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Municipal Waste Reduction Potential and Related Strategies in Tehran

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ABSTRACT: The main problem of solid waste management system in Tehran is to handle a large amount of waste (7.641 ton/day in 2008). Therefore, source reduction can be introduced as one of the first priority for solid waste management in Tehran. This research represents the first attempt to quantify the source reduction potential in the city, and subsequently, outlines the principle guidelines, legislations and strategies regarding source reduction application in Tehran metropolitan area.Based on the findings of current research source reduction strategies can be implemented in dealing with packaging material, paper, street waste, mixed household waste and hazardous household wastes. Also industrial wastes produced inside city boundaries can be reduced drastically by implementing source reduction measures. It is also found that any recycling program can be combined effectively with source reduction strategies.The waste reduction potential for each component of waste stream is calculated as the result of the research source reduction potential were determined as: horticultural waste, 80%; food waste, 80; paper and cardboard, 50%; textiles, 20%; metals including ferrous and nonferrous, % 90; Glass, % 30; PET%, 70, and plastic 80%.Finally, overall potential for source reduction in Tehran city is estimated to be 66% for the waste stream as a whole.

Key words: Source reduction, Source reduction potential, Household hazardous waste,Recycling

INTRODUCTION

In its *Agenda for Action* (1989), the U.S. Environmental Protection Agency gave source reduction the highest priority as a method for addressing solid waste issues. Source reduction is the only practice that is preventative. This proactive approach also reduces material and energy use.Recycling, composting, waste-to-energy, and landfilling are reactive methods for recovering and managing materials after they are produced. The USEPA defines source reduction as the design, manufacture, purchase or use of materials to reduce their quantity or toxicity before they reach the waste stream. Several terms are often used to mean source reduction. These include waste reduction, waste prevention, waste minimization, pollution prevention, and precycling.

Waste reduction is a broader term encompassing all waste management methods, i.e., source reduction, recycling, and composting that result in reduction of waste going to the combustion facility or landfill. Waste minimization refers to activities specifically designed to reduce industrial hazardous and toxic wastes as they affect land disposal as well as contribute to air and water pollution. Pollution prevention includes input optimization, the reduction of no product outputs, and production of low-impact products. Precycling refers to the decision-making process that consumers use to judge a purchase based on its waste implications; criteria used in the process include whether a product is reusable, durable, and repairable; made from renewable or nonrenewable resources; over-packaged; or in a reusable container.

The basic elements of source reduction include the following:

- reduced material use in product manufacture
- increased useful life of a product through durability and reparability
- decreased toxicity
- Material reuse
- Reduced/more efficient consumer use of materials
- Increased production efficiency resulting in less production of waste (R.O'Leary, 1995).

Area of study: Tehran, the capital of Iran, with the population of 8.2 million people, occupies 730 km^2 land expanse, which is 4% of total area of country. Tehran generated 2,788,912 ton (7,641 ton/day) of waste in year 2008. Hospital waste generation rate in Tehran reaches 83 ton/day. Almost 87% of total waste was disposed of by placing in a landfill located in Kahrizak region. This large amount of waste causes a significant challenge for the city.

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The "Organization of Waste Recycling & Composting (OWRC)", affiliated with Tehran municipality is responsible for operating and managing Kahrizak landfill and waste processing center (Abduli, 1996). This landfill occupies 500 ha of land and is located with 32 km southeast distance of Tehran. According to national waste management law, municipality is not responsible for hospital waste management, yet they are collected by municipality and deposited in the landfills in Kahrizak (Abduli, 1994). Fig.1 shows Tehran's 22 regional municipalities. Each regional municipality is responsible for collection and transportation of the waste it has generated (Abduli, 1995). After collecting dry waste by private contractors in each region, the waste is transferred to recycling stations to be processed. Mixed solid waste from regions, are sent to be transported from the transfer stations in Tehran (Darabad, Zanjan, Hakimiyeh, Chitgar, Beyhaghi, Banihashem, Harandi, Azadegan, Jade Seveh, Jahad and Share Rey). Then semi-trailers would transport them to Kahrizak to be landfilled or processed.

MATERIALS & METHODS

Current status of waste Generation: MSW generation trend in Tehran is shown in Fig.2. (OWRC, 2008). As it is understood from the figure, the generated waste in Tehran increased from 1991 to 1996. Investigations made in this regard shows that privatization of collection is the most important factor influencing this growth. In 1996 the electronic weighing system in transfer stations and Kahrizak landfill were installed; consequently, the weighing system becomes more accurate, and the tonnage of waste, reduced drastically. Afterwards, the generation of MSW produced in Tehran increased steadily with the annual rate of 2.055%. Part of this growth is due to the population growth and improved welfare of the citizens was also influential (World Bank, 2005). Amount of waste received, processed and separated in Kahrizak in 2008 is shown in Table 1. (OWRC, 2008).

To establish a clear picture of solid waste management in Tehran, the following data were collected and analyzed:

- Information and statistics related to solid waste generation (quantity and quality). Accurate prediction of municipal solid waste's quality and quantity is crucial for designing and programming municipal solid waste management system. But predicting the amount of generated waste is difficult task because various parameters affect it and its fluctuation is high (Jalili Ghazi Zade and Noori, 2008).
- On-site handling, storage and processing
- Collection system
- Transfer and transport with respect to transfer stations
- Current methods of recycling and waste processing in regional municipalities
- Current disposal method in Kahrizak landfill.

Source reduction programs:

Current source reduction programs in Tehran can be divided into three main groups:

I. Programs and actions that are the sole duties and responsibilities of Tehran Municipality and municipality and its affiliated organizations can implement them independently.

II. Programs and actions that are not included in Tehran municipality duties and municipality do not have a direct role in performing these actions, but can promote them.

III. Programs and actions that can be implemented by cooperation between municipality waste producers.

Successful source reduction programs need to be carefully organized and plan. Basic strategies for effective program are:

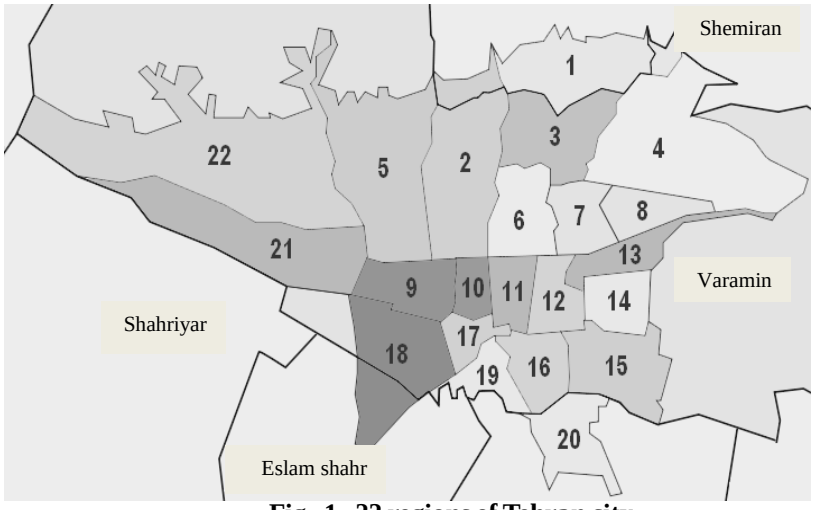

Fig . 1. 22 regions of Tehran city

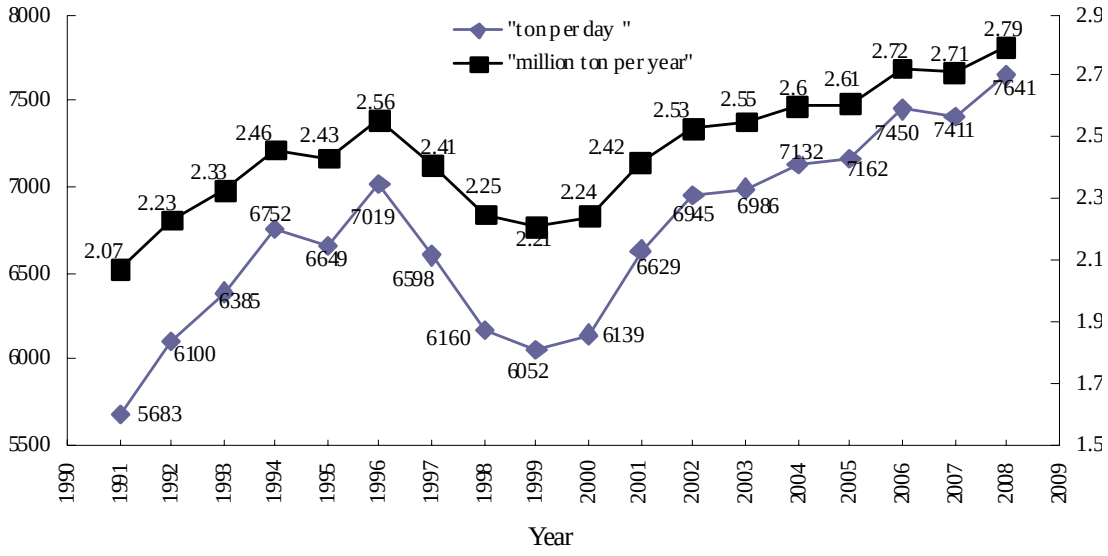

Fig . 2. Total solid waste generation in Tehran during 1991 to 2008

Table 1. Amount of waste received, processed and seperated in Kahrizak in 2008 (ton)

Waste receiving units in Kahrizak center		
Waste origins	**Yearly weight**	**Daily weight**
Regions through transfer stations	**2,140,950**	**5,866**
Companies and towns through transfer stations	**146,570**	**402**
regions directly	**370,743**	**1,016**
Companies and towns directly	**100,305**	**275**
Hospitals	**30,343**	**83**
Total	**2,778,912**	**7,641**

Waste generators		
Type	**Yearly weight**	**Daily weight**
Total waste	**2,511,693**	**6,881**
Hospital waste	**30,343**	**83**
Total sundry municipal waste	**228,988**	**627**
Industrial waste	**17,887**	**49**
Total	**2,778,912**	**7,641**

Type of wastes		
Type	**Yearly weight**	**Daily weight**
Hospital	**370,743**	**83**
Soil and sludge	**269,963**	**740**
Municipal	**2,481,483**	**6,799**
Branch and leaf	**2,460**	**7**
Other	**4,663**	**13**
Total	**2,778,912**	**7,641**

Waste processing units in Kahrizak center		
Receiving units	**Yearly weight**	**Daily weight**
Landfilled	**2,419,859**	**6,630**
Hospital waste and animal body parts	**30,591**	**84**
Composting plant	**125,866**	**345**
Karco composting plant	**32,183**	**88**
Biomechanical composting	**3,499**	**10**
Semi industrial composting units	**176,913**	**485**
Total	**2,788,912**	**7,641**

- The unique and consistent policy
- Wise select of supervisor and workgroup creation
- Efficient Collection required baseline data
- Implementation of Waste audits conducted to identify waste generation resources
- Evaluating options and implementing a waste reduction plan
- Setting training program for all employees
- Establishment of awards or incentive system for participants
- Designing a support system for sensing and monitoring components of successful programs
- Revising in the program if in case of need (U.S Army Center, 1994)

Waste management organizations: Effective waste management through MSW composition studies is important for numerous reasons, including the need to estimate material recovery potential, to identify sources of component generation and to facilitate design of processing equipment (Gidarakos *et al.*, 2006).The most influential organizations to reduce process of waste from the sources in Tehran, is Tehran Municipality. The most influential organizations related to MSW system affiliated to the Tehran municipality are:Laws and regulations Office, Studies and planning center of Tehran, Deputy for technical development, Coordination and planning Department, Urban Service offices of Regional municipalities. These organizations can play an important role in achieving the goals of source reduction in the city.

Also other waste reduction programs in industrial countries such as experiences made in Japan, China and South Korea in the field of source separation and recycling, as well as in Germany, Switzerland, the Netherlands and the United States were considered in this research.

Source reduction Potential: In order to calculate the residual flow, before implementing a source reduction program, managers can value a component of residual flow by multiplication factor related to the program. It helps to determine whether a specific source reduction program makes sense for their community. The base of this decision is that whether the programs of source reductions can reduce considerable waste flow by safe and cost saving methods (EPA530-F-99-006, 1999). According to this study and considering the possible factors such as applicability, feasibility and technology, the following reduction potential factors were determined for Tehran which can be applied to reduce the waste:
Food waste 80%, paper & cardboard 50%, textile 20%, metal 90%, PET 70%, glass 30% and plastic 80%. The results are shown in Table 2, Table 3 and Table 4.

In 2008, about 87% were landfilled; 2,419,859 ton, 4.5% composted, 1.15% processed in Karce, and 6.3% had processed in Semi industrial units.

In "integrated waste management strategy and implementation plan" of Tehran prepared (World Bank, 2005), the separation strategy was emphasized. It was expressed that separation at source is one of the major tasks within the strategy of waste reduction. This strategy can also help to increase the rate of dry recycling up to 20% and composting up to 50% by 2016. According to the presented statistics, in recent 3 years, the amount of collected dry waste from the regions is growing. The rate of source separation increased from 3.3% in 2006 to 10.5% in 2008; nevertheless, this study shows that there is appropriate technology for increasing the rate of recovery to 66%.

Source reduction strategies in Tehran: Waste management strategies such as how to gather information, government outlook, longtime objectives, the role of key organizations, topics related to specific waste material flow (such as hazardous waste) and the basic rules used for the development of sustainable waste management system put to action. This strategy considers our future outlook and tasks that each section require for the realization of conduct.

Source reduction legislation often focuses on establishing the following:
• specific goals (especially in domestic, commercial and industrial)
• government services
• purchases required
• packaging and related guidelines
• labeling and related guidelines
• limiting yard and street waste
• determine the type of chemicals and restrict their production and usage (R.O'Leary, 1995)

It should be mentioned that not only economic incentives but also the economic disincentives can be used to encourage source reduction strategies:
Economic incentives include:
• Funding for research and development of educational programs of source reduction
• Funding for waste conversion
• Funding for planning to use this material and sell them.
• assistance to industry reform
• provide tax credits or exemptions for industries in the drawings to attain goals to source reduction.
Economic disincentives include:
• Tax the situation is related to packaging waste disposal.
• Tax for raw materials if the materials can be used recycling.

• Tax for the disposal
• Establishing fundamental programs for products based on volume collected

Source reduction programs proposed for Tehran municipality: According to this study, source reduction programs in Tehran can be presented and performed as : source reduction in packaging, paper, street waste, household waste, industrial waste and household hazardous waste.

Source reduction in packaging: The purpose of source reduction is to rehabilitate waste disposal problems. Two main techniques that they should be implemented regarding waste quantity and toxicity due to residual control of packing products can be outlined as following:
A– Controls before production
B– Controls after the production

Control methods of production, are focused on the time that the products are made and the consumers use them. Reduction of packaging waste in this situation is the result of the following methods:
• Recycling packaging materials consumed products
• Reuse of packaging materials by consumer
• separation of materials and reduce their size
• Select the products by consumer due to packaging

Source reduction packaging goals before production include:
- Reducing to the minimum required size for packaging products
- For increasing the attractiveness of products, many companies, produce packages which is massive and unnecessary. By eliminating this material, minimum standard packages can be achieved.
- Removing or minimizing toxic materials of coating packaging
- Eliminating an integral material and replacing them with recyclable materials and avoiding usage
- Artificial replacement materials that not easily absorb to environment with natural materials (Waste online, 2006)

Source reduction of paper: Paper source reduction executive options are as following:
• support from management
• prepare an assessment of paper consumption
• identify program goals
• specify the opportunities of the powers of paper consumption for source reduction and
• monitor work progress to achieve set goals (Duke University, 1995)

Source reduction of street waste:
• use as a coating material
• used for filling holes and restore the earth
• use in sand factories
• use for the production of prefabricated concrete, cement and asphalt
• waste from horticultural and leaf of trees can be used to produce compost and fertilizer.
• Use as a base under the road (Land Technologies, Inc, 1997)

Source reduction of household waste: Household source reduction strategies are as following:

I. Source separation:
   • Educating programs that are focused on the customers buying habits and also generation methods on packaging factories.
   • Identified government programs, such as preparation materials of recycled products.
   • Exchange of household and commercial waste
   • Commercial waste audit programs, that is performed to evaluate the waste stream in a special career and includes proposed strategies to reduce waste and increase recycling.

II. Home composting: composting in gardens and parks, can be use with the range of possible activities to reduce waste and produce compost, soil and plant food.
   • Aerobic treatment (with air) in the open bottom bins (common method).
   • Using worms: Use of worms in a container in the package to improve the final product.
   • The use of microorganisms for fermentation, specifically for food residues.

III. Grass recycling: grass recycling includes leaving very small cuts on the earth. Because of their fine, these small cuts influence the roots of grass quickly and nutrients the soil and water. This work makes the uniformity of lawn. This work is not practical and suitable for all and some are rather to use special equipment. Municipal officials can give subsidies special washer machines, especially in the parks and help plan progress.

IV. Community compost: is complete home composting, in a way including preparation the material collected for a local composting. Composting interests in large-scale achieved by transport reduction and the displacement and will be with social benefits for society.

V. Centralized composting: includes; compost in large scale and size (inside the container for all organic waste) using materials that are collected from a large area and produce compost which carefully controlled for sale.

VI. Reuse of coordinated goods

VII. Education: Development and give subsidy to bins is not enough. Raise awareness and give the necessary training during the program for successful program implementation is also necessary.

VIII. Home composting can support the following methods:

- A brochure on how to start and be provided with preparing compost bins.
- Every four months or six months, a brochure containing information of seasonal and encouraging options be published.

Families can be support by the following methods:
- Help them to achieve and to resolve possible problems.
- Hold meetings and workshops with the people for exchange of views about composting to raise their knowledge in this field.
- Set up phone and website (with professionals) to help solve the problems of people (NRWF, 2006).

Industrial source reduction: Three main approaches in WM ((Waste Minimization) are considered: source reduction, recycling and refining. OWRC (Organization for Waste Recycling and Composting) is responsible for these activities. This is also a well known statement that the incentive policies and economic disincentives in the industry can be feasible (Hyde, 2000).

Source reduction of household hazardous waste:
Three main programs in source reduction of household hazardous waste are:
- Use of alternative products
- Hazardous materials remaining gift to friend or organization for use
- Separately collected household hazardous waste and their processing (Schnell, 2004).

In this case, not considering the reduction programs could cause serious problem. Apart from the toxic elements, leachate may contain microbes of which some are opportunistic pathogens. These microbes could produce toxins that may cause public health problem (Oshode, 2008). Although the effects of leachate are weakened with distance from the source of generation, it can still cause pollution of surface and groundwater, organic carbon affecting odor and taste of groundwater, nitrogen compounds producing eutrophication in surface waters and high nitrates in drinking water, and toxic heavy metals in ground and surface waters (Robinson, 1983).

Source reduction in recycling programs: recycling, perhaps the most positively received of all waste management practices, is going to be an essential part of contemporary waste management strategies, composting can play an important role, while incineration seems to be a conditionally feasible solution(Sadugh, 2009). This twelve-component plan provides an outline for successful program design:
- Identify goals.
- Characterize recyclable volume and accessibility.
- Assess and generate political support.
- Assess markets and market development strategies for recyclables.
- Assess and choose technologies for collection and processing.
- Develop budget and organization plan.
- Address legal and sitting issues.
- Develop start-up approach.
- Implement education and publicity program.
- Commence program operation.
- Supervise ongoing program and continue publicity/ education.
- Review and adjust program (Walsh,1993)

RESULTS & DISCUSSION

Regional municipalities are required by law to institute specific source reduction practices. Regional municipalities can model local policy to promote source reduction in their own institutions and in commercial and residential sectors, but all the targets which were set by the regional municipalities, should have the following strategies:
- Targets must indicate that the source reduction has the first priority, wherever practicable.
- Targets must be supported with a practical program.
- Local authorities should demonstrate to municipality of Tehran that the targets of the executive can be evaluated.
- Authorities must also report continuous improvement performance.
- Government, manufacturers, distributors and retailers assist in the maintenance of ecological processes and the biological diversity of the city, ensure that the management of renewable resources is based on a sustained yield and make decisions that reflect wise and efficient use of renewable and non-renewable resources.

According to this study, appropriate technology and adequate economic conditions already exist to reduce solid waste generation by 66 % (Reduction potential), in the next few years.Municipal and household waste management, need to be emphasized on recycling, composting, and energy recovery.
Due to the present status, the following targets for municipal management are proposed:
- Recovery value from 50% of municipal waste by 2016
- Recovery value from 60% of municipal waste by 2021
- Recovery value from 66% of municipal waste by 2026

The term “recovery” refers to the bellow activities:
- Recycling
- Composting
- Other forms of material recovery (anaerobic digestion for instance)
- Energy recovery (DETR, 2000)

The most important elements to achieve municipal and household waste targets are recycling and composting. Good quality compost requires separate

collection of biowaste combined with plenty of information and guidance to households and potential users of the compost. It also requires the setting up of monitoring systems and possibly quality standards or labels (EEA, 2009).

- Recycle or compost at least 25% of household waste by 2016
- Recycle or compost at least 30% of household waste by 2021
- Recycle or compost at least 33% of household waste by 2026

Government, the Islamic assembly and the department of Tehran Municipality of laws and regulations, by laws should reduce the growth of household waste generation and can even stop or reverse. Such changes are competitive and in some regions are likely to achieve them than others.On the other hand, the government and the Islamic assembly should set the following target to encourage businesses to reduce waste, and to put any waste that is produced to better use:

- By the year 2021, the amount of commercial and industrial waste sent to landfill should be 85% of that landfilled in 2006.

Standards must be primarily explains to municipal authorities of active regions in waste disposal. Authorities will be required to meet statutory standards for 2016, 2021 and 2026.Different standards for different groups of authorities and different conditions should be set. Standards for 2016 should be defined in the following levels:

• In regional municipalities where the separation rate in 1998, is less than 10% reach at least to 10%.

In countries with low material recovery and incineration, the introduction of separate collection systems for packaging waste successfully decreased landfilled waste in the first year (EEA, 2007).

• In regional municipalities where the wastes is recycled or composted between 5 to 15% in 1998, achieve the recovery rate of 15% at least.

Potential of source reduction in Tehran: It is not possible to recycle 100% of waste components. In the recycling systems, usually, 5 -% 20 of the materials are mixed together while they separated by the separator units. For Tehran the following coefficients can be applied as recycled percentages: Real coefficients of horticultural waste reduction 80%, food waste 80%, paper and cardboard 50%, textile 20%, metals including ferrous and nonferrous% 90, Glass% 30, PET% 70, and plastic 80%.Ultimately 66% of overall reduction potential can be achieved in Tehran which is 446,516,586kg annually. Tables 2,3 &4 show the reduction potential in 22 regions of Tehran in 2008. The potential of used bread collected is 94,201,811kg. Because the used bread is in the categories of food waste, they can be reducing through composting and also through the reuse in livestock. About 143,443,667kg of paper and cardboard can be reduced. All types of metals including ferrous and non ferrous, such as aluminum, copper, brass and... can be reduced 55,878,802kg. The glass 13,487,987kg and about 513,828,062kg textile can be reduced in different ways, about 118,180,454Kg in plastics, and finally PET waste, 20,981,313Kg.

Summary of the principles of source reduction legislations in Tehran: Source reduction legislations are pervasive and should be developed and approved at national level. However, due to regional, provincial, and municipal differences, laws and legislations of source reduction can be developed in regional, provincial and municipal levels. According to the divisions of the country, it is suggested that the laws and guidelines of source reduction prepare and approve in the following levels:

- The national source reduction legislations approved by The Islamic assembly government.
- The source reduction provincial legislations approved by The provincial council
- The urban source reduction approved by Islamic City Council

Support from management: One of the basic pillars of survival and the success of waste reduction programs is support from management. At first to establish the advisory committee of waste reduction, confirmation of the management is necessary. Actually, the management with endorsing objectives and program would announce its support of the team and also by participation in meetings, encourage team members and guide them, could benefit the team of the intellectual and psychological support.

Municipality powers: Municipality of Tehran establishes a department of source reduction to perform the provisions of this law. This department is independent. It monitors tasks and measure other organizations and regional municipalities for upgrading and strengthening the multilateral approach of source reduction programs and provides the necessary advice. The department director is appointed by the mayor. Mayors of regions establish departments of source reduction to implement source reduction programs and mission, in their regions.

Advisory committee of waste reduction (under municipality): Waste reduction team, consists of environmental engineers, industrial administer representative, education ministry representative, and a faculty member expert in the field of the source reduction. They are responsible for implementation, planning, designing, and maintaining waste reduction programs in the organization.

Generally, members of a source reduction team are responsible in the following factors:

Table 2. Reduction potential in 22 regions of Tehran in 2008

(Used bread, plastic, Paper and cardboard, Ferrous metals)(Kg per year)

region	Total received solid waste except slime and branches	Theoretical reduction potential of used bread	Real reduction potential of used bread (%80)	Theoretical reduction potential of Plastic	Real reduction potential of (%80) Plastic	Theoretical reduction potential of Paper and cardboard	Real reduction potential of Paper and cardboard (50%)	Theoretical reduction potential of Ferrous metals(light & heavy)	Real reduction potential of Ferrous metals (%90)
1	130,833,625	6,018,347	4,814,677	8,504,186	6,803,348	22,110,883	11,055,441	2,224,172	2,001,754
2	168,800,346	7,764,816	6,211,853	13,504,028	10,803,222	24,307,250	12,153,625	3,713,608	3,342,247
3	112,108,096	5,605,405	4,484,324	9,304,972	7,443,978	18,722,052	9,361,026	2,130,054	1,917,048
4	211,896,106	11,442,390	9,153,912	15,044,624	12,035,699	25,427,533	12,713,766	3,814,130	3,432,717
5	166,981,794	7,848,144	6,278,515	10,352,871	8,282,297	21,039,706	10,519,853	1,669,818	1,502,836
6	93,851,093	5,537,214	4,429,772	7,038,832	5,631,066	18,770,219	9,385,109	1,970,873	1,773,786
7	91,937,976	5,700,155	4,560,124	6,067,906	4,854,325	11,216,433	5,608,217	2,574,263	2,316,837
8	86,229,069	4,915,057	3,932,046	5,863,577	4,690,861	9,485,198	4,742,599	1,552,123	1,396,911
9	41,340,516	2,232,388	1,785,910	3,431,263	2,745,010	5,002,202	2,501,101	1,240,215	1,116,194
10	80,595,124	4,029,756	3,223,805	4,835,707	3,868,566	7,656,537	3,828,268	2,498,449	2,248,604
11	75,197,924	5,113,459	4,090,767	4,737,469	3,789,975	9,399,740	4,699,870	2,857,521	2,571,769
12	109,368,561	6,780,851	5,424,681	9,077,591	7,262,072	19,795,710	9,897,855	2,624,845	2,362,361
13	53,281,527	3,196,892	2,557,513	3,889,551	3,111,641	6,500,346	3,250,173	1,385,320	1,246,788
14	97,796,181	4,107,440	3,285,952	4,987,605	3,990,084	11,344,357	5,672,178	1,955,924	1,760,331
15	154,314,005	10,030,410	8,024,328	10,801,980	8,641,584	18,980,623	9,490,311	4,475,106	4,027,596
16	79,468,186	5,403,837	4,323,069	5,483,305	4,386,644	10,569,269	5,284,634	1,748,300	1,573,470
17	61,009,901	3,843,624	3,074,899	4,453,723	3,562,978	7,626,238	3,813,119	1,403,228	1,262,905
18	92,353,327	4,063,546	3,250,837	6,002,966	4,802,373	9,881,806	4,940,903	2,401,186	2,161,068
19	67,134,779	3,826,682	3,061,346	4,498,030	3,598,424	6,982,017	3,491,009	1,544,100	1,389,690
20	100,600,464	5,533,025	4,426,420	6,539,030	5,231,224	13,882,864	6,941,432	2,313,811	2,082,430
21	38,290,892	2,412,326	1,929,861	2,642,072	2,113,657	5,322,434	2,661,217	1,225,309	1,102,778
22	27,560,769	1,295,356	1,036,285	1,653,646	1,322,917	2,921,442	1,460,721	744,141	669,727
total	**2,140,950,260**	**117,752,264**	**94,201,811**	**147,725,568**	**118,180,454**	**286,887,335**	**143,443,667**	**49,241,856**	**44,317,670**

Table 3 . Reduction potential in 22 regions of Tehran in 2008
(Nonferrous metals, All types of metal, PET and textiles) (Kg per year)

region	Theoretical reduction potential of Nonferrous metals (copper, aluminum, brass)	Real reduction potential of Nonferrous metals (copper, aluminum, brass)(%90)	Theoretical reduction potential of All types of metal	Real reduction potential of All types of metal (%90)	Theoretical reduction potential of PET	Real reduction potential of PET (70%)	Theoretical reduction potential of textiles	Real reduction potential of Textiles (%20)
1	1,439,170	1,295,253	3,663,341	3,297,007	2,224,172	1,556,920	78,500,175	15,700,035
2	1,181,602	1,063,442	4,895,210	4,405,689	2,363,205	1,654,243	151,920,311	30,384,062
3	672,649	605,384	2,802,702	2,522,432	2,130,054	1,491,038	112,108,096	22,421,619
4	10,594,805	9,535,325	14,408,935	12,968,042	2,118,961	1,483,273	254,275,327	50,855,065
5	1,502,836	1,352,553	3,172,654	2,855,389	2,337,745	1,636,422	133,585,435	26,717,087
6	938,511	844,660	2,909,384	2,618,446	1,220,064	854,045	122,006,421	24,401,284
7	735,504	661,953	3,309,767	2,978,790	1,287,132	900,992	101,131,774	20,226,355
8	172,458	155,212	1,724,581	1,552,123	1,379,665	965,766	232,818,486	46,563,697
9	206,703	186,032	1,446,918	1,302,226	578,767	405,137	74,412,929	14,882,586
10	1,047,737	942,963	3,546,185	3,191,567	805,951	564,166	193,428,297	38,685,659
11	225,594	203,034	3,083,115	2,774,803	1,203,167	842,217	90,237,509	18,047,502
12	656,211	590,590	3,281,057	2,952,951	1,968,634	1,378,044	153,115,985	30,623,197
13	3,196,892	2,877,202	4,582,211	4,123,990	639,378	447,565	58,609,679	11,721,936
14	293,389	264,050	2,249,312	2,024,381	880,166	616,116	127,135,035	25,427,007
15	462,942	416,648	4,938,048	4,444,243	1,851,768	1,296,238	216,039,607	43,207,921
16	238,405	214,564	1,986,705	1,788,034	1,033,086	723,160	63,574,548	12,714,910
17	244,040	219,636	1,647,267	1,482,541	732,119	512,483	54,908,911	10,981,782
18	277,060	249,354	2,678,246	2,410,422	1,292,947	905,063	83,117,994	16,623,599
19	201,404	181,264	1,745,504	1,570,954	1,141,291	798,904	114,129,124	22,825,825
20	603,603	543,243	2,917,413	2,625,672	1,207,206	845,044	120,720,556	24,144,111
21	229,745	206,771	1,455,054	1,309,549	689,236	482,465	49,778,160	9,955,632
22	82,682	74,414	826,823	744,141	275,608	192,925	44,097,231	8,819,446
total	**12,845,702**	11,561,131	**62,087,558**	**55,878,802**	**29,973,304**	**20,981,313**	**2,569,140,311**	**513,828,062**

Table 4. Reduction potential in 22 regions of Tehran in 2008
(Glass and Total dry weight of valuable collected waste) (Kg per year)

region	Theoretical reduction potential of Glass	Real reduction potential of Glass (%30)	Total real dry weight of valuable waste without textiles and landfilled	Total theoretical dry weight of valuable waste without textiles and landfilled (66%~)	Reduction percentage potential
1	3,270,841	981,252	45,922,602	30,308,917	62.10%
2	4,220,009	1,266,003	56,885,716	37,544,573	64.20%
3	2,130,054	639,016	39,910,482	26,340,918	65.00%
4	4,026,026	1,207,808	61,661,767	40,696,766	80.40%
5	3,339,636	1,001,891	47,589,811	31,409,275	64.20%
6	2,815,533	844,660	37,821,991	24,962,514	62.80%
7	3,125,891	937,767	30,615,346	20,206,128	64.80%
8	1,465,894	439,768	24,489,056	16,162,777	66.70%
9	950,832	285,250	13,394,327	8,840,256	67.40%
10	1,128,332	338,500	20,712,947	13,670,545	72.50%
11	1,579,156	473,747	24,890,513	16,427,738	67.00%
12	2,187,371	656,211	42,763,107	28,223,651	64.50%
13	1,118,912	335,674	16,890,244	11,147,561	81.90%
14	684,573	205,372	24,155,657	15,942,733	65.40%
15	3,240,594	972,178	49,380,481	32,591,118	66.60%
16	1,192,023	357,607	25,509,288	16,836,130	66.10%
17	1,037,168	311,150	19,157,109	12,643,692	66.60%
18	2,031,773	609,532	25,212,458	16,640,222	67.10%
19	939,887	281,966	19,133,412	12,628,052	66.90%
20	2,515,012	754,503	31,789,747	20,981,233	65.50%
21	689,236	206,771	13,172,067	8,693,564	66.10%
22	578,776	173,633	7,496,529	4,947,709	65.80%
total	**44,959,955**	**13,487,987**	**676,540,282**	**446,516,586**	**65.90%**

- Cooperation with management for achieving primary and long-term goals of the team
- Gathering and analyzing information related to design and implementation
- Promotion of programs among all employees and trained team to participate in programs of source reduction
- Monitoring progress of programs
- Provide periodic reports to the management from the status of programs

Duties of the department of source reduction: To implement the source reduction program in Tehran, the municipality must prepare a strategy as the following:

- Establish standard methods of measuring source reduction.
- Coordination between the source reduction activities of affiliated organizations and regional municipalities.
- Developing an advanced and synchronized channel for easy public access to information collected in the field of waste reduction.
- Facilitate the implementation of waste reduction programs by different sections of the city, including exchange of information, publications, and technical and financial assistance.
- Define measurable goals, time table, responsibilities and organizational tools to access goals and strategies to reduce waste wherever possible and appropriate.
- Create an advisory committee from technical experts, including representatives of commercial, industrial, administrative, services, ministries and public interest groups to guide the municipality in collecting and disseminating data; implementing program and provide directives.
- Organizing training classes for the source reduction, including work shop guide lines, for governmental and private beneficiaries groups.
- Preparation the directives of source reduction.
- Identify barriers and incentives to encourage source reduction programs, including absolution and punishment.
- Identify opportunities that the government can incenses source reduction programs.
- Development, testing and auditing the models of source reduction opportunities and

- Create an annual award program to determine the creative companies and organizations and prominent of the source reduction

The database of waste reduction:
A - Responsibilities : Create database of source reduction, in order to classify information including virtual database management, technical and practical solutions to reduce waste from the source.
Municipality should use the database, in the following programs:
1- Transfer source reduction technology
2- Promote the active achievements and educational programs for regions and companies to fulfill the source reduction technology and
3- Conclude and categorize the reports by regions and companies related to operation and success of source reduction programs in the regions, B - Accessibility : Municipality may make access to public the information and also as soon as reviews new information from source reduction, put them in the site for public usage. The database should be designed and prepared in a way that the access would be easy.

Reporting: A -The first report of the municipality should be prepared one year from the date of the coming into force of this law and every two years thereafter, and be offered to the Islamic city Council. First report includes details of implementation of waste reduction strategies and the results. In this report, the effectiveness of database and financial support in promoting this strategy be evaluated and the lack of information be specified. B-Next reports should include the following:

- Analysis of data collected for each unit process, including the rate of waste reduction
- Analysis of validity and usefulness of the data collected for measuring the rate of waste reduction and adopting waste reduction programs with business activities
- Diagnosis of legal and illegal barriers of waste reduction and recognize the opportunities for promoting source reduction programs
- Recognition industries, units and priority sectors to improving waste reduction and prevention programs and practices
- by means of grants or other assistance, support and encourage the investment and research and development of source reduction
- identify opportunities and priority research and development methods and techniques of waste reduction
- Evaluation of technical feasibility and financial opportunities of waste reduction for the industry, processes, activities and other sectors of society and understanding barriers
- Evaluation coordination methods, efficiency and reform the public access to the collected data
- Evaluation the lack of information and also repetitive information that were collected.

As a result, the organizational chart of waste reduction in Tehran, including: Islamic city council, municipality powers, duties of the department of source reduction and advisory committee of waste reduction (under municipality), is recommended as shown in (Fig. 3).

CONCLUSION

Key and strategic issues in proposed Tehran source reduction law:

- To designate an organization responsible for planning, supervision and coordination of source reduction and determine the organization's authority
- Describing the waste generation in each section and determining the regarding source reduction potential
- Estimating the costs due to the cost saving goals
- Reporting the performance of different sections aim to source reduction to the responsible organization

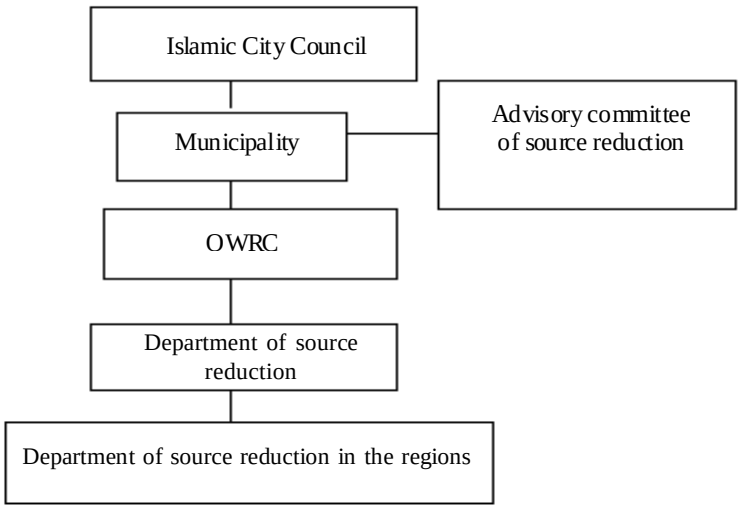

Fig. 3. The recommended organizational chart of waste reduction in Tehran

- Working with different industries to modify their products and set the strategies required
- Taxing disposal products
- Providing tax credits or exemptions to industries that meet set source reduction goals in design and produce
- Set the source reduction database of in each part (household, industrial, commercial)
- Implementing scientific researches and technologies regarding source reduction and preventing the negative influence on environmental and economic
- Monitoring, supporting and modifying program with international strategies

The key elements of the proposed law are as following:

• Incentivize efforts to reduce, re-use, recycle waste and recover energy from waste;

• Reform regulation to drive the reduction of waste and diversion from landfill while reducing costs to compliant businesses and the regulator;

• Target action on materials, products and sectors with the greatest scope for improving environmental and economic outcomes;

• Stimulate investment in collection, recycling and recovery infrastructure, and markets for recovered materials that will maximize the value of materials and energy recovered; and

• Improve national, regional and local governance, with a clearer performance and institutional framework to deliver better coordinated action and services on the ground.(DEFRA, 2007).

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