backyard (NIMBY) effect

Table 9 Comparison of collection systems

From the comparison we conclude that the most preferred system is the usage of plastic bags. Usage of 720 litre community containers is an alternative for shopping centres and areas with small alleys. It is very important that sufficient container capacity and emptying frequency is obtained, in order to reduce the risk on overflow of community containers. The usage of mini-containers and 16 m3 containers is hardly possible due to private and public space limitations in Tehran.

Collection trucks

Main operational options for collection trucks are:

1 pick-up trucks: Nissan trucks drive on average 1,5 shifts per day, bringing 3,5 truckloads per shift with average 1 tons/truckload. Truck effectiveness is 5,3 tons/truck/day.
2 FAUN collection trucks. The trucks drive on average 1,5 shifts per day, bringing 2,5 truckloads per shift with average 2,2 tons/truckload. Truck effectiveness is 7,8 tons/truck/day.
3 compaction trucks (load capacity 8 up to 12 tons). The trucks drive on average 1,5 shifts per day, bringing 2,5 truckloads per shift with average 5 tons/truckload. Truck effectiveness is 18 tons/truck/day.

4 two-compartment compaction trucks (load capacity 8 up to 12 tons). The trucks drive on average 1,5 shifts per day, bringing 2,5 truckloads per shift with average 5 tons/truckload. Truck effectiveness is 18 tons/truck/day.

A comparison between the four collection trucks is presented in Table 10.

	Pick-up	FAUN collection truck	Compaction truck	2-compartment compaction truck
3-R strategy	- Truck effectiveness: 5,3 tons/truck/day	- Truck effectiveness: 7,8 tons/truck/day	+ Truck effectiveness: 18 tons/truck/day	+ Truck effectiveness: 16 tons/truck/day
Economic Viability	+ investment: $20.000 - costs: $ 10,5 /ton	+ investment $60.000 0 costs: $ 9,5 /ton	- investment $ 150.000 + costs: $ 8/ ton	- investment: $ 200.000 - costs: $ 11 / ton
Technical Reliability	0 old technology, but not much mechanical components	+ not much mechanical components	0 new technology, but requires good maintenance. - Difficult to use in small inner city.	- new technology, a lot of technical components - Difficult to use in small inner city.
Environmental Impact	- inefficient motors and low tonnage/day - not good for separate collection of dry waste	0 relatively low tonnage/day + good for separate collection of dry and wet waste	+ efficient motors and high tonnage/day 0 fairly good for separate collection of dry and wet waste (compaction reduces quality)	+ efficient motors and high tonnage/day + specially made for combined collection of dry and wet waste
Socio-Political Acceptability	0 accepted, but older car models do not promote innovative recycling business.	0 accepted, but older car models do not promote innovative recycling business	+ good to promote new waste activities + good ergonomics for collection personnel	+ good to promote new waste activities + good ergonomics for collection personnel

Table 10 Comparison of collection trucks

We see that collection costs for pick-up trucks and FAUN trucks have a low truck effectiveness. Investments are low but operational costs are relatively high. Compaction trucks and 2-compartment trucks are more expensive in investment, but have a high truck efficiency which results in relatively low operational costs.
Looking at future developments (separation dry/wet, larger transport distance due to less transfer stations, more waste per capita per year, traffic problems, traffic pollution problems) it is necessary to renew the old trucks for environmental friendly, new trucks with optimal truckload (especially for dry voluminous waste) and with optimal dimensions for each type of district (inner city areas: what is minimum dimension).

Collection frequency and time frame

Looking at door-to-door collection in more detail, it is important to choose the right frequency of collection and time frames that households can put their waste outside.
People in Tehran are used to a very high service rate of 7 days per week. It results in small 30 litre bags that are put outside. In future it might be acceptable to change the frequency to 3 days per week (Saturday-Monday-Wednesday and Sunday-Tuesday-Thursday) by introducing 60 litre bags with more capacity in households (if we compare to The Netherlands and Germany, a frequency of 1 x per week is most often used).

We propose to use only one time frame that people are allowed to put their waste outside. The recommended time frame is from 20:00 hrs to 22:00 hrs. Before and after it is not allowed to put waste outside.

Strategic options collection frequenct of wet waste / dry waste

- Wet waste 7x per week, Dry waste 3x per week
    - When collecting start with wet waste first: truck load + 30%: larger area covered with one truck load -> faster finished with collection of wet waste. Transport to 9 transfer stations and direct dump in watertight semi-trailer.
    - Dry waste second (in 50% of sub-district): truck load – 30 %, but only half sub-district to be covered -> truck drives in second part of the night. Transport to sorting plant located at a transfer station or in district (shorter distance).
    - Total contract will only slightly increase due to extra time.
- Future development: change wet waste from 7x per week to 3 x per week (half sub-district: Saturday-Monday-Wednesday, other half sub-district: Sunday- Tuesday-Thursday). People will get used to putting waste outside only 3 x per week by introduction of dry waste during 3x per week.
- In beginning 10-30% of people will put the wrong waste outside on the wrong day. Trucks can be provided with a small compartment (20% of total load capacity) to collect wrongly disposed waste: when collecting wet waste this compartment is used for dry waste, when collecting dry waste it is used for wet waste.

Transfer and transport of mixed waste

Strategic allocation of transfer stations

One of the issues in the SWM infrastructure is the strategic allocation of transfer stations and sorting lines in the City of Tehran. Some existing transfer stations do not meet environmental standards and are located in the middle of residential areas. OWRC wants to reduce the number of transfer stations to 9 by rehabilitating 4 existing transfer stations and implementing 5 new stations. As we understand it is very difficult to find new locations for these 5 transfer stations, since a large area is required (also introduction of sorting lines for dry recyclables and/or for mixed waste) and there is resistance from surrounding neighbourhoods (Not-In-My-Back-Yard).

We will not go into details about the allocation of the transfer stations, but will only address the points-of-gravity regarding population density. The domestic waste will grow up to 9.300 tons/day in 2014 requiring each transfer station to have a capacity of 1000 tons/day. The Central and Southern part of Tehran is most densely populated (400-800 persons per hectare). Transfer stations in this area might require a capacity of up to 1500 tons/day in order to meet future

growth in waste quantities. The Northern part of Tehran is less populated (100-400 persons per hectare) and transfer stations require a capacity of 1000 tons/day. The western part is very low populated at the moment (district 21 has mainly industries), but future extension of Tehran will especially be in the western area (district 22) and waste quantities will grow accordingly.

Direct dump or compaction

For transfer and transport of mixed waste two basic technical principles are proposed (see also BC Berlin Landfill Study, nov 2004):

1 platforms with direct dump in 65 m3 semi-trailers (comparable to current situation, but with renewed trailers)
2 platforms with dump in compaction press and pressing waste in trailer with 65 m3 compaction container.

	Direct dump in semi-trailer	Compaction in special trailers
3-R strategy	+ waste is not compacted and recyclables can be separated at land fill or composting plant. + good applicable for organic waste and for demolition waste.	0 no waste reduction (leachate has to be stored in tank) - not good applicable for organic waste and for demolition waste.
Economic Viability	+ low investments and operational costs $3/ton , simple and cost-effective system.	- high investments and operation costs $5/ton..
Technical Reliability	+ no mechanical components, enough unloading places for collection trucks and flexible for several fractions	0 one-line system with mechanical components, requires good maintenance, not enough unloading places for collection trucks.
Environmental Impact	+ low environmental impact (leachate should be collected in future and stored and treated) 0 moderate transport effectiveness due to average 19 tons/ trailer load.	+ low environmental impact, only electricity usage at transfer station, + good transport effectiveness due to average 22 tons/ container load.
Socio-Political Acceptability	- public do not like existing system, roofed platforms might be required.	- public do not like existing system, advantage is that waste is in closed container.

Table 11 Comparison transfer/transport

Based on above comparison we propose to continue with the existing transfer and transport system of direct dump in semi-trailers. This is also in line with future developments: separation in wet and dry fraction; organic waste goes via transfer stations to composting industry and is best transported in semi-trailers with high transport effectiveness (up to 25 tons/trailer load); dry waste is sorted and baled and is using another system. The platforms are very usefull for further separate transfer and transport of large waste streams (demolition waste, large consumer products, industrial waste, etc).

Land filling and pre-treatment of mixed waste

The development of the new Houshang Abad sanitary landfill site is not optional but a must, knowing the situation that the current landfill is full in 2006. The waste flow to the land fill will

reduce from 6000 tons/day in 2004 (86 % of total waste) to approximately 3000 tons/day in 2014 (30% of total waste), depending on the results of the waste reduction strategy.

A step to reduce the waste quantity to the landfill is introduction of pre-treatment at the land fill site. Incoming waste is shredded and some high value recyclables are separated. The residue is put on large heaps and the waste fraction inclines and leachate evaporates. A total waste quantity reduction of up to 60% will result. This is currently executed by giving 3 new contracts of 1000 tons/day to private companies to pre-treat mixed waste. It will result in reduced costs for OWRC. In view of the strategy it can be considered as a first attempt to reduce the waste volume. When separation at source in wet and dry waste is introduced on a large–scale, these industries can develop a methodology for high quality composting.

For the long term future waste incineration might be considered, but operational costs are much higher than land filling costs (50-100 dollars/ton versus 4-10 dollars/ton).

5.4 Healthcare waste

The basic requirements of managing HCW are already available through the guidelines provided by the MoH. In brief the separation at source using different labelled and coloured bags and containers within the hospitals is highlighted. This faces operational problems in terms of employing limitedly educated staff as well as limited (if any) legal control.

Referring to the HCW policy note provided by the World Bank, it can clearly be concluded that the management system is not consistent and educated enough to put the well designed guidelines in practice. This as stated earlier lies both in the operational and institutional deficiencies.

Relatively unclear distribution of HCW management responsibilities to the MoH, DoE and the municipality is another shortfall of the system. The municipality has to build the capacity in terms of safe disposal of the hazardous HCW portion while the MoH has to enhance source separation. Lack of appropriate disposal facility and also collection/transport equipments leads to mixed waste disposal which is environmentally and socially not favourable.

Therefore the key to minimization and effective management of health-care waste is segregation (separation) and identification of the waste. Appropriate handling, treatment, and disposal of waste by type reduce costs and do much to protect public health. Segregation should always be the responsibility of the waste producer, should take place as close as possible to where the waste is generated, and should be maintained in storage areas and during transport.
In addition to the colour coding of waste containers, the following practices are suggested:

- General health-care waste should join the stream of household waste for disposal.
- Sharps should all be collected together, regardless of whether or not they are contaminated. Bags and containers for infectious waste should be marked with the international infectious substance symbol.

- Highly infectious waste should, whenever possible, be sterilized immediately by autoclaving.
- Small amounts of chemical or pharmaceutical waste may be collected together with infectious waste.
  Large quantities of obsolete or expired pharmaceuticals stored in hospital wards or departments should be returned to the pharmacy for disposal.

5.4.1 Waste generation

Currently 70 tons/day of HCW is generated in Tehran of which 40% is infectious and 60% general waste. As stated earlier the HCW is not segregated at source. Therefore the basic requirement is considered to be improving the source separation through implementation of the existing guidelines. This requires well trained collection staff and managers. Separation of the hazardous fraction of the HCW within the medical establishments is by law a responsibility of the MoH.

5.4.2 Collection

Separation of infectious or generally hazardous portion of the HCW at the medical establishments is a must based on the requirements provided by the MoH as well as Waste Management Law.

Based on the existing guidelines the collection of infectious HCW should be carried out using special vehicles. Two basic strategic options for collection of HCW are proposed:

Option 1- Collection of disinfected or incinerated ash of infectious portion using ordinary waste collection fleet.
Option 2- Collection of infectious waste using special vehicles as required by the existing guidelines.

Option 1 requires the disinfection of the separately stored infectious portion of the HCW through decentralized autoclaves and/or incinerators. Option 2 requires a centralized disinfection and/or incineration facility to convert the infectious material to inert waste capable being disposed of along with the domestic waste.

The domestic portion of the waste has to be collected separately using the ordinary waste collection fleet. It is recommended to dispose the so collected waste in a sanitary landfill together with the domestic waste rather than introduce it to the composting and recycling facilities. This mainly can eliminate the risks for potential contamination of the final products which are compost and recycled materials.

5.4.3 Treatment

The two basic options for treatment of the HCW are incineration and autoclaving which can be carried out in a decentralized or centralized form.

Option 1- Incineration
- Decentralized
- Centralized

Option 2- Autoclaving
- Decentralized
- Centralized

Decentralized incinerators have almost widely been experienced by the hospitals, although not fully successful. The limited (if any) success of the decentralized incinerators were mainly associated with the lack of adequate knowledge for maintenance as well as the associated costs. Incineration can also be an environmental concern considering the potentials for air pollution.

Centralized or decentralized autoclaving can also be considered as an option for HCW treatment. Although not experienced much in Iran it is proposed to assess the feasibility of this option.

The treatment options as described above can provide the material which can be disposed of at a sanitary landfill along with the domestic waste.

Since costs for safe treatment and disposal of hazardous health-care waste are typically more than 10 times higher than those for general waste, all general, i.e. non-hazardous, waste should be handled in the same manner as domestic refuse.

Short term: resolve improved separation procedures including type definitions, improve source separation in coordination with MoH and improve the special transport equipment.
Medium term: Consider incineration option in cooperation with MoH.

5.4.4 Disposal

Currently the disposal method for the HCW is almost in line with the guidelines provided by the MoH. The mixed (hazardous and non-hazardous) currently waste is disposed of in a separate trench (cell) and covered with lime.
The disposal options development strongly depends on the method of treatment. In other words a well disinfected HCW can be disposed of in a sanitary landfill while the non-disinfected HCW has to be disposed of either in a special cell at the landfill or in a special landfill. A feasibility study is required. The disposal options are as follows:

Option 1- Disposal of the hazardous portion of the HCW in a special cell in the sanitary landfill
Option 2- Disposal of the hazardous portion of the HCW in a special landfill
Option 3-Disposal of disinfected HCW along with the domestic waste in the sanitary landfill

5.3.5 Conclusion

The options for HCW management are presented graphically in . It is worth noting that selection of options highly depends on the results of feasibility studies conducted through the course of strategy development. Generally the HCW strategic options can be summarized as follow:

- **Option 1-** Decentralized incineration/autoclave, ordinary collection and disposal at sanitary landfill
- **Option 2-** Separate collection of hazardous waste and centralized incineration
- **Option 3-** Separate collection of hazardous waste and centralized autoclave
- **Option 4-** Separate collection of hazardous waste and disposal at a special cell in sanitary landfill
- **Option 5-** Separate collection of hazardous waste and disposal in a special landfill

The source separation of the HCW at medical establishments is a necessity in the course of practicing a sustainable waste management system. HCW strategic options are compared in Table 12 Comparison of the HCW strategic options.

	Option 1	Option 2	Option 3	Option 4	Option 5
3-R strategy	+ hazardous waste reduction	+ Hazardous waste reduction	0 Comparatively less waste volume reduction	- No hazardous waste reduction	- No hazardous waste reduction
Economic Viability	375 $/ton + collection and disposal costs	160 $/ton for industrial incinerator and collection costs; limited share of HCW	110 $/ton + collection and sanitary landfilling	6$/ton + collection costs	More than 6$/ton + collection costs
Technical Reliability	- Low control and higher maintenance	0 Comparatively medium maintenance, it can also be used along with industrial waste	+ low operational control and maintenance	+ Comparatively the least operation control and maintenance	+ Relatively low operation control and maintenance
Environmental Impact	- high air emission control required	- high air pollution control requirement	+ Low adverse impacts	- higher potential adverse impacts (requires extensive care)	- higher potential adverse impacts (requires extensive care)

Socio-Political Acceptability	0 Medium	+ highly in line with the policies	+ highly in line with policies	0 Medium	0 Medium

Table 12 Comparison of the HCW strategic options

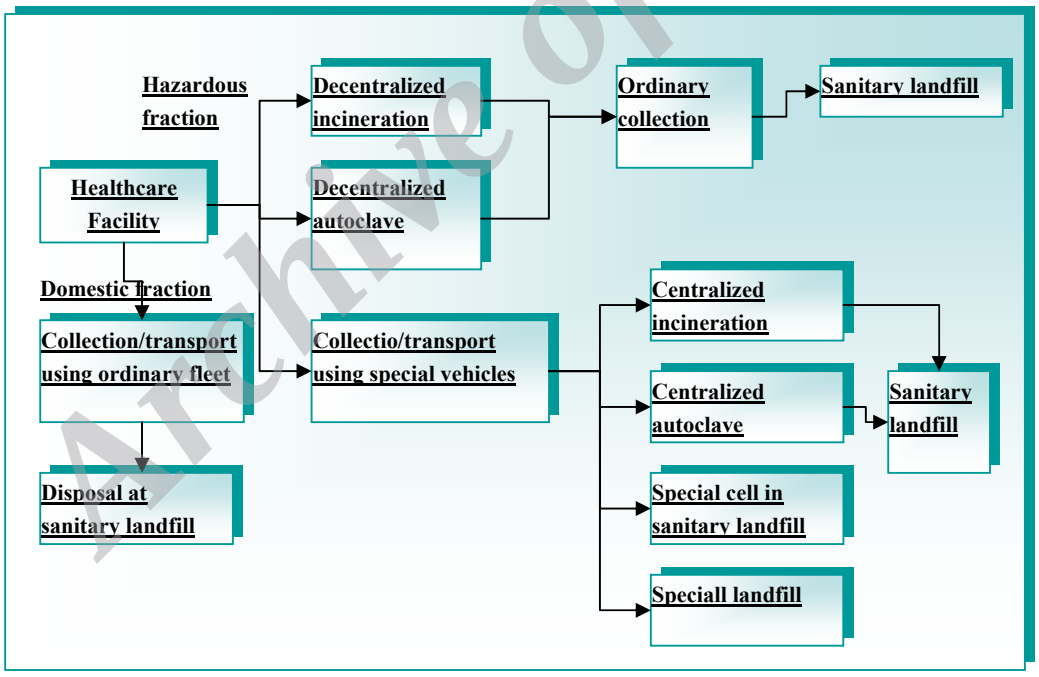


Figure 15 Strategic options for HCW management

5.5 Industrial waste

As stated earlier the industrial waste management scheme currently lacks a consistent system of identification of different wastes including but not limited to hazardous and non-hazardous waste as well as waste categorization and characterization procedures. The responsibility of

industrial waste is by law with the MI. This implies that the MI should establish the required capacity and infrastructure.

This can partly be initiated by a set of actions taken by the municipality in terms of providing services of collection, transport and disposal of non-recyclable industrial and specially hazardous waste.

Since a significant fraction of the industrial waste is already recycled on a business to business basis. The residual industrial waste is subject to disposal and includes a wide range of wastes such as ashes, industrial wastewater treatment sludge etc.

As a pre requisite to a sustainable industrial waste management, establishment of certain guidelines, standards and regulations should be given priority. Such a capacity should be developed by the MI through cooperation with the municipality (OWRC).

5.5.1 Waste generation

The industrial waste which is subject to disposal should basically be characterised and categorized in order to enter the overall chain of SWM system. In other words, if the municipality is to collect and dispose the industrial waste (which is the case in current situation), then the types of waste each requiring certain methods of handling and disposal should be practically known.

Therefore development of an identification system along with a codification system is crucial for the industrial waste management system.

5.5.2 Collection

Collection of industrial waste can be done either by the industry or by the municipality. These can be regarded as the basic options of industrial waste collection. Both options require the concise and practically viable system of chain monitoring in form of a series of log sheets.

Collection of industrial waste by the municipality can be regarded as a source of cost recovery. The sources of financing should be evaluated for industrial waste collection. Since the majority of the so collected waste is assumed to be no-recyclables and hazardous material, a special collection fleet with certain specifications should be employed.

The same applies to the option where the waste has to be collected by the industry (i.e. waste generator). The system of logging should be the same as the former option so as to facilitate the control and monitoring for the municipality.

In summary the two basic options of the industrial waste collection are:

Option 1- Collection with special fleet along with unique codification system
Option 2- Collection by the industry along with a unique system of codification

5.5.3 Transfer/transport

Regarding the necessity of source control of the industrial waste there seems to be no need for transfer stations. Transfer stations are only required in case that the collected waste still has recyclable materials. In this case the transfer station should also be equipped with sorting lines.

Strategically the sustainability of the SWM system in Tehran still necessitates source management in terms of separation of recyclable materials at source.

5.5.4 Treatment and disposal

Treatment of industrial waste could be regarded in terms of enhancement of the current business to business opportunities which can also improve the private sector involvement.

Disposal of the industrial waste which is not capable of being recycled can either be incinerated or landfilled. Therefore the basic options for industrial waste disposal are:

Option 1- Incineration
Option 2- Disposal in a special cell in the sanitary landfill
Option 3- Disposal in a special landfill

The disposal of the industrial waste can potentially be of significant cost recovery opportunity.

5.5.5 Conclusion

The strategic options of industrial waste management are compared in Table 13 Comparison of industrial waste management options.

	Option 1	Option 2	Option 3
3-R strategy	+ hazardous waste reduction	0 No hazardous waste reduction	0 No hazardous waste reduction
Economic Viability	160 $/ton + collection and disposal costs	To be calculated upon specific design (> 6$/ton)	To be calculated upon specific design (>> 6$/ton)
Technical Reliability	0 high operation control and maintenance, can also be used simultaneously for HCW	+ low operation control and maintenance	+ low operation control and maintenance
Environmental Impact	+ Limited environmental adverse impacts, air emissions should be controlled	- Relatively high potential adverse impacts	_ Relatively high potential adverse impacts
Socio-Political Acceptability	+ Medium to high	0 Medium	0 Medium

Table 13 Comparison of industrial waste management options

It can be stated that in the short term the feasibility of the incineration of the hazardous fraction of the industrial waste should be well investigated. The incineration scheme will require additional costs which can be recovered through strengthening the *polluters pay principle*. This can also be of additional support to the municipality in terms of cost recovery.

While studies are being conducted on the feasibility of the hazardous waste incineration, it is recommended to construct a special standard cell in the proposed sanitary landfill to safely dispose of the hazardous fraction of the industrial waste.
In medium term practically best option will be selected and the implementation will be started, while the special cell within the sanitary landfill will be still receiving the hazardous waste.
In the long term, the selected option; incineration, special cell in the sanitary landfill or a combination of the two will be expected to be available in full capacity.
The overall layout of the industrial waste management is shown in figure 16.

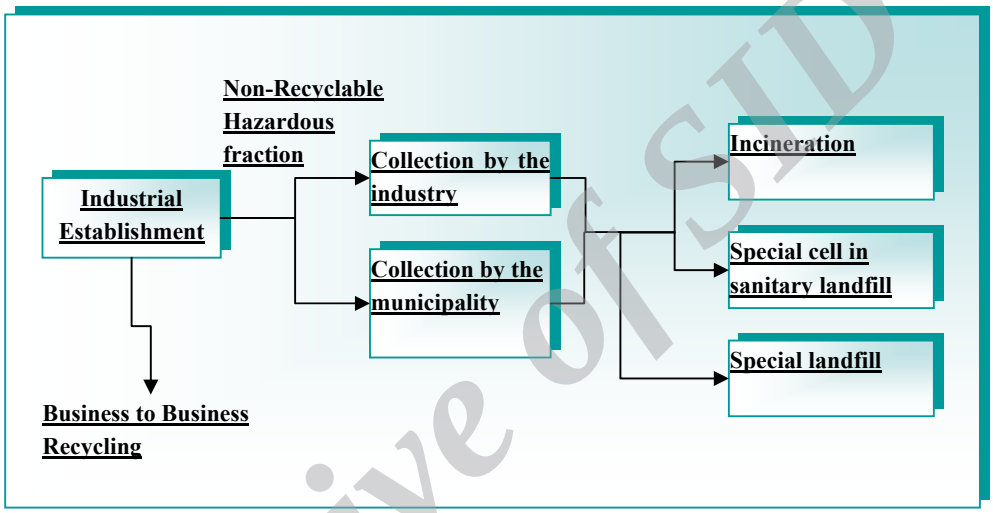


Figure 16 Industrial waste management options

6 COST ANALYSIS AND COST RECOVERY STRATEGY

As has been discussed in the Baseline study for the Tehran waste management strategy, there is a strong need for a financial management and control system in order to have a consistent view on market pricing, operational costs, invoicing, contract routing, cost recovery etc.

With respect to the financial WMS strategy the following main topics are relevant:

1. Development of a financial management and information system (FMIS),
2. The economic analysis for the operational and institutional strategic options,
3. Usage of financial instruments to support and stimulate the strategy,

Although an in depth financial analysis might look as a required tool for making the strategic decisions, it also requires a solid system of collected financial data and a minimum level of market insight.
In this stage of development, both are not fully available. In order to handle this situation a strong effort should be made to start with the FMIS system and implement a financial monitoring system that covers all related stakeholder parties. As suggested in the Baseline study, the use of shadow process could overcome the inadequacy of some financial data.

The strategic choices to be made require a financial analysis based on the available data in order to have some view on the consequences of the strategy that will be followed.

6.1 Financial system for cost analysis

The importance of sound financial management within the overall solid waste management effort becomes crucial. Scarce monetary resources to pay for his improvement will have to be carefully mobilized and efficiently utilized. Whether or not OWRC choose to improve solid waste management by upgrading existing internal capacity, or by contracting with the private sector, effective financial management plays an important role. Ensuring that sound financial management practices are incorporated into the overall municipal solid waste management structure is critical for districts. If a district is considering contracting with the private sector for municipal solid waste collection and disposal services, good financial management practices become important in the context of dealing and negotiating with the private sector.

Financial management can be described as a cyclical resource allocation process.
The process has three principal components:

- Determine actual current costs.
- Estimate future costs.
- Set and collect solid waste management fees.

A current "best practice" in the solid waste management field is the use of Full Cost Accounting (FCA). FCA is defined as: "*…a systematic approach for identifying, summing, and reporting the actual costs of solid waste management. It takes into account past and future outlays, overhead (oversight and support service) costs, and operating costs*."

FCA recognizes a truck as a resource, will not be used up in the year purchased. Rather, it will have a useful life of many years. As a result, the expense of the truck will be spread out over those years of service (depreciated). A critical concept inherent in FCA systems is the differentiation of the terms outlay and cost. Outlay refers to the actual expenditure of monies for the purchase of an asset or the payment for services. Cost refers to the monetary value of resources as they are used or expended. In the above example, the outlay for the vehicle is the price paid to acquire the vehicle. The cost of the vehicle will be the annual depreciation applied against its value.
Similarly, gross billings of rates (not actual receipts of money) would be recognized as income under FCA rules. Persons or companies that didn't pay their rates would be reflected under a separate account in the system.

The first step in upgrading information systems to FCA standards is collecting accounting data. On the revenue side, begin by listing all sources of revenue for the past year.

In the end, good financial analysis is only possible with good financial accounting. The results of financial analysis serve as a tool to improve efficiencies, eliminate waste, improve service to citizens, and lower costs.

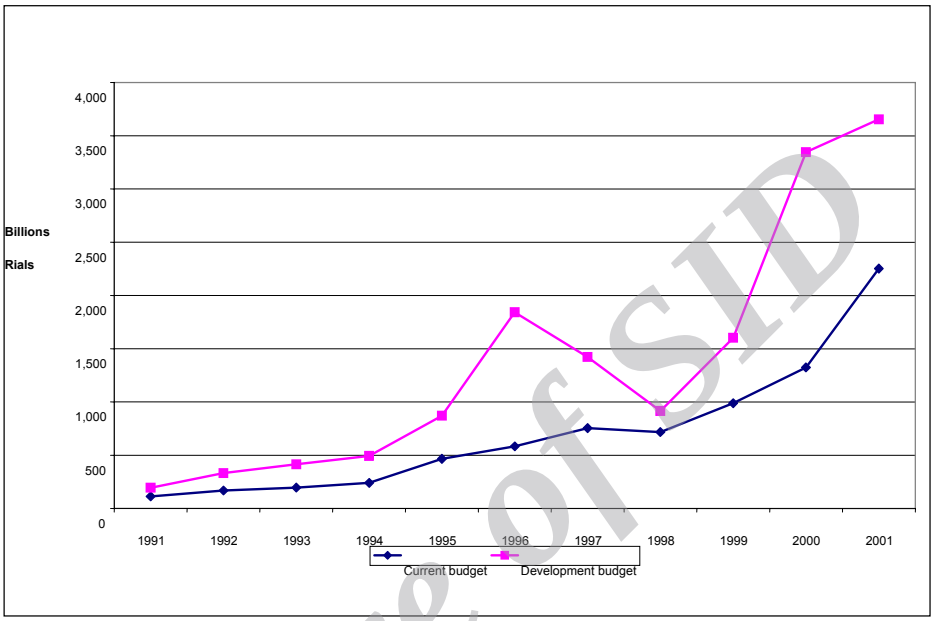
The levying of waste collection and disposal fees should be based on waste generation rates and according to the economic standard of the area, whilst considering the nature of the waste wherever necessary. However, these fees should not be levied solely to meet the financial lacunae for management and the equipment demand. The larger generators should be charged on excessive waste generation which could be prevented with cleaner production principles.
Promotion of private investment for waste management and recycling should also take into consideration the establishment of a waste recycling information center. This could encourage investment by the private enterprises on resource recovery as well as on sanitary disposal facilities and waste processing units. Granting of soft loans and subsidizing or exempting taxes for machineries, equipments and spare parts which need to be imported would encourage the private sector.

6.2 Annual budgets

The Municipality of Tehran has six main goals for subdividing the annual Municipal budget:

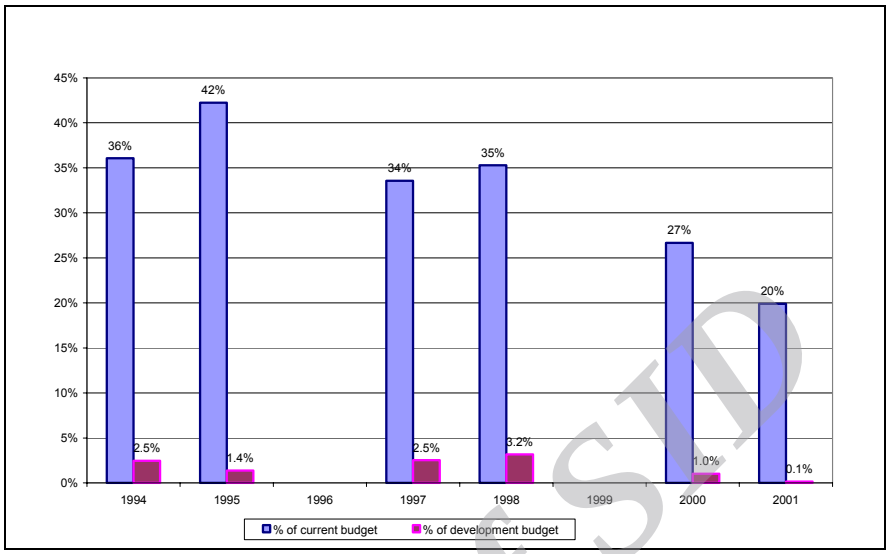
1. Clean city (Weather quality company, central office for general checking of automobiles, Motor Pool organization, OWRC, Urban services)
2. Moving city (Public transportation, Terminals organization, Subway)
3. Green city (Tehran organization of parks & green fields, District's green fields)
4. Reached cultured city (Deputy of social services, central office for research, Public and international office)
5. Dynamic city (Central office of budget and planning, Central office of organization & education, Organization of Daily grocery markets)
6. Ideal city (Architectural& urbanization office, Beautification office, Development & Engineering office, Behesht Zahra cemetery, fire-fighting)

Every year the municipality of Tehran allocates an operational budget and a development budget to above activities. The graph 1 shows the trend of Tehran Municipality's development and current budget.



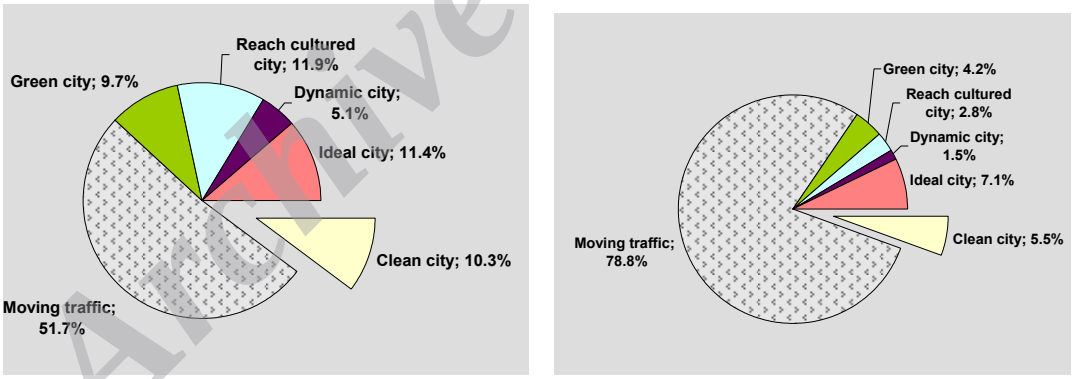
Graph 1:The trend of Tehran municipal budget

The operational budget is increasing every year to a level of 2.300 billion Rials (260 million dollars). The development budget is fluctuating and was in 2001 1.500 billion Rials (170 million dollars). In graph 2 the portion of the budget is shown that is allocated for street sweeping and solid waste management. In 2001 this was an operational budget of 54 million dollars (20% of total). The development budget was in 2001 0,1% but is in general around 1,5% or 4 million dollars per year.



Graph 2 The portion of SWM & cleaning streets budget of Tehran municipality's budget

Graph 3 shows the portion of the each Municipality's goal from development budget in respectively 1997 and 2001.



Graph 3 The contribution of municipality's development budget in 1997 and in 2001

From the figures we can learn that 75% of the development budget in 2001 is used for improvement of traffic flows and public transport in Tehran. The portion for clean city is reduced to 5,5% in 2001.

The investment costs for anticipated projects for Tehran integrated waste management are estimated and shows in Table (1). Table (1) provides an overview of potential investments based on existing information of OWRC (2004) and a first estimation of DHV for investments in sorting plants and recycling shops. This table is subject to further study based on the final implementation plan and actor (investments by Municipality or by private sector).

Potential Investment Plans	Source	Million US $
Collection: new trucks (pick-ups and larger trucks)	OWRC	11
Cleaning of streets: new trucks and means	OWRC	5
Transfer stations: renewal and 4 new TS	OWRC	6
Transport: new trucks and trailers	OWRC	18
Landfilling: realization of Hooshang Abad	BC Berlin	140
Recycling: several new initiatives (PET, wood, compost, metals, paper, tyres, glass)	OWRC	32
Public Awareness Programs	OWRC	5
Hazardous waste: 2 incineration plants	OWRC	36
Other projects	OWRC	2
Total current investment plans from OWRC		***255***
Additional investments: sorting plants for dry recyclables and recycling shops	DHV	60
Total potential investment plans		***315***

Potential Investments Plans in SWM structure

Based on historical data, the average annual development budget was allocated to waste management and cleaning streets is about 4 million US$. Comparing this amount of money and the future investments, it needs about 80 years to complete these projects. Therefore as mentioned before, OWRC should:

- Cooperates and encourage private sector to investment.
- Planning to obtain soft loan.

6.3 Financial management and information system

In the preferred institutional option as described in the previous chapter, the following main stakeholders are present:

Municipality

- OWRC
- TMWS
- Districts
- Motor pool
- Private companies

The financial management and control has its focal point in the OWRC organisation. Since more operational activities have to be place in the TMWS organisation, the OWRC will have the task to focus on the development of the FMIS system.

In addition to developing its own operated system, the OWRC should be able to introduce adequate financial methods and standards for other stakeholders in order to have consistency in the data and procedures. The span of control of the OWRC will also cover operational aspects of elements that are operational in the waste chain.

These elements comprise the following:

Motor pool, the motor pool requires a transparent financial control system and operational target with respect to the uptime of the equipment. The current operational percentage of available equipment, is low due to lack of maintenance.

Transfer stations, Transport, currently the Motor Pool plays a role in the operation of the transfer stations and transport. In the future institutional setting, the Tehran Municipal Waste Services (TMWS) will take over these activities and the Motor Pool will have as core business the leasing (including maintenance) of equipment.

Composting plant, the composting initiatives taken so far, did not result in an operational capacity. In addition, the current composting operation requires a relative large financial support and there is a need for restructuring the composting activities into a more feasible system.

Landfill operations, since the currently used Kahrizak landfill will be closed in the near future, the construction of the new sanitary landfill is required. The plans for the new landfill are in a final stage now and require the final decision.

Recycling, various recycle operation are ongoing and should be promoted in the near future in order to come to a higher overall recycling percentage and a relative lower tonnage to the landfill. OWRC should monitor the recycling activities in a financial and technical way and develop and update the required policies for the various recycle structures.

6.4 Financial analysis of strategic options

6.4.1 Unit cost analysis

In chapter 5 an analysis is made of operational systems and several alternatives where considered. Based on this information and based on the current operational costs of SWM in Tehran, an overview is made of currently used unit costs in Tehran and proposed costs based on our experience.
In Table <<>> an overview of unit prices is shown.

Unit prices for operational costs	Description	Unit price – current (US$ / ton)	Unit price – proposed (US$ / ton)
Collection costs mixed waste	Collection of mixed waste from households and shops	4,6	10
Collection costs dry waste	Collection of dry waste from households and shops		15
Collection costs organic waste	Collection of organic waste from households and shops		8
Street cleaning costs	Costs for street cleaning (sweeping, cleaning gutters, etc)	4,6	10
Transfer costs mixed waste	Proposed transfer costs will rise due to new investments	0,6	2,5
Transport costs to Kahrizak	Transport of 19 tons in semi-trailers over 30 km	1,3	1,5
Transport costs to Hooshang Abad	Transport of 19 tons in semi-trailers over 70 km		2,5
Sorting of mixed waste	Sorting of mixed waste in sorting installation	10	12
Wind-row composting costs	Composting costs in wind-row system (system in Kahrizak) with pure organic material	12	10 (8-12)
Bio-mechanical composting costs	Composting costs in bio-mechanical system with mixed organic material	3	4 (2-6)
Land filling costs	Costs for land filling (and after-treatment)	0,4	5,7
Recycling shop costs	Costs for recycling shops in sub-district, including sorting and storage of dry recyclables		30
Large-scale sorting line costs	Sorting of dry recyclables in 220 tons/day sorting line		12
District level sorting line costs	Sorting of dry recyclables in 90 tons/day sorting line		15
Unit prices for revenues			
Transfer revenues	Revenues from districts for transfer at transfer stations	0,6	2,5
Transport revenues	Revenues from districts for transport to final treatment	2,0	2,5
Land filling revenues	Revenues from districts and private sector for land filling	1,3	5,7
Dry recyclables revenues	Average revenues for dry recyclables	110	90 (70-130)
Composting revenues	Average revenues for compostables	10	7 (0-15)

Table 14 Unit costs overview

These unit prices are used for calculation of the strategic scenario's mentioned in the next paragraph. The prices are open for further improvement, based on required investments and operational costs and based on strategic pricing (i.e. landfill revenues can be higher than land fill costs to obtain cost recovery for recycling)

6.4.2 Overview main financials flows

In order to make a financial analysis we review the following model for the agglomerated financial data.

The financial flows represent the yearly costs in million US$ for the services delivered.
The municipality pays the Solid Waste System that basically consists of OWRC, the Motor and the Motor Pool for handling the waste. The districts are using part of their income from the municipality for taking care of the part they are responsible for.
Finally the private sector pays for waste they receive from the system for further recycling.

In Table 15 Aggregated financial flows, the number for various situations are presented.

First of all the current situation based on the data as they were collected from OWRC. In the second line the same current situation is represented but based on a more realistic system of cost calculation.

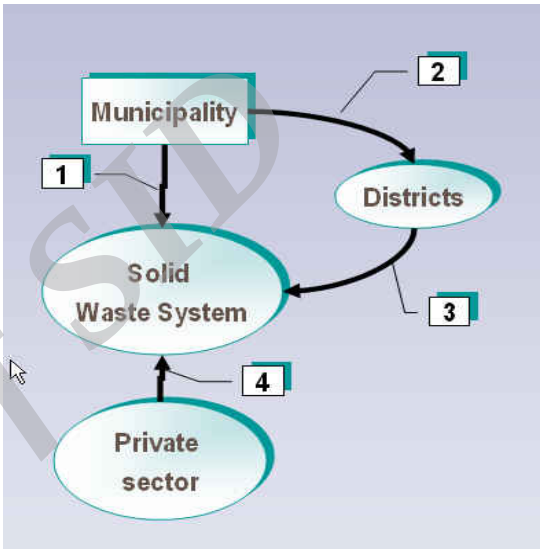


Figure 17 Main financial flows

The third scenario is a prognosis of the financial flows based on a simple cost rise model.
In the fourth scenario, the optimal mix of private sector initiative and governmental interference is calculated.
The flow numbers correspond with the number in the system in Figure 17. Stream 5 is the net costs per year for the waste system. Stream 2 is the total flow from the municipality to the districts. A fraction of this flow will be used for waste management.

Financial flows in million US$	1	2	3	4	Net costs
SWM - current situation 2004	30	?	7	3	**20**
SWM - calculated real costs 2004	60	?	7	3	**50**
SWM - option 1 landfilling 2014	100	?	19	6	**75**
SWM - option 2 A waste reduction 2014 - high public sector involvement in setting up SWM infrastructure (collection, transfer, transport) and marketing of recyclables.	140	?	20	75*	**45**
SWM - option 2 B waste reduction 2014 – high private sector involvement in setting up SWM infrastructure (collection, transfer, transport) and marketing of recyclables..	95	?	20	15	**60**

* mainly based on revenues on sold dry recyclables.

Table 15 Aggregated financial flows

The Option 2A is attractive from financial point of view but there are two points to be considered:

1. the risks involved
2. the required organisation to handle the required activities

In the Option 2B, the revenues from the market are less but the risks are consequently lower as well.

6.5 Financial Instruments

Various financial instruments are available for giving stimulants or discouraging certain events. For every instrument used, a careful analysis in needed in order to reduce side effects, detrimental effects and to optimize the objectives. This can be process of many years.

Some of the instruments that can be used in relation to waste management are:

- Financially support or loans for basic studies,
- Providing soft loans to recycle initiatives form the private sector,
- Taxation on the production of certain packaging to pay for downstream disposal,
- Set-up deposit system for reusing products
- Financial market price support or subsidies for products that use recycled materials
- Financial market price support or subsidies for recycled materials
- Guaranteed minimum price for products
- Establish a funds that are filled by taxation and used for very specific targets

Some of these instruments will have a direct influence on the market mechanism and will influence the market balance. This is however often the effect that was envisioned and the certain market shifts in a financial sense, will result in market shifts in quantities or tonnage.

A monitoring system that keeps track of the effects of an instrument should be an integral part.

An example of using the financial instrumentation is subsidizing recycled PET with a certain amount. This will stimulate private initiatives to enter into the recycle business. The subsidy will be available for a limited period after which the private sector should fully take over.
Basic investments can be supported by providing soft loans or financial guarantees.

7 PUBLIC AWARENESS AND PARTICIPATION

The involvement of the public in reaching recycling at source targets are critical for the success. The process of awareness increase has been started already years ago in various initiated projects.

The strategy towards public participation is based on a step-by-step approach, implementing the results and experience subsequently. It needs not only a mechanism to reach to the public, it needs as well a consistent policy from the municipality, preventing a public cynicism on the requested participating activities.

There are two parallel strategic actions to be developed:

One: demonstration projects on public participation in two representative districts:
- low income, high population density,
- middle income, relatively low population density,

Two: development of information on awareness aimed at special target groups.
- Starting communication of basic principles like waste types
- Starting communication of municipal policy towards waste
- Starting communication and promotion of usage of recycled products to public and private organisations (i.e. compost: farmers, public services; paper: schools, public administration, private companies; plastic: public and private organisations)

The advantage of this approach is that experience is generated on a very practical level in the demonstration projects and simultaneously the introduction of the results on a wider scale is being prepared and basic concepts have been communicated on a large scale.

The strategic goal with respect public participation cannot be seen independently from the development of required infrastructure for waste collection.

The short term actions that are supporting the strategy are:
1. Initiate the demonstration program in two districts
2. Initiate a communication plan for basic concepts.

7.1 Demonstration project

The outline of the demonstration project has already been defined in a precursor document.
The project will result in an in depth view on the possibilities to have a waste reduction scheme by source separation.
Basically, a full separation of household waste stream, should be the long term goal. The waste stream that should be facilitated are:

Wet waste for composting versus dry recyclables plus hazardous waste (batteries, paint residues, medicines etc)/ paper / carton / glass etc.)

This target is however a long term target and not a realistic option for the short term. Main bottleneck is the public awareness and the subsequent preparedness to follow an other way of handling waste.
Also the roles of the informal sector, the collection structure etc. play a role in the way the public will envisions waste handling.

The short term target should have a low failure risk that will block all subsequent activities.
The household separation in dry/wet fractions (or recyclable/rest fractions) has to be considered in the demonstration project.

The topics for the demonstration project are:

- Choice of the districts,
- Needed facilities,
- Cooperation between partners.

7.2 Tehran Waste Communication plan

The communication plan has the primarily objective to set-up a structure for enhancing the awareness of the Tehran population on waste. It should not cover directly an invitation for source separation or anything that requires up-stream or down stream facilities.
It must convey the message that waste is something you have to deal with in a responsible way and waste removal is something that basically cost money. It is a first step in a polluter pays way of thinking.

The secondary objective of the communication plan is to provide practical information to health care institutions, small and medium size enterprises with the objective to provide information on how source separation can be done in practise. Attention should be paid to a clear definition of types of waste and how to identify them in an easy and practical way.
An information centre can be made available for responding to questions, suggestions and encountered problems.

8 OVERVIEW SWM STRATEGY COMPONENTS

The Solid Waste Management Strategy has been developed and discussed in the previous chapters and various options have been proposed.
The highlights are summarized in this chapter and refer to main components.
The implementation requires partly more detailed studies, partly decision making, partly require political support.
The reform of the organisation is one of the main components since a successful reform results in an effective organisation on all fields of policy and the complete waste chain in Tehran.

8.1 Main components

In compliance with the vision the following main strategic targets are defined. Review of these focal points at every milestone (1 year and 3 year) is necessary in order to upgrade and optimise a sustainable SWM system. The following strategic targets for the period 2004-2014 are defined:

1. **Institutional, financial and legal strengthening of SWM organisations**

   Institutional
   Make an OWRC restructuring plan within 6 month.
   Implement new structure within one year.
   Have full functional capacity on control function of new OWRC within 11/2 year.
   Establish understanding between stakeholders on expectations and responsibilities.

   Legal
   Set up an inspection department that independently inspects the compliance to procedures.
   Review the legal basis to support focal points like recycling, financial system and institutional rearrangement based on national legal requirements.
   Identify legal bottlenecks on national and municipal level.
   Introduce ordinances on municipality level to regulate initiatives on e.g. source separation.
   Developments of standards for compost, recycled materials and labelling of hazardous materials.
   Introducing and stimulate certification

   Financial
   Develop financial management and information system.
   Develop of cost monitoring system.
   Stream line financial information exchange with subcontractors.
   Develop financial instruments to support recycling
   Maximize cost recovery by founded price calculations for gate fees and subcontracts.
   Push non ‘core business’ activities to private sector.
   Start PPP at medical institutions and industry by developing ordnances.

2. **Separation of dry waste plus hazardous waste at source: 20% of total waste flow**
   Initiate demonstration programs for two districts.
   Scale up awareness based on experience and review of the demonstration results.

Initiate a communication plan for basic waste concepts on municipality level.

3. **Separation of wet waste at source: 50% of total waste flow**
   Initiate demonstration programs for two districts.
   Scale up awareness based on experience and review of the demonstration results.
   Initiate a communication plan for basic waste concepts on municipality level.

4. **Realization of private composting industry: 5000 tons/day**
   Maximize private recycling enterprises but keep a control function by OWRC.
   Promotion of usage of recycled products to households, private and public organisations.

5. **Realization of private dry recycling industry: 2000 tons/day**
   Maximize private recycling enterprises but keep a control function by OWRC.
   Promotion of usage of recycled products to households, private and public organisations.

6. **Realization of required infrastructure for collection, transfer, sorting of dry waste and transport of all Municipal waste.**
   Renewal program for collection trucks and further study on usage of compaction trucks
   Start-up of separation-at-source by door-to-door collection, face-to-face transactions and/or recycling shops.
   Realization of recycling shops and sorting plants for dry waste at (sub)district level.
   Realization of 4 or 5 new transfer stations including sorting lines for dry waste.

7. **Realization of new sanitary landfill at Houshang Abad.**
   Realization of Houshang Abad land fill
   Closure and Rehabilitation of Kahrizak land fill
   Development of pre-treatment industry

The points covered in the table will result in specific and concrete actions, activities and studies in a coherent and consistent way.

It is envisioned that the reformed structure of OWRC into a role partly as 'command and control' type and partly in a role as facilitator, will be asked to guide and initiate the various topics. The OWRC should have the resources to do so and a organisational plan covering fields of expertise, know-how, staffing, span of control etc is needed.

The reform plan has the highest priority since all downstream organisational processes are more or less dependent on it.

The number of covered topics will all need the attention, preparation and decision making process. Supporting studies have to be done and the capacity should be available to define the study targets and implement the results. Care must be taken not to overburden the organisation so the results of the efforts are annihilated.

8.2 Action/Implementation Plan

The implementation plan comprises two basic elements: the actions that are proposed and the following implementation of the proposed actions.

8.3 Institutional

General

1-2 years	2-5 years	5-10 years
(i) Develop and implement a Municipal Ordinance (ii) Develop and implement a Waste Strategy Plan (wait for results from bio-mechanical composting and separation line at TS 15) (iii) Prepare a detailed implementation study on selected option for re-organisation (organisation, staffing, tasks, financing, etc.) (iv) Prepare amendments to Waste Management Law (v) Prepare standard pre- qualification criteria, contract conditions and evaluation parameters for sub-contracting of operational activities (vi) Set up a Complaint Desk at OWRC for waste generators, contractors and private recyclers	(i) Implement the selected Option for re-organisation (ii) Implement the Waste Management Department at District level (iii)) Develop and implement a Waste Action Plan on District level (iv) Start training programmes at Municipal and District level (v) Set up a system of registration and licensing for collection, transport, recycling, etc. (vi) Prepare guidelines for composting, recycling, operations of transfer stations, reporting, etc.	(i) Start discussion to continue with land filling or incineration

Table 16 Implementation Institutional Components

Domestic waste

1-2 years	2-5 years	5-10 years
(i) Carry out a public satisfaction survey in all Districts (ii) Improve tender conditions (duration, bonus instead of penalty, etc.) for contractors (iii) Prepare conditions and procedures for privatization of composting and recycling facilities (iv) Develop Public Awareness programmes for Municipal and District levels and arrange for extra financing (v) Analyse, upgrade and adapt the separation at source activities in all Districts. (vi) Develop training programmes based on the selected option for Municipal and District staff, operational staff at private companies	(i) Implement training programmes (ii) Prepare guidelines for composting, recycling, operational manuals for waste collectors, drivers, etc. (iii) Privatise the composting and recycling facilities (iv) Review and update the reporting and databank system and dissemination of the information	

Table 17 Implementation domestic waste

Healthcare (infectious waste) waste

1-2 years	2-5 years	5-10 years
(i) Carry out an investment study on the implementation of central treatment (incineration, autoclaving) facilities by Municipality at landfill in comparison to individual facilities at hospitals (ii) Prepare a standard contract for collection, (eventually) treatment and final disposal. Calculate the tariff based on cost recovery (iii) Prepare the licensing criteria for collection and transport by Municipal or private contractors	(i) Invest in special collection trucks (ii) Invest (eventually) in central treatment facilities	

Table 18 Implementation healthcare waste

Industrial waste

1-2 years	2-5 years	5-10 years
(i) Prepare inventory and set up databank for industries and type/volume of waste produced (ii) Prepare an industrial waste classification list (iii) Prepare the licensing criteria for collection and transport by Municipal company or private contractors (iv) Set up a reporting and documentation system to be used by the transporter (v) Prepare a tariff system depending on type and volumes of industrial waste. Actual tariff should be cost price plus profit. (vi) Prepare a standard contract for collection and disposal.	(i) Invest in large containers and hook lift trucks	

Table 19 Implementation industrial waste

Other (hazardous) waste

1-2 years	2-5 years	5-10 years
	(i) Prepare a market survey on the waste from electrical and electronic waste, especially the products with a hazardous waste component such as fridges/freezers, TV sets, fluorescent lamps and batteries; tyres; end-of life vehicles; waste oils.	(i) Introduce the producer responsibility with a take back obligation and recycling fee to be paid by buyer of the product (ii) Prepare amendments to the legislation (iii) Prepare a Public Awareness campaign for the introduction of the producer responsibility.

Table 20 Implementation other waste

8.4 Operational

Source reduction

1-2 years	2-5 years	5-10 years
(i) Define a policy to stimulate waste reduction at source from households (i.e. bottles) and commercial enterprises (i.e. pallets, boxes, industrial packaging) (ii) public awareness campaigns on source reduction and usage of recycled products.	(i) Promotion / awareness campaigns for source reduction	

Table 21 Implementation of source reduction

Improvement of dry recycling up to 20%

1-2 years	2-5 years	5-10 years
Dry recycling separation at source and collection (i) Continuation, monitoring and evaluation of existing program to separate dry recyclables at source by face-to-face transactions in day-time. (ii) Start of door-to-door collection pilot in one high-density district using coloured bags and in one low-density district using community containers, monitoring and evaluation of pilot. (iii) feasibility study on large-scale implementation of circa 130 recycling shops with capacity of 10 tons/day in all districts. (iv) Implementation of 4 to 5 recycling shops in one high-density district, monitoring and evaluation of pilot. (v) Demonstration project with different kind of collection trucks (hand carts, pick-up, compaction truck, 2-compartment truck) and monitoring of results. (vi) Training program for collection personnel and personnel of recycling shops.	**Dry recycling separation at source and collection** (i) further improvement of face-to-face transaction system in all districts. (ii) implementation and monitoring of door-to-door collection in all districts. (iii) implementation of 130 recycling shops in districts. (iv) Roll-out of training programs for collection personnel and personnel of recycling shops. (ii) Review possibilities for more recycle chains (tyres, hazardous waste from households)	**Dry recycling separation at source and collection** (i) further operational optimisation to achieve high recycling targets (number of community containers/recycling shops, collection frequency).
Dry recycling sorting, transfer and transport (i) Geographical study on existing (informal) transfer points for dry recyclables and future plans with these points. (ii) feasibility study on implementation of circa 20 recycling centres with capacity of 50 tons/day in 50% of districts and 4 to 5 large-scale sorting lines at transfer Stations with capacity of 200 tons/day for other 50% of districts. (ii) design and realisation of 2 recycling centres in one low-density and one high-density district, monitoring and evaluation of pilot. (iii) design and realisation of 1 transfer station with	**Dry recycling sorting, transfer and transport** (iv) implementation of 20 recycling centres in relevant districts. (iii) design and realisation of 4 extra transfer stations with sorting line for dry recyclables.	**Dry recycling sorting, transfer and transport** (i) further operational optimisation. (ii) implementation of transfer depots in all relevant districts in Tehran

sorting line for dry recyclables. Monitoring and evaluation of pilot.		
Dry recycling industry and marketing (i) Marketing study for dry recyclables and phasing plan and opportunities for national recycling industry. (ii) Role of municipality in promoting (and purchasing) of recycled products (compost, paper, plastic bags, glass) (ii) start-up of tendering procedure, quality standards and subsidy programs for relevant dry recyclables. (iii) start-up of pilot project with existing private recycling company to set up and evaluate tender procedures.	**Dry recycling industry and marketing** (i) tender procedures for implementation of relevant recycling industries. (ii) promotional campaigns for recycled products (iii) development of purchase procedure for sustainable products for Municipality of Tehran.	**Dry recycling industry and marketing** (i) further operational optimisation. (ii) implementation of transfer depots in all relevant districts in Tehran

Table 22 Implementation dry recycling

Improvement of composting up to 50%

1-2 years	2-5 years	5-10 years
Organic waste separation at source and collection (i) Continuation, monitoring and improvement of existing organic waste collection from Fruit- and Vegetable Centres (FVC), parcs/green areas and other relevant large organic waste producers. (ii) Feasibility study on separation at source of organic waste using special mini-containers in low-density area and/or fruitshops and restaurants. (iii) Feasibility study to achieve a more or less separate collection and transfer of "wetter" waste per district.	**Organic waste separation at source and collection** (i) implementation of separation at source of organic waste in one low-density district. (ii) Feasibility study and small-scale experiment on at-home composting in low-density district.	**Organic waste separation at source and collection** (i) further operational optimisation to achieve high recycling targets
Organic waste sorting, transfer and transport (i) Geographical study on best allocation areas for sorting and pre-treatment of organic waste. (ii) Introduction of special trailers for transport of organic waste (no leakage of leachate) and allocation of transfer dump locations at each transfer station especially for wet waste. (iii) Feasibility study on large-scale sorting of wet waste at composting plant in high-quality.	**Organic waste sorting, transfer and transport** (i) further operational optimisation	**Organic waste sorting, transfer and transport** (i) further operational optimisation.

Composting industry and marketing (i) Out sourcing of current composting industry (Kahrizak) (ii) Marketing study for different qualities of compost (export, agricultural, parcs, landfill) and phasing plan and opportunities for national composting industry. (iii) Role of municipality in promoting (and purchasing) of compost for parcs. (iv) Allocation study for future composting industries on 1 to 3 locations around Tehran (alternatives for closure of Kahrizak landfill). (v) start-up of tendering procedure, quality standards and subsidy programs for compostable materials. (vi) start-up of large-scale bio-mechanical treatment of mixed waste (1000 up to 3000 tons/day ???), evaluation of obtained quality of compost.	**Composting industry and marketing** (i) tender procedures for implementation of relevant composting industries (both high quality and pre-treatment quality). (ii) start-up of large-scale bio-mechanical treatment of mixed waste (up to 5.000 tons/day).	**Composting industry and marketing** (i) further operational optimisation.

Table 23 Implementation composting capacity to 50%

Improvement of mixed waste

1-2 years	2-5 years	5-10 years
Mixed waste collection (i) Optimisation and renewal program for collection trucks: optimum truck size for each type of district. (ii) Feasibility study for introduction of OWRC collection bags for households and for small enterprises and introduction of tariff systems for households and enterprises. (iii) Efficiency and ergonomic improvement of material handling. Set-up of training program for collection personnel.	**Mixed waste collection** (i) implementation of separation at source of organic waste in one low-density district. (ii) Feasibility study and small-scale experiment on at-home composting in low-density district. (iii) roll-out of training program for collection personnel.	**Mixed waste collection** (i) Study on Tariff differentiation (depending on waste volume, waste tonnage or no. of people per household)
Mixed waste transfer and transport (i) Geographical study on best allocations for transfer stations (in relation to recycling centres and recycling shops). (ii) Introduction of special trailers for transport of organic waste (no leakage of leachate) and allocation of transfer dump locations at each transfer station especially for wet waste.	**Mixed waste transfer and transport** (i) further operational optimisation	**Mixed waste transfer and transport** (i) further operational optimisation.
Mixed waste treatment (i) Development of after-care program for Kahrizak landfill. (ii) Realization of first phase of Houshang Abad land fill. (iii) Development of pre-treatment installation(s) (iv) Impact of pre-treatment on phasing of Houshang Abad.	**Mixed waste treatment** (i) Start-up of Houshang Abad Landfill (ii) Start-up of pre-treatment installation(s) (iii) Closure of Kahrizak landfill and start up of after-care program.	**Mixed waste treatment** (i) further operational optimisation.

Table 24 Implementation mixed waste

Health care waste

1-2 years	2-5 years	5-10 years
- Initiate source separation campaigns at medical establishments - Separation at source (hazardous and non-hazardous wastes) at medical establishments - Enhance the hazardous fraction collection fleet - Study centralized/decentralized incineration/autoclaving - Develop a special cell for hazardous waste disposal at the sanitary landfill and start disposal - Form a committee comprising OWRC, DoE and the MoH for review, monitor and decision making	- Targeted source separation of hazardous/non-hazardous waste up to 50% - Start implementation of the selected option for hazardous fraction of the HCW disposal	- Targeted source separation at full capacity - Optimize the operation of the selected option

Table 25 Implementation of health care waste

Industrial waste

1-2 years	2-5 years	5-10 years
- Establish a clear definition and categorization scheme for industrial waste identification and codification - Study and establish special collection fleet for hazardous (non-=recyclable) industrial waste - Develop a special cell in the sanitary landfill for hazardous (non-recyclable) industrial waste disposal - Define and establish a tariff system for hazardous (non-recyclable) industrial waste disposal - Study alternative disposal methods (mainly incineration) feasibility	- Initiate implementation of the selected option for hazardous (non-recyclable) industrial waste - Targeted 50% of the industrial areas in Tehran to be covered by the special collection fleet	- Implement andd operate the selected hazardous (non-recyclable) industrial waste disposal scheme

Table 26 Implementation of industrial waste

The operational actions including waste quantities are summarized in Table 27 Overview strategic operational actions.

Operational Actions		Short term (1-2 years)	Medium term (2-5 years)	Long term (10 years)	Main actor
Dry recyclables	**Collection**	(i) Wet/dry collection pilot project (ii) Face-to-face demonstration project (iii) Recycling shop	(i) Wet/dry collection structure in 50% of districts (ii) Face-to-face collection structure	(i) Wet/dry collection structure in all districts (i) Face-to-face collection structure	OWRC + districts

		demonstration pilot (fruit markets) Capacity: 200 tons/day	(iii) Recycling shop structure in 50% of districts Capacity: 1400 tons/d	(ii) Recycling shop structure in all districts Capacity: 2000 tons/d	
	Transfer	(i) implementation of 1 sorting plant at 1 Transfer Station (ii) Study on sorting plants at district level Capacity: 200 tons/day	(i) implementation of 2 extra sorting plants at 2 TS (ii) implementation of 6 sorting plants at district level Capacity: 1400 tons/d	(i) implementation of 2 extra sorting plants at 2 TS (ii) implementation of 6 sorting plants at district level Capacity: 2000 tons/d	OWRC + districts
	Final Treatment	(i) promoting and tendering private recycling industry (ii) promoting usage of recyclable products Capacity: 200 tons/day	(i) implementing private recycling industry (ii) promoting usage of recyclable products Capacity: 1400 tons/d	(i) extension private recycling industry (ii) promoting usage of recyclable products Capacity: 2000 tons/d	OWRC+ private industry
Organic waste	**Collection**	(i) Wet/dry collection pilot project Result: 500 tons/day	(i) Wet/dry collection structure in 50% of districts Result: 2500 tons/day	(i) Wet/dry collection structure in all districts Result: 5000 tons/day	OWRC + districts
	Transfer	(i) leachate-tight semi-trailers at TS			OWRC+ Motor pool
	Final Treatment	(i) implementation pre-treatment (80%) and quality composting (20%) (ii) promoting usage of quality compost Result: 5000 tons/day	(i) develop to pre-treatment (50%) and quality composting (50%) (ii) promoting usage of quality compost Result: 5000 tons/day	(i) develop to pre-treatment (20%) and quality composting (80%) (ii) promoting usage of quality compost Result: 5000 tons/day	OWRC+ private industry
Residue waste (mixed waste)	**Collection**	(i) Study on large-scale usage of compaction trucks (ii) demonstration project comp.trucks	(ii) Large-scale renewal of collection trucks	(iii) continuous update of collection trucks	OWRC+ Districts+ private collectors
	Transfer	(i) implementation of 1 new TS with sorting plant (ii) improvement of 4 existing TS	(ii) implementation of 2 new TS with sorting plants	(ii) implementation of 2 new TS with sorting plants	OWRC+ Motor Pool
	Final Disposal	(i) Closure Kahrizak land fill Capacity: 4000 tons/d	(i) Open Hooshang Abad land fill (ii) Rehabilitate Kahrizak land fill Capacity: 3000 tons/d	(ii) Study future options for treatment (incineration, ,..) Capacity: 1600 tons/d	OWRC

Hazardous waste	**Collection + transfer**	(i) demonstration project for collection from households of dry fraction and sorting in recycling shops and sorting plants	(i) further development of hazardous waste collection and separation in sorting plants and recycling shops	(i) full working structure for hazardous waste collection and separation.	OWRC + districts+ private collectors
	Final Treatment	(i) Study special land fill for hazardous/ infectious waste	(ii) implementation of special land fill or special cell at Hooshang Abad land fill	(iii) study incineration of hazardous waste	

Table 27 Overview strategic operational actions

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- Mr. Maziznani, (Kahrizak compost plant)
- Mr. Davari and Salimi (Urban services department)
- Mr. Mehdipour (Manager of the department of statistics of OWRC)
- Mr. Narimani and Nikpour (Motor pool)
- Mr. Salimi (Mayor of sub-district 7 of district 1)
- Mr. Kalantary (Deputy of financial and administrative affairs of the municipality)
- Mr. Rahmani and others (Manager of financial department and head of the accounting department of OWRC)
- Mrs. Fatemeh Zargar (urban services department, specialist)

10 COLOPHON

Client	:	Islamic Republic of Iran, Municipality of Tehran Organisation for Waste Recycling and Composting
Project	:	Report on Phase 2
File	:	X8114.01.001
Length of report	:	83 pages
Author	:	D. Jansen,
Contributions	:	G. Erens, E. Safari, G. Simonis, I. Allahdadi, Mrs. T.Ariyan
Project Manager	:	D. Jansen
Project Director	:	Jan Oomen
Date	:	20 January 2005
Name/Initials	:	

Annex 1

Municipal Waste Ordinance (example)

A Municipal Ordinance sets the local rules and regulations on a Municipal level. It is a legal document and violation is a legal abuse and will be penalised. It can be one document covering several municipal aspects or it can be a document for each aspect separately. Some Municipalities have a separate "Waste Ordinance". The Ordinance fixes the tasks and responsibilities of the waste collector, the waste generator and the Municipality. Taking into account the special character of Tehran Municipality about 8 million inhabitants divided over 22 Districts whereby each District has its own character), it is recommended to prepare:
- a general Waste Ordinance for the whole metropolitan area
- an addendum for each sub Districts specifying the details.

The content of a Municipal Waste Ordinance could be as follows:

Chapter I- Waste Collection
Appointment waste collection company
- Name of company assigned by District for household waste and/or separated waste collection on sub-District level
- Other companies appointed by Municipality to collect other types of wastes on Municipal level (industrial, hospital waste)

Separate Collection
- Following components could be collected separately: dry recyclables (paper/carton, packaging glass, plastics, metals), household rest waste, small chemicals (batteries, outdated medicines, paint cans), electrical and electronic waste, construction and demolition waste, bulky household waste.
- Means of collection (bag or container) and the facilities are determined by the Municipality or District per individual house, group of houses/flats, city district waste yard

Frequency of collection
- Household rest waste: daily
- Dry recyclables waste: once per week
- District decides on frequency of collection of other separated waste components

Licensing
- Forbidden to collect waste without a license issued by the Municipality
- License can be refused in the interest of efficiency

Chapter II – Offering household type waste for collection
To other companies/persons
- Forbidden to offer to other companies or persons than the ones appointed/ licensed by the Municipality

By others than users of house/flat/companies
- Forbidden to offer household waste for collection except by users of house/flat, small shops

Separated offering of waste

- Following components should be offered separated: dry recyclables (glass, paper/carton, plastics, metals) and rest waste
- Municipality/District will determine to whom it should be offered. It is forbidden to offer to others.

Means of collection (bag or container)

- User of house/flat should offer the waste in the means of collection assigned by the District
- Forbidden to put other waste components in the means of collection than the ones indicated by the Municipality/District
- District can determine the location of means of collection. Waste offering to other locations is forbidden
- District can determine the max weight per means of collection and number of means of collection that can be offered
- Others than the user of the house/flat/small shops are not allowed to use the means of collection to offer their waste

Times and days

- District fixes times and days for household waste collection
- It is forbidden to offer waste outside these times and days

Chapter III – Other waste components

Waste Collection Company

- District can determine which other waste components will be collected by the assigned waste collection company
- Forbidden to offer other waste components than household waste except when authorised by the Municipality/District

Protection of Environment

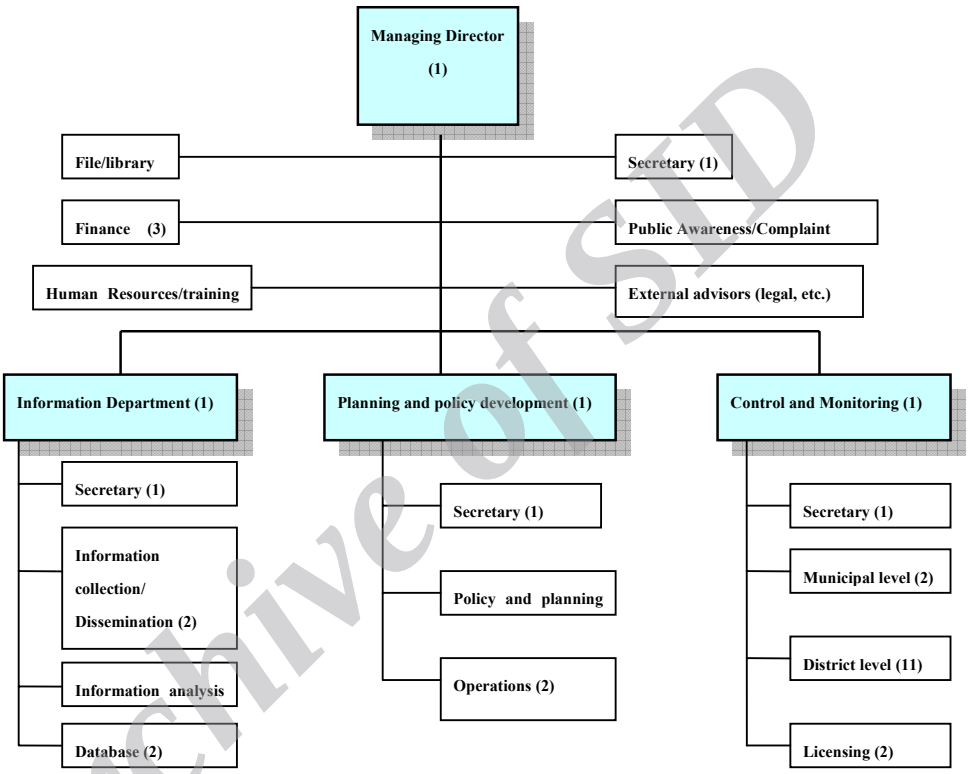
- Forbidden to search in and to spread around the waste waiting for collection
- Street waste should be deposited in the assigned bins. No other waste is allowed in the bins.
- Waste storage and treatment is forbidden except for licensed persons/companies and for home composting
- Transport of non-hazardous waste with a risk of street pollution is forbidden
- When during (un)loading/transport the street will be polluted the transporter will be obliged to clean the street

Chapter IV – Penalty

- Violation of the Ordinance might result in imprisonment or a fine.

Annex 2

PROPOSED ORGANIZATION OWRC



General

The main tasks of OWRC will be to act as an Advisor to the Municipality for:

- Development and implementation of policies in the field of waste management
- Collection of statistical information and the setting up of a Database and the dissemination of the information
- Control and monitoring of waste management activities both at Municipal and District level

Organizational set up

OWRC will be managed by a team comprising the Managing Director and the three Department heads. OWRC will comprise the following Departments:

- *Information Department*

The main tasks of this Department can be summarized as follows:

- setting up, implementing and updating of a reporting system by all stakeholders i.e. at Municipal level (waste collectors of industrial and healthcare waste, landfill, any recyclers) and at District level (District offices, transfer stations, transporters, recyclers)
- evaluation of the information and requests for clarifications (if needed)
- setting up of a Database
- dissemination of the information within OWRC and to outside parties
- preparation of regular Management Information reports

- *Planning and Policy Development Department*

The main tasks of this Department can be summarized as follows:

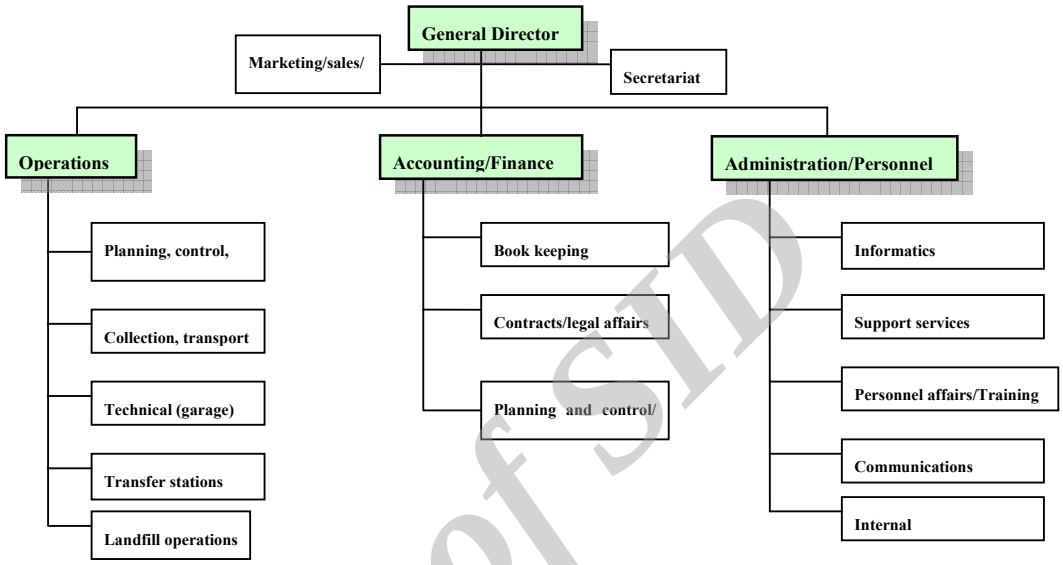
- Preparation/ regular updating of a Municipal Ordinance including annexes per District
- Preparation/ regular updating of a Municipal Waste Management Plan
- preparation of any amendments to the Law
- introduction of standard contracts and evaluation criteria of tenders
- preparation of operational guidelines
- introduction of licenses for waste collectors, transporters, recyclers, landfill operators, etc.
- study on new developments in waste management e.g. introduction of producer responsibility, collection and recycling of special (hazardous) waste steams, etc.
- critical analysis of efficiency and effectiveness of waste management operations and achievement of targets. This will be mainly based on information received from the Information Department and the Control and Monitoring Department.

- *Control and Monitoring Department*

The main tasks of this Department will be the control and monitoring of the operations and its compliance with the rules and regulations as issued by the Municipality for:

- collection and transport both at Municipal level (industrial, healthcare and construction and demolition waste) and at District level (domestic, special waste streams)
- landfilling
- recycling
- finance/budget
- contracting procedures
- complaint/dispute handling
- assistance to District Waste Management Departments (to be established)
- enforcement and penalty levy

PROPOSED ORGANIZATION TMWS



General

The main tasks of TMWS will comprise:

- collection of healthcare waste for the total municipality
- collection of industrial waste for the total municipality
- collection of construction and demolition waste (optional)
- operations of transfer stations and transport to landfill
- operations of landfill
- treatment at landfill (incineration of infectious healthcare waste) if contracts can be concluded and finance can be secured.

Organizational set up

TMWS is a 100% municipal organization but it will operate as an autonomous "commercialized" organization. The management of the company will consist of:

- *the General Director*

He will be mainly responsible for:

- the daily management and future development of the company,
- reporting to OWRC on budget and results
- marketing/sales as the company will operate on a "commercialized" basis in a competitive environment especially for waste collection from institutional and private companies.

- *Operational Department*

This Department will be mainly responsible for:

- planning of the equipment and control of actual results
- execution of collection and transport
- execution of transfer station operations
- execution of landfill operations
- technical section with the garage for daily and small maintenance (preventive and corrective). It is assume that most of the equipment will be leased from the Motor pool and thus the Motor Pool will be responsible for the major overhaul/repair.

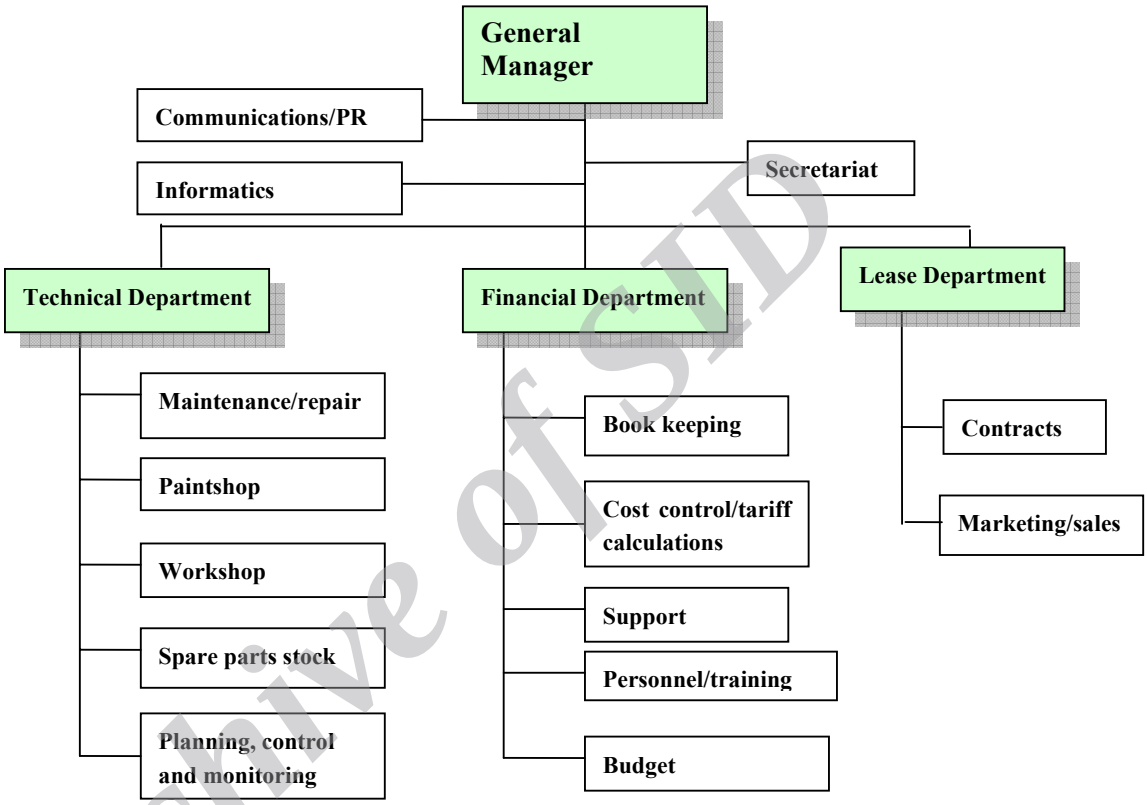
It is also foreseen that most of the workers will be hired in through contracts with private companies. Only the management of the company will be on the payroll of TMWS.

- *Accounting/finance Department*

This Department will be mainly responsible for the following:

- Preparation of contracts both for waste collection and for sub contracting of services
- Financial bookkeeping
- Planning and budget preparation
- Cost control and monitoring

PROPOSED ORGANISATION MOTOR POOL



General

The main tasks of the Motor Pool include:

- Management of vehicles owned by Municipality
- Keeping the vehicles in good condition through regular overhaul and repair
- Leasing the vehicles to waste management companies both municipal and private

Organizational set up

The Motor Pool will consist of:

- *A General Director* being responsible for:
  - the daily management
  - communications and public relations
  - reporting to OWRC

- *A Technical Department* being responsible for:

  - Planning of the equipment and control thereon
  - Repair and overhaul in the garages including spare parts stock control

- *A Financial Department* being responsible for:
  - Personnel/training
  - Book keeping
  - Cost control and tariff calculations
  - Support services such as documentation, repair/maintenance of facilities/buildings, etc.

- *A lease Department* being responsible for:
  - contracting
  - marketing and sales

Annex 3

Standards for Composting Quality

Table 1
Available standards concerning heavy metals (in mg/kg dry matter) in the various EU Member States in relation to the standards in the community Eco-label

	Chrome (total)	Nickel	Copper	Zinc	Cadmium	Mercury	Lead	Arsenic
Eco-label	140	50	75	300	1,5	1,0	140	7,0
Austria:								
Class 1	70	42	70	210	0,7	0,7	70	-
Class 2	70	60	100	400	1,0	1,0	150	-
Belgium(Flan.)	70	20	90	300	1,5	1,0	120	-
Denmark	-	30	-		0,8	0,8	120	-
Finland	-	100	600	1.500	3,0	2,0	150	50,0
France	200	-	-	-	8,0	8,0	800	-
Germany:								-
RAL[1]	100	50	100	400	1,5	1,0	150	
Blue Angel	75	-	-	300	1,0	-	100	-
Italy:								
National law	510	200	600	2.500	10,0	10,0	500	10,0
Reg. Lombardia	150	50	200	400	3,0	2,0	200	5
Reg. Piemonte	500	150	50	1.500	5,0	2,5	350	2,5
Reg. Veneto	151	150	300	1.250	5,0	3,0	200	5,0
Netherlands:								
Compost	50	20	60	200	1,0	0,3	100	15,0
High qual. com.	50	10	25	75	0,7	0,2	65	5,0
Spain	750	400	1.750	4.000	40,0	25,0	1.200	-
Sweden	100	50	600	800	2,0	2,5	100	-

[1] Also used in Luxembourg