

Hazardous Waste Management in Turkey

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Abstract: An increase in population, energy demand, industrial activities and other technological developments inevitably cause large amount of waste to be produced. It is a known fact that traditional methods for the collection, transportation and disposal of wastes are not capable anymore to prevent health problems and economic losses. Any deficiency in the management of hazardous wastes, which constitute a significant part of solid wastes, has a range of negative effects for environmental health and safety. The aim of this study is to assess the situation of hazardous solid-waste management in Turkey. This was achieved by reviewing the rates of waste generation across the country. Current requirements and challenges in hazardous waste management are also discussed, and suggestions for solving problems are presented.

The study results that the Kocaeli and Izmir, as the two cities with the larger population and industrial activities of Turkey, produces the largest amount of hazardous waste in Turkey. On the other side, Istanbul, which is the mostly populated city with advanced health service, is by far the largest medical waste producer across the country. This is followed by Ankara, the capital city of Turkey and then Izmir. Although hazardous waste management in Turkey has improved because of a strong governance and institutional involvement in recent years, efforts directed by scientific research are still required to enable robust waste management. These efforts will greatly aid decision makers such as municipal authorities.

Keywords: Environmental health, hazardous waste, waste generation, waste management, safety.

Türkiye’de Tehlikeli Atık Yönetimi

Öz: Nüfus, enerji talebi, endüstriyel faaliyetler ve diğer teknolojik gelişmelerdeki artış kaçınılmaz olarak daha fazla miktarda atık üretilmesine neden olmaktadır. Atıkların toplanması, taşınması ve bertarafı için geleneksel yöntemlerin artık sağlık sorunlarını ve ekonomik kayıpları önleyemediği bilinmektedir. Katı atıkların önemli bir bölümünü oluşturan tehlikeli atıkların yönetimindeki herhangi bir eksikliğin çevre sağlığı ve güvenliği için çeşitli olumsuz etkileri vardır. Bu çalışmanın amacı, Türkiye’deki tehlikeli atık yönetiminin mevcut durumunu değerlendirmektir. Bu değerlendirme, ülke genelinde atık üretim oranlarının belirlenmesini gerektirmektedir. Bu çalışma ile Türkiye’nin tehlikeli atık yönetim sistemi ile ilgili mevcut gereksinimlerin ve zorlukların neler olduğu tartışılmış ve çözüm önerileri sunulmuştur.

Bu çalışmanın sonucunda, Türkiye’nin artan nüfus ve endüstriyel faaliyetlerine sahip iki şehir olan Kocaeli ve İzmir’in, en fazla tehlikeli atık ürettiği sonucuna varılmıştır. Öte yandan, ülkenin en ileri sağlık hizmeti veren en kalabalık şehri İstanbul, Türkiye’nin en büyük tıbbi atık üreticisidir. İstanbul’u, Türkiye’nin başkenti Ankara ve İzmir izlemektedir. Türkiye’deki tehlikeli atık yönetimi, son yıllarda güçlü bir yönetim ve kurumsal katılım nedeniyle iyileşmiş olsa da, güçlü atık yönetimini mümkün kılmak için bilimsel araştırmalara yönelik çabalar halen gereklidir. Bu sebeple bu alanda üretilen bu ve benzeri çalışmalar, belediye yetkilileri gibi karar vericilere büyük ölçüde yardımcı olacaktır.

Anahtar sözcükler: Atık yönetimi, atık üretimi, çevre sağlığı, güvenlik, tehlikeli atık.

INTRODUCTION

Traditional methods for collection, transport and disposal of wastes create health problems and economic losses (Seadon, 2010). Potential problems that could arise when handling hazardous wastes are even more serious as they inherit hazardous characteristics, such as carcinogen, flammable, explosive, abrasive, mutagenic, oxidising, toxic, etc. (Couto et al., 2013). Health effects of hazardous waste exposure were highlighted by many researchers. Sufficient evidence was found of association between exposure to oil industry waste that releases high concentrations of hydrogen sulphide and acute symptoms by Fazzo et al. (2016). It was also found out that heavy metal exposure causes lower neurodevelopmental scores in children by Sarigiannis (2017). Therefore, there is an urgent need for the appropriate management systems to be established by taking into account the characteristics of hazardous waste. When establishing a robust hazardous waste management plan, it is essential to provide a safe, efficient and economical collection, transportation, processing and a waste disposal service (Misra & Pandey, 2005).

Before 2000s most of the urban areas disposed of their collected waste into the land and river or directly into the sea. Hazardous waste also got mixed with municipal solid waste. Hazardous waste management systems have recently been established in developing countries. In 2005, approximately 12 million tonnes of industrial waste, specifically hazardous waste, was produced in China and 177 official hazardous waste treatment and disposal centres were established (Duan et al., 2008). In Turkey, efforts to create hazardous waste management systems have accelerated, with the adaptation process to European Union environmental legislation. For instance, the recent focus of researchers has become the analysis of the time process of hazardous waste management in Turkey (Akkoyunlu et al., 2017; Yilmaz et al., 2017; Oncel et al., 2017). However, a lack of financing and the mismanagement of financial resources still remain the main challenges to the waste disposal problem in economically developing countries.

Therefore, this study aims; to reveal the current status of the hazardous waste management system in Turkey, to make a comparison of different hazardous waste management practices across various regions in Turkey and to provide a structural analysis regarding the gaps and weaknesses involved in this system. These were achieved by reviewing the currently applied implementation methods and the quantity of hazardous waste produced in Turkey.

METHODOLOGY

The methodology of this study is based on the literature review regarding the generation and management of hazardous wastes in Turkey. Related data and information were gathered mainly from the sources such as Waste Sector

Assessment Report: Turkey's National Action Plan on Climate Change Project (Ministry of Environment and Urbanisation [MoE], 2010), Hazardous Waste Statistics: 3rd Volume of Hazardous Waste (MoE, 2013), Environmental Status Report for İstanbul (MoE, 2015) and National Waste Management and Action Plan 2016-2023 (MoE, 2016)

RESULTS

Hazardous Waste Generation in Turkey: Many industrial processes have the potential to produce hazardous waste. Figure 1 presents the distribution of hazardous waste production from different sectors in Turkey. As it is seen from Figure 1, metal industry has by far the largest share in this production.

According to the data from the hazardous waste declaration system, total amount of hazardous waste was almost 0.7 and 1.4 million tonnes in 2010 and 2014 subsequently (MoE, 2016). This also shows consistency with the data provided by the Life Hawaman Project-Improvement of Industrial Hazardous Waste Management in Turkey included in the study conducted by Yilmaz et al. (2012). This increasing trend of Turkish hazardous waste production is generally estimated to be based on a rising population and accelerating industrial facilities of the country, especially in the western regions.

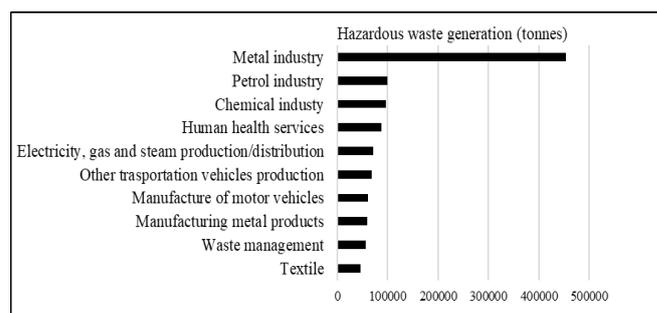


Figure 1. Hazardous waste production based on sectoral activities (MoE, 2016).

Figure 2 gives details for some cities which produce more than 10 thousand tonnes of hazardous waste. As it is seen from Figure 2, Kocaeli and Izmir, as the two cities with the larger population and industrial activities of Turkey, produced 209 and 176 thousand tonnes of hazardous waste in 2013 subsequently. İstanbul, the most populated city in Turkey, was the third largest hazardous waste producer with almost 85 thousand tonnes of hazardous waste. It was followed by Hatay, which is one of the biggest commercial centres of the south eastern Turkey.

Figure 3 presents the provinces with hazardous waste generation ranging between 1 and 10 thousand tonnes. It is shown in Figure 3 that one of the largest producers in this group is Zonguldak which has commercial mining

activities. Zonguldak has also five mines, which have been operating for almost 31 years (Turkish Coal Institute, 2014). There is also a specific hospital, called Uzunmehmet Occupational Disease Hospital, which produces hazardous medical wastes, to conduct regular health checks of mine workers who have been exposed to hazardous emissions over years.

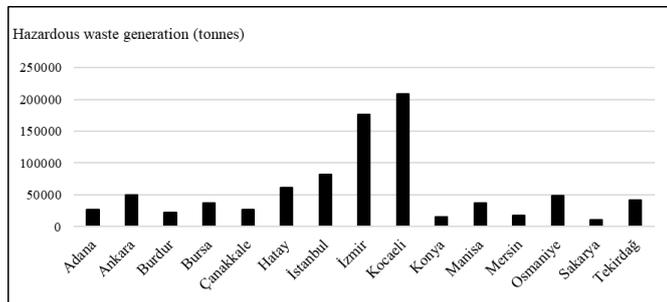


Figure 2. Hazardous waste generation (more than 10 000 tonnes) (MoE, 2013).

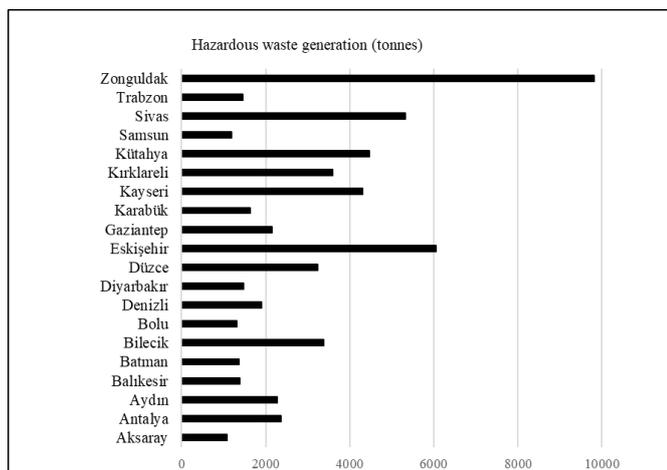


Figure 3. Hazardous waste generation (1 000 - 10 000 tonnes) (MoE, 2013).

Figure 4 presents the provinces which produce hazardous waste less than a thousand tonnes. These cities in Figure 4 are generally located in central Turkey. There is a limited size of industrial activities in these cities, but the main livelihood is livestock and agriculture.

There are also some provinces which produce relatively small amount of hazardous waste, even less than a thousand tonnes annually, such as Agri, Bayburt, Bitlis, Iğdır, Kilis, Mus, Ardahan, Bingöl, Hakkari, Karaman and Tunceli. Some of these cities are very close to Syrian border and some are located around the Eastern Anatolian steep mountains.

According to the study carried out by Akkoyunlu et al. (2017), Aegean, Central Anatolia and Marmara regions have higher hazardous waste generation rates than the other regions such as Mediterranean and Black Sea regions along with that the Eastern and Southeast Anatolia have the lowest production rates as resulted in this study.

One of the factors which affects the amount of hazardous waste is “mixing”. When the content of hazardous waste is examined, it is seen that large part of hazardous waste is medical waste which is generated from hospitals, veterinary clinics, pharmacies or health institutions (Ciplak & Barton, 2012). Furthermore, hospital waste consists of 80% domestic waste, 15% pathological and infectious waste, 3% chemical and pharmaceutical waste and 1% radioactive waste (Ozder et al., 2013). When municipal waste, such as some household products, is mixed with hazardous items, the whole waste stream becomes hazardous as it contacts with infectious, flammable, explosive etc. type of wastes (Ciplak, 2015).

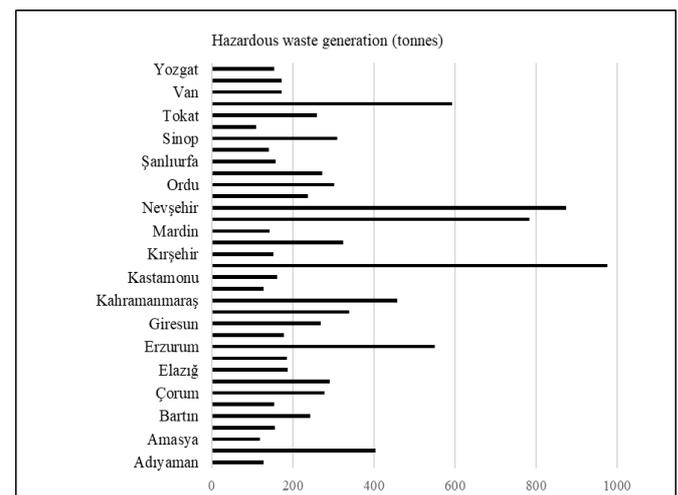


Figure 4. Hazardous waste generation (less than 1 000 tonnes) (MoE, 2013).

Figure 5 shows the distribution of medical waste production, by focusing on ten provinces with the highest generation rates. It is seen from Figure 5 that İstanbul, which is the mostly populated city with advanced health service is by far the largest medical waste producer in Turkey. It is followed by Ankara and İzmir. However, the total amount of medical waste produced in İzmir and Ankara is still smaller than the medical waste produced from only İstanbul.

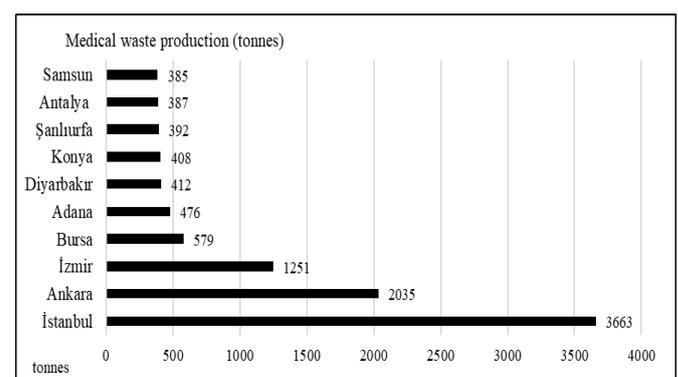


Figure 5. Medical waste production of the 10 cities (The first 6 months of 2015) (MoE, 2015).

When the total medical waste production of the ten cities, as named in Figure 5, is compared with the medical waste generation from the rest of Turkey, it is seen from Figure 6 that the generation from the ten cities corresponds more than a half (approximately 66.7%) of the Turkish medical waste production. It is also known from the study conducted by Korkut (2018) that almost 30% of Turkey's total collected medical wastes were generated in healthcare facilities of Istanbul.

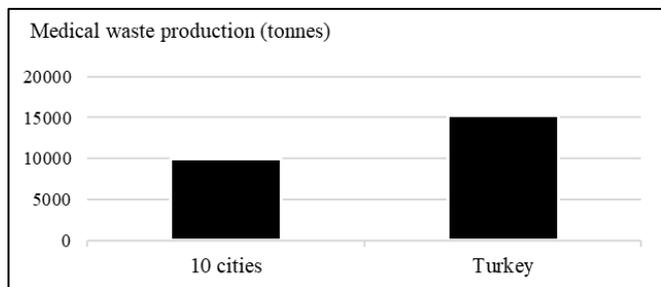


Figure 6. Comparison of medical waste production (The first 6 months of 2015) (MoE, 2015).

As there are different production rates of medical waste across the regions in Turkey, it is also possible to come across with a diverse range of generation rates across countries. Table 1 presents medical waste generation rates in different countries. It is seen from Table 1 that medical waste production could range between 1.71 – 8.4 kg/bed/day. This generation tends to be smaller in developing countries due to lack of doctors and/or a deficiency in hospital bed investments (Kucuk, 2013; Aydemir, 2017).

Table 1. Medical waste production

Country	Kg/bed/day	Reference
Dhaka, Bangladesh	1.71	Patwary et al. (2009)
Iran	2.439	Taghipour & Mosaferi (2009)
Portugal	3.9	Alvim-Ferraz & Afonso (2003)
Greece	8.4	Tsakona et al. (2007)

More specifically medical waste generation rate was reported as 1.85-2.171 kg/bed/day in Istanbul (Alagoz & Kocasoy, 2008) and 0.99 kg/bed/day in the provinces of Karabuk, Zonguldak and Bartin (Ciplak & Kaskun, 2015) and 0.83 kg/bed/day in Gaziantep (Aydogan et al., 2010), which sits in the south east of Turkey. It is considered that the level of development has an effect on the production of medical waste. This gives an indication that there is a cause and effect relation between the medical waste production and the level of development between the regions and also the countries.

Hazardous Waste Management in Turkey: Figure 7 shows the distribution of hazardous waste treatment and disposal methods applied in Turkey. It presents that almost 57% of hazardous waste is recycled, whereas 40 % of them is sent to landfills. Some recycling activities of hazardous waste are carried in place.

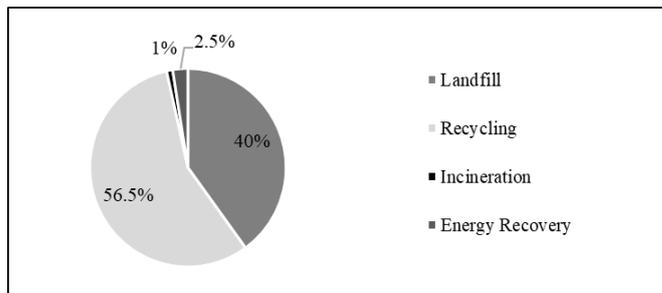


Figure 7. Distribution of hazardous waste disposal methods in Turkey (MoE, 2010)

Up to 2013 there was an only facility in Turkey for the treatment of hazardous wastes, called Izmit Waste and Residue Treatment, Incineration and Recycling Incorporate (Izaydas). In 2013, Petkim (Petro-chemistry Company) was built to incinerate petrochemical hazardous wastes (Salihoglu, 2010). The Izaydas, as the oldest and the largest plant in Turkey, has a capacity of 35 000 tonnes per annum (5 400 kg/hour) and it treats medical and hazardous wastes by incinerating them with energy generation. The facility also includes a landfill, a medical waste sterilisation facility and a biogas plant.

As hazardous waste generation in Turkey is far beyond the current capacity, it is urgently required to invest new treatment plants and to motivate waste segregation to reduce mixing. There are various problems related to mixing hazardous waste with municipal waste in place. The purpose of doing so is to eliminate hazardous wastes because of the lack of adequate hazardous waste processing and disposal facilities in place (Alagoz & Kocasoy, 2007; Birpinar et al., 2009; Yigit et al., 2013). Even though hazardous wastes must be stored and disposed of separately from non-hazardous wastes (Tinmaz & Demir, 2006), they could get mixed with municipal waste in Turkey (Alagoz & Kocasoy, 2008).

When the distribution of hazardous waste treatment facilities across Turkey is concerned, it is seen that treatment facilities are heavily concentrated on the western part of the country, especially around Kocaeli and Izmir where the hazardous waste production is high (as mentioned previously). The facilities located in the Marmara Region and Aegean Region and in the Central Anatolia (including the capital, Ankara) are generally refuse-derived fuel plants, whereas there are some cement plants to incinerate hazardous wastes in eastern provinces.

So far, it has been planned to establish 4 hazardous waste transfer facilities; one in the Marmara Region, one in the Central Anatolia (including Ankara); one in the Aegean Region (including İzmir) and one in the Mediterranean Region (including Adana and Mersin) to meet the 2023 targets set by the Department of Auditors (Taser & Erdogan, 2009). Meeting these targets has a vital importance for Turkey as the disposal of excessive amount of hazardous wastes to unsanitary landfills or dumping areas causes fatal effects on human and environmental health (Malakahmad et al., 2017; Yidong et al., 2012).

When medical waste generation is concerned, it is found that 75 thousand tonnes of medical waste was collected and 68% of them was landfilled after pre-treatment, 22% of them was buried inappropriately and the rest, 10%, was incinerated in Turkey in 2014 (Aydemir, 2017). In addition to Izaydas, there is also another plant to treat Turkish medical

waste in Istanbul with 24 ton/day capacity, operated by the Istanbul Metropolitan Municipality. In Turkey, alternative technologies (mainly autoclaves and hydroclaves), incinerators and disposal facilities are run by municipalities. Municipalities could work with affiliated private sector in large cities where population is dense and waste production is relatively high. These facilities are lacking in small cities. In some cases, medical waste treatment facilities located at a particular city also accept medical wastes from the surrounding provinces. For instance; the autoclave facility, located in Zonguldak in Western Black Sea Region and operated by Ilke Medical Waste Management Company, also accepts the medical wastes from Karabuk and Bartın (Ciplak & Kaskun, 2015), the autoclave in Gaziantep, which has 21 600 kg per day capacity, not only treats medical wastes from Gaziantep, but also from Hatay, Osmaniye, Adiyaman, Kilis and Sanliurfa (Aydoğan et al., 2010).

CONCUSSION and DISCUSSION

The main objectives of waste management, hazardous waste management is no exception, are to protect human health and the environment. It is necessary to include political, economic, legal and engineering aspects during the planning and operation of a waste management programme.

In the last decade, hazardous waste management in Turkey has improved. The number and the variety of treatment facilities have increased. However, there are still problems with hazardous waste management. Landfilling, the last choice in the hierarchy of waste management still remains one of the main methods adopted for hazardous waste management.

Having a developing economy and a shortage of engineering capacity for new technologies, Turkey still has a number of problems in environmental protection and hazardous waste management. These problems are similar to other developing countries (Ikhlayel, 2018a; Han et al., 2018; Ikhlayel, 2018b; Garlapati, 2016; Fagnani, 2017; Thi et al., 2015). Some of the most important problems, and suggestions for their solution, are as below:

1. Increasing in population and socio-economic development in Turkey has led to a significant increase in the amount of hazardous and medical waste. Increasing industrial activities in Istanbul and Kocaeli region causes much more hazardous waste production than other regions of the country. The capacity of Izaydas and other municipal facilities established for the processing of hazardous wastes are limited. Open dumping or burning of hazardous waste creates significant human health and environmental problems. It is necessary for the municipalities to make investments for processing and disposal of hazardous wastes.

2. The processing and disposal of hazardous wastes is a more costly process than that of the other solid wastes. For this reason, the separate collection and processing of hazardous wastes from municipal wastes has a great importance. Within the medical waste management system, waste is collected in different bags at the source. However,

due to wrong placing of the waste in a wrong bin, it is seen that the medical and municipal wastes are mixed together. In this regard, relevant personnel must be trained for the process of waste production, storage and transport to treatment.

3. While the intensified industrial activities cause an increase in the generation of hazardous waste, they could create employment and result in an increase in the population by migration. For example, Istanbul is a city with a population of around 15 million people. Once it is considered that Turkey has an almost 90 million population, 16% of the population lives in Istanbul. This results in an acceleration of development of the metropolis and attracting migrants seeking employment and education. It is known that the number and capacity of hazardous waste treatment facilities need to be increased in other regions where the hazardous waste production is also high. This could help the balance of a migration pattern and the distribution of employment set much equally across the regions in Turkey.

4. It is known that there are a good number of regulations in the developing countries. They are usually adopted from developed countries or from the guidelines of international organisations. This means that they contain almost all the details and characteristics of developed countries but far from local facts and challenges in place. However, implementation of any legislation in practical terms is more significant than the existence of these regulations.

5. There are some efforts to stop mixing municipal waste with medical waste in Istanbul, such as labelling. When municipal waste, such as some household products, is mixed with hazardous items, the whole waste stream becomes hazardous. It is, therefore, necessary to record the correct amount of production at source. Enforcement of sanctions should be applied to prevent the removal of unregistered waste from its source.

6. It is evident that it takes longer to implement any waste management plan in developing regions, so local economy should be revised periodically. For example, only the planning of a sanitary landfill in the province of Karabuk took more than five years to finalise.

7. While the number of scientific studies regarding municipal waste management has been increasing in Turkey, the engineering capacity for different sort of solid wastes, such as hazardous wastes and medical wastes is still low across Turkey. Funds should be supplied for research to determine the effectiveness of integrated systems to increase the technological capacity for a better environmental protection. Carrying out a pilot study does not make sure any success, but it does increase its likelihood. Similarly, universities generally study basic research subjects by focusing only on one type of waste, usually municipal waste, but collaborative studies including integrated waste management approach are very rare.

In conclusion, there is a great need to reduce the amount of hazardous waste in Turkey. In all large provinces in developing nations, this could be achieved through changing technology and reuse of hazardous wastes in industry via different ways, such as solvent reclamation, reproduction of acids and bases, reusing as oils in chemical industry. Developing strategies to increase recycling is not yet a primary concern. It is suggested that once the capacity for hazardous waste management should be specified and then a hazardous waste management system should be designed accordingly.

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