Material Recovery Stations in City of Tehran: A Case Study

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Abstract

This paper presents practical experiences in design, manufacturing and management of the Material Recovery Station (MRS). In addition this paper uses some related information to report the current state of MRS in Tehran. Here, Tehran's MRS systems will be analyzed with respect to their performances. Considering the local needs, a tailor made cost-effective waste recovery system is proposed to optimize the current MRS. It is estimated that once the proposed MRS plant is implemented, it will increase the recovery rate by 5 to 10 percent. In other words, considering all the 22 stations in Tehran municipality equipped with the proposed system, at least 140,000 tons of waste per day can be recovered and hence diverted from the landfill.

Keywords

Material Recovery Station, Municipal waste, Source Separation, Recovery Line, Recovery System

1 Introduction

Municipal Waste Management is a serious environmental challenge confronting local municipal authorities in many countries around the world. This is especially true for the developing countries. As a result of rapid population growth and increasing rate of unplanned urbanization in many cities in developing world, volume of the MSW is increasing tremendously. (H.A. Abu Qdais, 2007)

Due to the high price of land around the large cities, landfilling that uses a large area of land will become costly. Distancing the landfill site from the cities may reduce the land price but instead will increase the transportation costs. The aforementioned costs are in addition to the environmental and social impacts that landfilling may cause.

Due to the economical, environmental and social problems with the landfilling, it will be acceptable to invest in alternative solutions. This means diverting the waste from the landfills. MRS is one of the best known solutions. (Horng-Guang Leu et al., 1998)

1.1 Waste Management in Tehran

Tehran, the capital and largest city of Iran, with the population of 7.8 Million people, produces approximately 6000 tons of municipal waste daily (OWRC, 2008) (SCI, 2006). Municipal solid waste includes more than 97% of Tehran’s solid waste, while three other types of solid waste, hospital waste, industrial waste and construction & demolition wa-

ste comprise respectively 1.0%, 0.6% and 0.5%. (Abdolmajid Mahdavi Damghani et al., 2008)

Organization of Waste Recycling and Composting (OWRC) of Tehran is a subsidiary municipality organization responsible for processing waste produced in Tehran. This organization is responsible for Training programs, public awareness activities, dry waste (recyclables) collection and processing, and the whole final disposal treatments of the waste produced in Tehran.

Collection and transportation of the mixed waste from the household to the landfill through the transfer stations is the responsibility of a subsidiary municipality organization, called Motorized Services Organization (MSO).

Household SW is collected in two ways. First, the household SW is collected at doors, which is done once every night at 21:00. Second, recently public waste containers (660 and 1100 liter) provided by Tehran municipality is available on the road sides within each neighborhood as a part of its Program for the Mechanization of the SW Management System in Tehran (Abdolmajid Mahdavi Damghani et al., 2008).

The mixed waste is collected daily and transported either directly or through transfer stations to the Tehran's only landfill, in southeast of the city by MSO's private suppliers. Tehran's landfill, called Kahrizak, is being used to receive the whole waste of Tehran since almost 80 years ago. OWRC of Tehran has taken several steps to improve the use of Kahrizak landfill. Installing several compost plants and initiating a source separation program were part of this effort.

Unfortunately, despite all these efforts, there are still many problems in dealing with the enormous amount of the waste Tehran produces every day.

1.2 Source Separation Program

Tehran has 22 municipality districts. Each district has a MRS used to receive and sort the collected recyclables.

After some research, MROT started the Waste Management Plan of Tehran few years ago. The Tehran Source Separation Program (TSSP) was an important part of that. In the TSSP, free plastic bags are distributed between the households and, later on, filled bags are collected at doors once or twice a week. The dry waste collected from each household is transported into the separation stations.

Bags are transported to MRS of the same district where mixed recyclables are manually sorted. The sorted recyclables are simply packed into large bags and then without any further treatment they are sold to the dealers. Other cities in Iran follow similar schemes.

The collection frequencies can be variable in different places, or, households may receive free trash bins instead of free plastic bags.

The waste production rate and daily waste recovery rate in individual districts of Tehran are presented in Table 1. Based on information reported in Table 1, the Total amount of municipal waste produced in Tehran is calculated to be 5847 tons/day and the average recovery rate for the recyclables is 8.4% (OWRC, 2008). As it is shown in the Table 1, the recovery rates for some districts are higher than the rest. This is due to the better performance of the collection systems and availability of mechanized equipment in these stations. On contrary, in some other districts despite the larger MSW production, the recovery rate is much lower. This big difference is mostly due to the sorting line equipment deficiencies.

This paper uses the district 22 as a case study where different aspects of the proposed system are studied. The goal is to increase the waste recovery system's performance by proposing a mechanized sorting line for the MRS of the district 22.

1.3 Environmental Depletion Control

Implementing the new system will not only generate Tehran municipality the substantial financial advantages, but also will save the environment by recovering more recyclables and to prevent depleting and damaging the natural resources.

Tehran's current landfill site is currently receiving more than 7500 tons of municipal and industrial waste of Tehran and the suburb area daily. Recently the old landfill was completely filled and is now out of commission (Figure 1). Consequently a new sanitary landfill was prepared (Figure 2).

The new landfill is a well engineered facility with leachate and gas collection systems. Despite municipality's effort to design and implement a new cell under acceptable standards to control gas emission and the leachate, it still has to deal with the large amount of waste produced in Tehran daily. The current source separation program can only divert less than 10% of waste from landfill.

Table 1: Performance of all 22 Material Recovery Stations of Tehran Municipality (OWRC, 2008) (SCI, 2006)

District Number	Population	Produced Municipal Waste (ton/day)	Material Recovery (ton/day)	Recovery Rate (%)
1	379962	349	13	***3.7***
2	608814	478	54	***11.3***
3	290726	311	26	***8.3***
4	819921	569	45	***7.8***
5	679108	445	35	***7.8***
6	237292	300	35	***13.7***
7	310184	279	16	***6.4***
8	378725	233	34	***14.6***
9	165903	120	9	***7.5***
10	315619	219	7	***3.1***
11	275241	195	28	***14.6***
12	248048	273	32	***10.6***
13	245724	144	20	***13.7***
14	483432	262	24	***8.9***
15	642526	427	26	***6.1***
16	291169	213	23.5	***11***
17	256022	165	12	***7.6***
18	317188	250	5.5	***2.2***
19	247815	179	11	***6.2***
20	335634	256	15	***5.5***
21	159793	110	6.3	***5.7***
22	108674	70	6	***8.5***
Total	7797520	5847	483.3	

Figure 1: Tehran's old landfill

Figure 2: Tehran's new landfill

2 District 22 MRS: A Case Study

The 2008 statistics shows that the district 22 with an area of 62 km^2 had a population of 109 thousand people. Approximately 70 tons of MSW is produced in this district daily (OWRC, 2008).

Like most other MRS, the MRS of the district 22 is ran by the private sector and supervised by district municipality authorities. Based on the population density of the district,

up to 5 special vans are assigned to collect the recyclables from the doors. District 22 is divided into several zones. Free plastic bags are distributed in each zone on weekly basis, different days for each individual zone. Consequently, the filled bags are collected from the doors on pre-assigned days. Unfortunately, only a limited number of households are cooperating with this source separation plan. Every now and then, the district authorities plan and execute encouraging programs to persuade more people to join the plan.

The collected plastic bags picked from households' door, are transported directly to the recovery station, where, they will be discharged in a room close to the conveyer. Bags are emptied on top of the conveyer belt, where they will be sorted. The whole process is performed manually. This process is depicted in Figure 3.

Figure 3: Sorting Line in Recovery Station of District 22

The recovered materials are packed in large bags. There is always a good market for recyclables in Iran. Most materials are sent to the second suppliers for further treatment before being sold out to the final customers. In this case, the compaction and shredding of the recyclables will decrease the transportation cost and increase the material value.

The rejected material will be collected at the end of the line and then transported to the landfill by municipality's public collection services.

Despite the current public training programs, only 8.6% of 70 tons of the waste is collected at doors and transported to the recovery station (OWRC, 2008). The rest of recyclables are still thrown away with the mixed waste and will end up in the landfill.

The current low rate of material recovery is mainly caused by two factors:

1. The lack of public awareness concerning the advantages of the recovering the recyclables.
2. The lack of proper mechanized equipment in this station (Mahak Sabouri, 2007).

The first factor will directly affect the number of people who will voluntary cooperate with the WMPT. To increase the number of volunteered families, more training and uprising programs for the different levels of the population is certainly required. This subject is out of scope of this paper (Abdolmajid Mahdavi Damghani et al., 2008).

As for the second factor, providing proper mechanized equipment can help to improve the current situation. Details of the proposed system are explained in the next section.

3 The Proposed Recovery System

In the MRS of the 22nd district, lack of a proper separating and sorting method is one of the main reasons that keep the recovery rate of the material low. In the current system, the sorting line is not designed properly. Therefore, the sorting labors don't have easy access to the recyclables on the sorting line (Mahak Sabouri, 2007).

In the proposed system, the conveyer belt should be with a right size (in width and length). It should be equipped with a speed controller, positioned on the right height. In the proposed recovery system a sorting conveyer belt with one meter width and 12 meters length is located a few meters above the ground (Mahak Sabouri et al., 2008).

Due to the low density of the recyclables, the second factor in decreasing the recovery rate is the high cost for the transportation of these materials. In the proposed plan, two press machines, one heavy duty and one light duty, will be used to compact the heavy and light recyclables, respectively.

As an overview on the whole system, the mixed recyclables delivered to the stations are discharged in the feeding hopper and then the waste will be transported to the sorting line through a declined T-conveyer. There is an electro-magnet at the beginning of the line to separate the metals. There is also a blower which flattens the compacted waste piles on the conveyer belt to make the manual separation easier in the following stages of the process. The block diagram of the process is depicted in Figure 4.

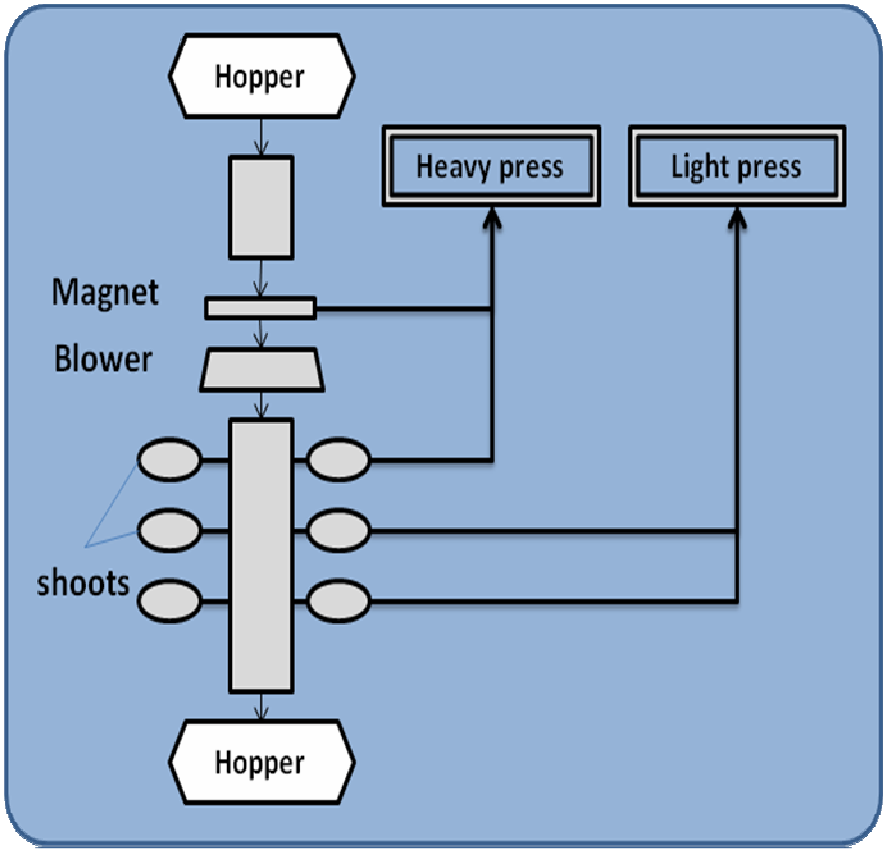

Figure 4: Sorting line

Applying the proposed system, the recovery rate is estimated to improve by at least 5%. This rate is based on the results of the questionnaire completed by managers of the recovery stations in nine districts of Tehran. This improvement is firstly due to the higher sorting efficiency in this process, and secondly due to the effect of the compaction of the materials and the increased transportation efficiency.

At the present, 70 tons of waste is separated at houses and collected by the dry collection system and transferred to the MRS daily. Considering 5% increase in recovery rate by implementing the new system, 3.5 tons more waste will be recovered and hence the same amount of waste will be diverted from the landfill daily.

4 Results

The approximate price of the mix recyclables in Tehran is 100 Euro/ton (Mahak Sabouri, 2007). The cost of waste collection from the doors, transporting them to transfer stations and then to the landfill and finally disposing the waste at the landfill site of the city, is 30 Euro/ton in 2008 (OWRC, 2008). Considering the aforementioned unit prices, the financial benefits of the proposed plan for the municipality is calculated and reported in the Table 2.

Table 2: Finantial profit of increased rate of recycling (Euro)

	Daily	Monthly	Yearly
Only in District 22	497	14,910	181,405
In all 22 Districts (for the whole city)	41,514	1,245,411	15,152,501

The cost of manufacturing and commissioning the sorting line by a local manufacturer is calculated to be around 190,000 Euros in year 2008. The sorting line equipment include feeding hopper, elevating inclined conveyer, blower, electro magnet, sorting conveyer, 6 shoots, 3 wheeled wagons, 50 and 100 tons press machines. (Mahak Sabouri et al., 2008)

It is estimated that implementing the proposed system only in district 22, the Tehran municipality will save at least 181,405 Euros annually (Mahak Sabouri et al., 2008). As reported in Table 2, municipality can save even more, once all 22 districts of Tehran Municipality are equipped with such new lines.

5 Conclusions

Tehran municipality is currently investing on increasing public awareness towards the general training programs. This paper is aimed to prove that investing on MRS will not only reduce environmental impacts of the municipality waste but also will help to save on the waste management costs. Selling the recovered recyclables will provide an additional income for the municipality. Considering all the 22 districts and only a 5% increase in the recovery rate, the municipality can save around 41,514 Euros per day in expenses through selling the recovered recyclables and diverting more waste from the landfill. The proposed system can be applied on any of the 22 districts in the city of Tehran. However, a few of them have initial waste treatment equipment. The proposed plan can be also applied to other cities where the source separation plan is in the planning phase or already started.

6 Future Work

Considering our previous experiences in design, manufacturing and managing similar systems in other Iranian cities, goal is to convince the Tehran municipality to consider the proposal and to implement the system in at least one of its districts.

Intension is to use new sensor technologies for the detection of the material. For example, sensor technologies such as Ultra-sound or Near Infra Red (NIR) can be used to

detect the type of the material placed on the conveyor belt. Detecting the material of the objects, system can sort them automatically. As a result of implementing this approach the manual sorting will be eliminated.

7 Literature

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