



## Types of waste in the context of waste management and general overview of waste disposal in Turkey

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### Abstract

In Turkey, there has been an increase in waste management applications within the context of sustainability activities recently. The most important reason for that was the legal requirements for recycling and disposal of the waste generated by the producers. Developing nations still utilize the storage method, while developed countries recycle almost all produced waste to produce raw materials and energy. Although there is an increase in the number of work conducted on waste management in Turkey, the attained levels are still far from satisfactory. This is mainly due to waste recycling or recovery costs. In order to convert the problem of waste into economic benefits, it is of utmost importance to recycle the waste, avoid the transfer of waste to landfills and to conduct waste management. Thus, an environmentally and economically sustainable productivity would be achieved. In the present study, waste management in Turkey was scrutinized. In this context, types and volume of the waste produced in Turkey and utilized disposal methods were discussed. The present study also provided a general overview on waste disposal business processes such as sanitary landfills, composting and recycling in Turkey. Thus, the study aimed to shed light on future studies on waste management.

**Keywords:** Waste management, Types of waste, Disposal methods, Sanitary landfills, Composting, Recycling

### Introduction

It was estimated that the world's population exceeded 7 billion by 2015 (Ağdağ, 2009) and the number of individuals who lived in urban areas doubled or tripled as a result of rapid urbanization. Urbanization, which is a natural consequence of rapid population growth, is not a problem in itself, however it leads to several environmental problems such as damages to public spaces and wetlands, air and water pollution and solid waste generation as a result of random and unplanned growth (Demir et al., 2006).

The need for natural resources and energy increases with global economic growth and population increase, and the indiscriminate use of resources has become a serious environmental threat. Similar to elsewhere in the world, waste

management is of great importance to eliminate these threats in Turkey. The environmental damage caused by humanity increases with globalization. The most important among these damages is the rapid consumption of natural resources, associated with the increasing raw material use and production of waste. Thus, it is necessary to separate and assess the waste at the source. This could be achieved by initially changing the waste perception of individuals. The perception of waste, which neglects economic and environmental aspects of waste where it is considered as a financial burden and a form of garbage, should be transformed into an asset that contributes to the economy and the environment (Kocak, 2018). Thus, with the popularity of waste management, the economy and ecology would be considered as a whole, optimum utilization

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of resources would be realized and the harmony between humankind and nature would be sustained both for living individuals and to allow the right of future generations to live in a healthy environment.

International waste management philosophy is described as systematic product and process design and management to prevent and reduce the toxicity in waste and products, to protect and preserve all resources, and to prevent waste incineration and burial. The environmental and waste management philosophy of the Environmental and Urban Development Ministry in Turkey is to review the causes of waste to prevent or minimize waste and separate collection and recycling of the waste at the source (Republic of Turkey Env. U.M., 2016).

It is important to design products that could be recycled safely and economically, that are reusable, compostable or could be converted into biogas in order to prevent the waste in production and businesses. This approach where the waste is classified at the source, collected adequately and waste production is prevented would lead to sustainability of natural resources. In the present study, 1) waste management in Turkey 2) the types of waste produced in Turkey 3) and disposal of these waste was investigated and certain personal recommendations were presented to improve the conditions in Turkey and improve the ease of application and efficiency.

#### **Waste Management in Turkey**

Waste is significant for both human and environmental health as well as the economy in Turkey similar to the rest of the world. There is a need for a planned waste management in order to remove the waste that should be regularly collected, transported, stored and disposed in urban areas to protect the environmental health before causing major problems (Yılmaz and Bozkurt, 2010).

Since the early years of the Republic, solid waste management, conducted as sanitation and public health services by the Ministry of Health, was evolved into an environment-based approach in the 1970s as a result of the increasing interest in environmental problems in the world and led to the inclusion of waste management in the realm of Ministry of Environment with its establishment in 1991. Developed countries completed the solid waste management process in the '80s, and began to seriously discussed phenomena such as sustainable waste management, waste ethics, when discussing the serious cases such as waste management, ethics, and waste management ethics, the topic was started to be perceived as a problem that needs to be managed in the following years in Turkey due to the impetus created by international developments, although the developments in waste management in Turkey were rather slow (Drinking, 2012).

In Turkey, where the traditional method of landfills is used to dispose the waste, the explosion that occurred at Ümraniye landfill on April 28, 1992, killing 39 people, was a cornerstone of a new era in solid waste disposal (Turan et al., 2009).

Due to these requirements, collection and removal of solid waste are conducted within the context of Solid Waste Control Regulations and related directives (Regulation on Control of Medical Waste, Regulation on Control of Hazardous Waste, Regulation on Control of Packaging Waste, Battery Waste

Control Regulation, Oil Waste Control Regulation, Excavation Soil, Construction and Demolition Waste Control Regulation) issued on 14.03.1991 (No: 20814) based on the Environmental Law no: 2872. Municipalities are authorized and responsible for the collection, transportation, storage, recycling and disposal of waste under the Municipal Law No. 5393 and the Metropolitan Municipality Law no. 5216 (Yılmaz and Bozkurt, 2010).

Recent studies reported the annual waste collection volume in Turkish cities as 25.28 million tons, while only 27.8% of this volume was recycled with disposal methods and the problems associated with the remaining part were attempted to be solved with landfills (Ağdağ, 2009). These findings demonstrated that there were developments in disposal of solid waste in Turkey, however the performance was not satisfactory.

Several recycling projects are implemented in developed countries and developing countries including Turkey. Although these projects are attractive, several political, social and economic factors are required to achieve success. A determined government, financial support for municipalities and the private industry, maximum collection and recycling, market development and promotion, training and informative studies are required for recycling projects. The operations in recycling facilities are not efficient in Turkey due to low recyclable waste volume, the effect of street collectors, the high plant capacities and inefficient collection operations (Şen and Kestioğlu, 2007).

The most common and implemented separation method in Turkey is separation in the field. However, this method is conducted by waste sorters at landfills under unhealthy and unsafe conditions. Similarly, the waste collectors collect paper and metal waste from the containers on the streets. Although 20% waste recycling is achieved in these processes, unfortunately the rate is quite limited. The most important reasons for that include high operating costs, mistakes in feasibility studies, economically unproductive waste sorting and recycling units, leading to a short operating life (Leblebici, 2001).

#### **Types of Waste in Turkey**

In order to assess waste management, initially waste characterization should be determined. In Turkey, 34% of organic waste is used in compost production, 16%, which includes paper and cardboard products, are used as paper pulp, 2%, which includes plastic waste, is used as granules and burrs, 6%, which is glass waste, is used as cullet, 1%, which includes metal waste, can be converted into raw materials such as iron and aluminum (Turkey Env. U.M., 2016).

The phenomenon of waste is defined in various literature and regulations. Demir et al. (2006) defined waste as solid substances with economic value that are not wanted by the owner and should be collected and disposed based on artistic and scientific rules, scientific and engineering principles for the benefit of the society, while in the Regulation on Solid Waste Control, it was defined as solid substances and sewage sludge that are considered trash by the owner and should be disposed of regularly for social peace and in particular, to protect the environment.

The waste is defined by Palabiyik and Altunbas as substance produced by domestic, commercial and/or industrial activities and disposed of by the owner due to lack of use, and should be disposed regularly due to environmental and human health reasons as well as other social benefits (Palabiyik, 1998), and waste is categorized in four categories (Drinking, 2012): Domestic Waste, Industrial Waste (Hazardous and Non-Hazardous Waste), Medical Waste, and Special Waste.

Although waste is a general concept that includes all waste products except hazardous waste, liquid waste and atmospheric gases, urban waste is caused by residential, commercial, institutional, construction-demolition and urban services (Badram et al., 2006). It is possible to classify the methods used to dispose the waste that occurs as a result of human

activities as dump sites, sanitary landfills, composting, reuse, recycling, recovery and incineration (Palabiyik and Altunbaş, 2004).

Review of annual waste collection by the municipalities in Turkey revealed that the volume has increased every year. This waste include the domestic waste produced by daily activities and could be categorized as paper, glass, cardboard, plastic, tin and fuel waste. The vegetable market, school, office, agricultural, tree and land waste that are not produced at homes, but collected by the municipalities as garbage, is also considered as domestic waste (BKAI, 2016). The mean municipal waste per capita and municipal waste collected in Turkey are presented in Figures 1 and 2.

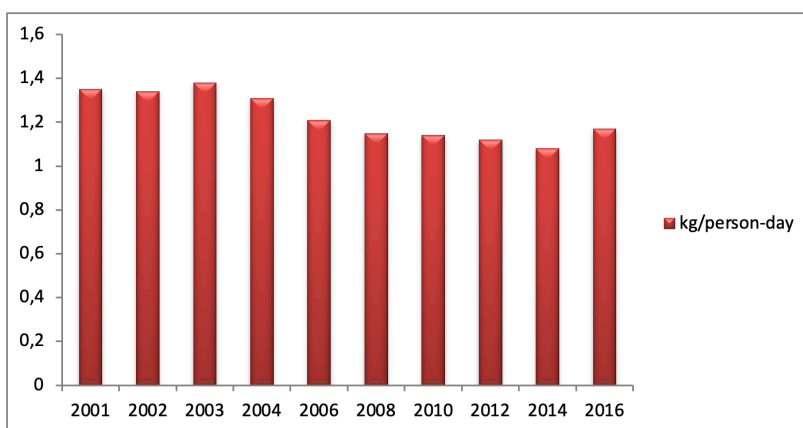


Figure 1. The mean municipal waste per capita in Turkey

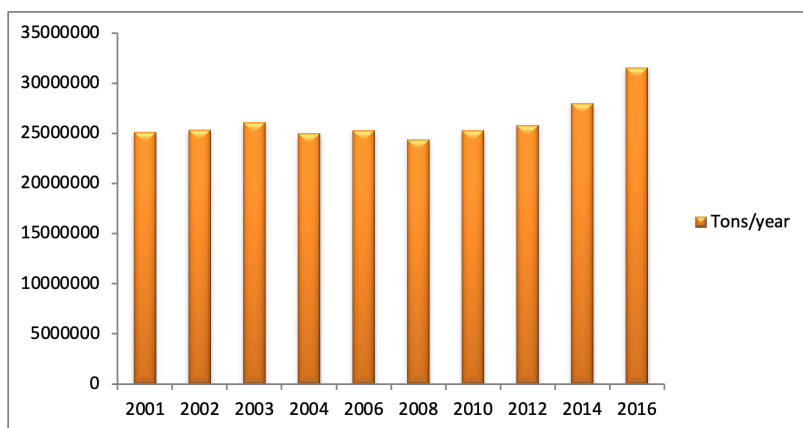


Figure 2. Waste collected by the municipalities in Turkey

**Waste Disposal Methods in Turkey**

It is possible to classify the methods used to dispose the solid waste produced by human activities as dump sites, sanitary landfills, composting, reuse, recycling, recovery and incineration.

**Sanitary landfills**

Based on the costs, sanitary landfill method is widely used for waste disposal in Turkey. The management of leachates and gases produced in landfills is extremely important in order to classify a landfill as sanitary landfill. In other words, measures should be taken for collection, removal, treatment, disposal and reuse of the leachate and gases.

The objective of sanitary landfills is to remove the solid waste from residential areas and prevent the damages caused the solid waste that could not be economically recovered for reuse through mechanical, chemical and biological processes or produced by these processes and hazardous for human health or for other living organisms and damage the environmental aesthetics (BKAI, 2016).

Sanitary landfills that are built in accordance with technical standards, such as suitable site selection and environmental protection measures are the most effective method to dispose of the waste. The sanitary landfill waste volume in Turkey is presented in Figure 3.

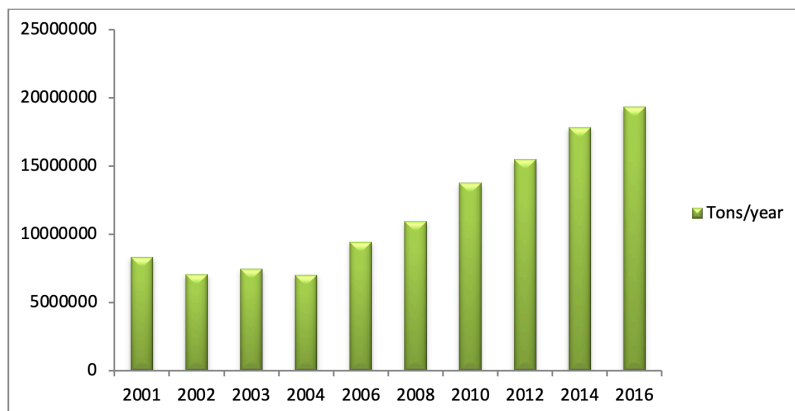


Figure 3. Sanitary Landfill Volume in Turkey

### Unsanitary landfills

It is a method used in undeveloped or developing countries where solid waste is removed from the human environment by randomly disposing the waste to open spaces without any precautions. This method leads to serious problems such as formation of dust clouds due to wind in landfills, the air pollution caused by the formed gases, the environmental and visual pollution caused by the solid waste spread over a large

area, and the infectious diseases caused by the animals that inhabit and feed in these areas.

The disposal of waste randomly in open spaces, seas or lakes leads to disturbing views and bad odor. The use of such unsanitary landfill methods that adversely affects soil, air, water and human health in Turkey almost ended in recent years. The volume of waste randomly disposed to rivers, streams and lakes in Turkey is presented in Figure 4.

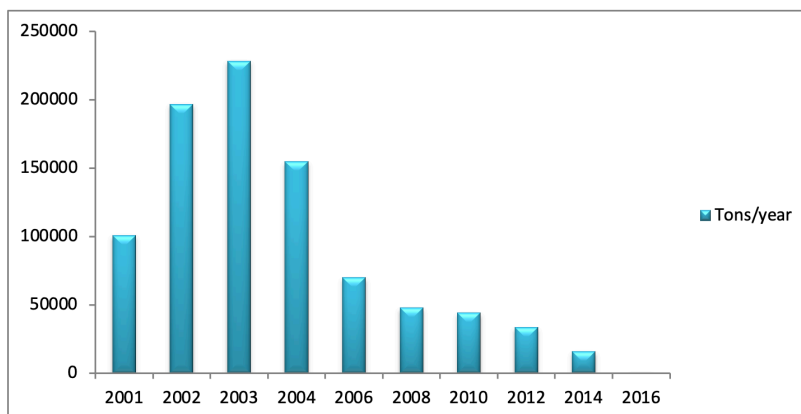


Figure 4. The waste disposed to rivers, streams and lakes in Turkey

### Incineration

It is a method used to make solid waste hygienically harmless, to reduce their volume and to obtain energy from this type of waste when it is economical. In order to obtain effective results with this method, the waste must be rich in combustible material, while the toxic gases released during the combustion and the storage of highly hazardous residues after the incineration process lead to significant problems.

As a result of the waste incineration process, about 350 kg ash and 650 kg gas waste (6000 - 7000 m<sup>3</sup>) are produced. Incineration method is generally preferred in developed countries with land shortage and incineration costs are very high. Open space waste incineration volume decreased in Turkey during recent years and it is presented in Figure 5 (He et al., 2009).

### Recycling

This is the method that includes both reuse (reuse of waste without any process except cleaning for several times) and recycling concepts and conversion of waste into other products

or energy via physical, chemical or bio-chemical processes using the properties of the waste (Gören, 2005). Recycling is the process of introducing the waste into the production process as secondary raw material after physical and/or chemical processes.

It is the process of converting waste into other products or energy using physical, chemical or biochemical methods based on the properties of the components of the waste. The recycling method contributes to the national economy in terms of raw materials. Pre-treatment is important in recycling processes and in the first step, waste volume is reduced. Certain equipment is used in the volume reduction processes that are utilized for temporary storage or transportation of waste.

First, it is possible to mention cullet crusher equipment. Its function is to crush container, bowl, bottle cullet waste, etc. into pieces of a few millimeters and to reduce the material volume.

Another equipment is the hydraulic plastic and paper press, whose function is to concentrate the material such as

cardboard, paper, plastic bottles and convert this waste into bales. 200-500 kg bales could be stored on top of each other. Such a press could be used where the paper, cardboard or plastic bottle waste volume is high.

Other important equipment is the fly press for metal beverage cans, and it could be used by the staff in cafeterias to raise awareness. Thus, utilized beverage cans could be compressed before disposal into separate collection boxes.

Finally, fluorescent bulb crusher equipment can be mentioned. This equipment can be used in places that frequently change fluorescence bulbs and has limited storage space. It contains a filter system that separates dust and mercury vapor. Thus, the environmental risks due to mercury/dust emissions that occur when the fluorescent bulbs are involuntarily broken during recycling could be avoided.

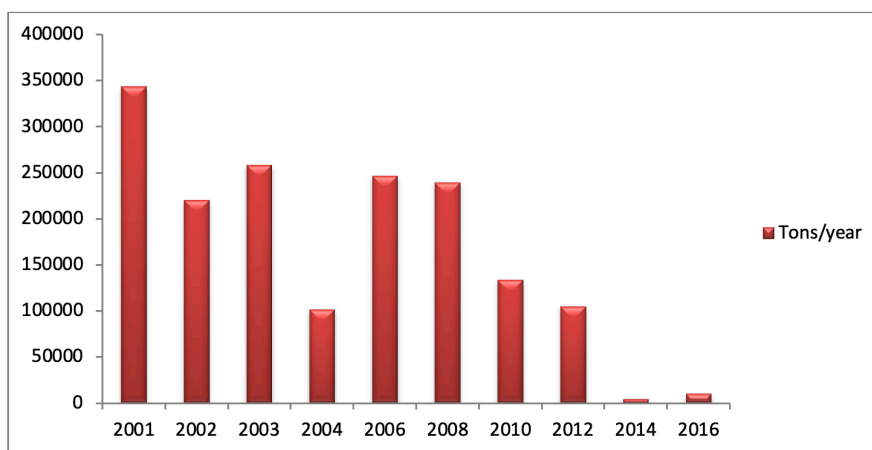


Figure 5. Open space waste incineration volume in Turkey

### Composting

The other waste disposal method used in Turkey is compost production and composting is the transformation of the organic parts of the waste into mold by microorganisms in an oxygenated or oxygen-free environment. Composting takes place at 65-75°C. Raw waste is heated by the heat generated by bacteria metabolism, and then gradually cooled down and separated into pieces and transformed into soil. During the process, the water in the waste partially evaporates and partially discharged as leachate. A portion of the solid material is converted to heat, thus leading to a significant loss of substance. A ton of waste yields 200 - 400 kg compost (Republic of Turkey Env. U.M., 2016).

Compost processes have certain advantages and disadvantages. Open compost piles technique do not have initial investment costs, require very little labor, the capacity is flexible and occupies little space. Disadvantages include visual pollution, odor and pest problems when not operated well, lack of protection against rain and sun, and long composting process.

In single compost box technique, the investment cost is low, it is suitable for small capacity facilities, there is no need to mix and move the compost, it provides protection against rain and sun and requires little labor. Disadvantages include lack of a domestic manufacturer in Turkey, visual pollution, long composting process, odor problem when not operated well, and lack of irrigation requirement.

In double, triple or quadruple compost box line technique produced with recycled plastic, the investment cost is low, processing volume is flexible, it is suitable for mid-size

buildings, it provides protection against rain and sun, contributes to plastic recycling, and requires little labor. Disadvantages include lack of a domestic manufacturer in Turkey, visual pollution, long composting process, odor problem when not operated well, and lack of irrigation requirement.

In single or multiple compost box technique produced with waste pallets, the investment cost is low, processing volume is flexible, it is suitable for mid-size buildings, it provides protection against rain and sun, contributes to wood recycling, and requires little labor. Disadvantages include visual pollution, long composting process, irrigation requirement, and odor problem when not operated well.

Finally, the technique of composting machine could be automatically operated to compost different volumes and deployed anywhere, creates no odor and pest problem, and it is convenient and rapid for large buildings. Disadvantages include high cost, requirement for trained technicians, leachate discharge and treatment. It only produces pre-compost. The annual waste volume disposed to composting facilities is presented in Figure 6.

Within the context of the disposal methods generally described above, the number of plants in Turkey and the tons of waste disposed in these plants are presented in Table 1.

Review of waste recycling facilities demonstrates that there has been an increase in the number of facilities and waste conversion column in 2016 when compared to 2014.

The distribution of sanitary landfill, unsanitary landfill, composting and recycling facilities in Turkey and the waste recycled in these facilities in tons are presented in Figure 7.

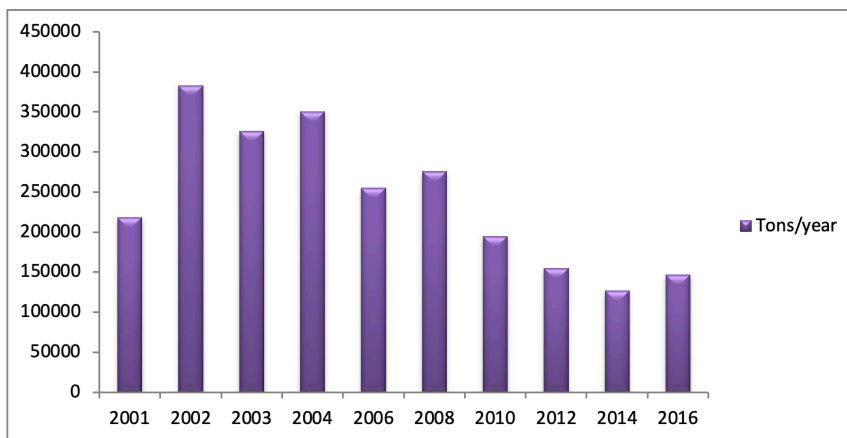


Figure 6. The annual waste volume disposed to composting facilities in Turkey

Table 1. Waste volume in Turkey based on the disposal method

Years/Disposal Method	2014		2016	
	# of plants	Waste volume (ton)	# of plants	Waste volume (ton)
Sanitary Landfill Plant	113	41.281.755	134	43.815.135
Incineration Plant	4	42.882	6	310.127
Waste Recycling Plant	868	19.724.241	1.558	33.083.400
Compost Plant	4	94.019	7	140.467
Co-incineration plant	39	532.343	35	738.908
Other Recycling Plants	825	19.097.879	1.516	32.204.025

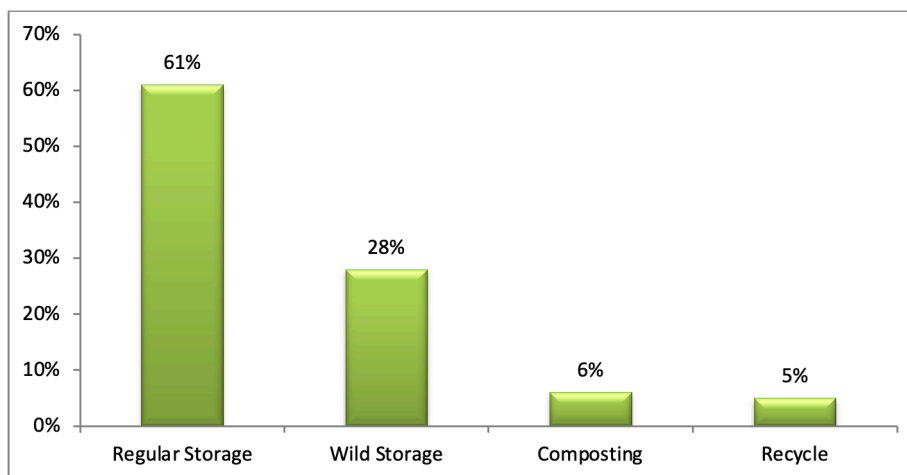


Figure 7. The distribution of waste disposal processes in Turkey

**Conclusion**

In the present study, waste management in Turkey, types and volume of waste produced in Turkey, as well as waste disposal methods were discussed. The study also provided information on waste disposal methods such as sanitary landfill, composting and recycling processes and the general status of these processes in Turkey to provide a basis for future studies on waste management.

The review of the types of waste produced in Turkey and waste disposal systems identified certain significant findings on waste management in Turkey. As is known, several municipalities and licensed facilities, collect the mixed waste from both homes and businesses, separate part of this waste in sorting facilities and compost the rest. Although these processes are attempted to be conducted in an organized manner, composting processes are not widespread in Turkey

and conducted only in a preliminary level.

General review of waste disposal processes in Turkey would demonstrate that 61% of the waste is disposed in sanitary landfills. This is followed by unsanitary landfills, which are no longer utilized in developed countries and where 28% of the total waste is disposed in Turkey. 8.100.000 tons of waste has been accumulated in open spaces due to unsanitary landfills and poses an environmental risk. This needs to be remedied in accordance with the relevant laws and regulations. This type of open space unsanitary landfills should be replaced by sanitary landfills. Among the waste disposal methods, only 6% of the total waste is disposed with composting processes. As mentioned-above, the percentage of this application, where the waste is transformed into the environment in the most efficient way, is still at the beginning level in Turkey and it is open to development. The last in waste disposal methods implemented in Turkey is the recycling operations with a share of 5%, which is extremely low.

Although important studies have been conducted on waste in Turkey, these studies are far from sufficient. This is mainly due to the high recycling costs that are considered as a major burden. In the long term, this type of practices would provide much more than the initial costs due to the national development they would lead to. Thus, both public spaces and private corporations would produce more, providing economic growth and development on one hand, and on the other, when they adopt an environment-friendly sustainable approach, they would guarantee their existence in the future.

Local governments often have to opt for external financing for high cost solid waste services, since their own resources are usually insufficient. The related institutions and organizations should be made aware that waste management could lead to savings and profits in the long run, despite the initially high recycling or recovery costs. Training and seminars should be conducted to raise awareness and to lay the foundation for sustainability studies to create a more habitable environment for future generations.

In medium and long term, solid waste management should be conducted based on socio-economic, technical, demographic and geographical conditions in Turkey and active participation of ministries and other central government institutions and organizations, and local governments, municipalities, businesses, NGOs, associations and individuals is required.

### **Compliance with Ethical Standards**

#### **Conflict of interest**

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

#### **Author contribution**

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

#### **Ethical approval**

Not applicable.

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### **Data availability**

Not applicable.

### **Consent for publication**

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