

O 1. ANKARA CITY MAMAK DISTRICT CENTRE SOLID WASTE POTENTIAL

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ABSTRACT: Ankara Province is the capital city of Turkey and the second largest city in the country. While all the solid wastes of the city center were transported to the irregular landfill in the district of Mamak, a new sanitary landfill area was formed, and the rehabilitation of the Mamak landfill was started for the negative effects that occurred because the area reached a very large area and remained close to the settlements. Both the realization of rehabilitation works, and the solid waste management of this landfill are important. In this study, research on the determination and management of solid waste characteristics were carried out in Mamak district center of Ankara province. The activities of the Mamak Municipality, which operates in the field of waste management, for reducing the amount of waste, providing waste recovery and integrated management of the ITC-Mamak facility are examined. In the light of this information, the problems encountered in solid waste management were investigated and suggestions were presented. As a result, within the framework of the information obtained, it is important for the management to collect the solid wastes generated in the houses separately, to increase the amount of recycling and to reduce the amount of solid waste that will go to the landfill.

Keywords: Integrated Solid Waste Management, Solid Waste Disposal, Mamak, Zero Waste

1. INTRODUCTION

Changes in human behaviour and the expectation of a comfortable life have transformed humanity into a society that consumes more than before. As waste generation increases as a result of production and consumption activities of people, environmental impacts such as climate change and depletion of natural resources emerge. For a proper waste management, the use of natural resources should be reduced, waste should be rendered harmless and economic value should be created (Ulaşlı, 2018). Factors such as industrialisation, economic conditions, increase in population, urbanisation and welfare level in our country in recent years and today have caused waste problems. In this regard, "sustainable waste management approach" aiming to create zero or minimum waste has become a necessity (Ulaşlı, 2018).

In order to minimise the damages caused by solid wastes to individual health and the environment, appropriate and controlled methods should be used. These methods consist of collection, reuse, recycling, recycling, recovery and finally storage of solid wastes, and the zero waste approach is an understanding that has emerged in this context. Its main purpose is to prevent waste, to use resources more efficiently, to prevent or minimise waste generation by re-evaluating the causes of waste generation, and to ensure the recovery of waste by collecting it separately at its source. Solid waste management is the responsibility of waste generators and municipalities. For an efficient solid waste management, it is important to encourage individuals to recognise the waste produced, to raise awareness for the protection of nature and to encourage environmental cleanliness.

In this study, quantities and characterisation of solid wastes generated in Ankara-Mamak district centre, collection, accumulation and transport of solid wastes, locations of landfills, recovery of solid wastes, Mamak Municipality solid waste management services and zero waste practices, problems encountered in solid waste management were investigated. In the light of this information, the aim of the study is to prevent and reduce solid waste generation in Mamak district centre and to evaluate the work that can be done for a conscious waste management with an integrated approach. In addition, determining the problems encountered in solid waste management and presenting solution suggestions will also make an important contribution.

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2. MATERIAL AND METHOD

In the first stage of the research, information was obtained from Mamak Municipality Directorate of Cleaning Affairs by face-to-face interview technique about the amount and characterisation of solid wastes generated in Mamak district centre, waste management, collection and transportation of solid wastes, Mamak Municipality solid waste management services and zero waste practices, problems encountered in solid waste management services. In the second stage, face-to-face interview technique was applied with the responsible personnel of ITC Integrated Solid Waste Management Systems Facility and detailed information was obtained about the location of landfill areas and recycling of solid wastes.

2.1. Characteristics of the Study Area

This study was conducted in the centre of Mamak district of Ankara province located in the Central Anatolia Region of the Republic of Turkey. Mamak district consists of 65 neighbourhoods. The district is neighbored by Altındağ in the north, Elmadağ in the east, Çankaya and Elmadağ in the south, Çankaya and Altındağ in the west. The district has a typical continental climate. The winter season is rainy and cold, and the summer season is hot and dry. The annual rainfall in the region is approximately 360-420 kg/m². The distance to Ankara city centre is 3.5 km. Its height from the sea is 899 m and its surface area is 308 km². Mamak district has a hilly geography (Mamak Municipality Promotional Booklet, 2021). Service Sector, Mining Sector, Agriculture Sector, Industry and Trade Sector are important on the district economy respectively. The main economic activities in the district are civil servant, tradesman, private sector and construction labour. In addition, Slums and Infrastructure, Unemployment, Lack of Education, Security and Transport are seen as the main problems of the district (Mamak Municipality, 2022).

According to 31 December 2022 Address Based Population Registration System results, Mamak district has a population of 687,535 people (TUIK, 2022). It is the 4th largest district of Ankara according to population density. The total female population of Mamak district is 346,420 and the total male population is 340,915. As a percentage, 50.38% of the total population is female and 49.62% is male. It is seen that the population of Mamak has been increasing from past years to the present. Mamak population statistics between 2007-2022 are shown in the table.

2.2. Mamak landfill

Since the 1950s, Mamak has been one of the most important symbols of squatting, unplanned urbanisation and environmental destruction. The most important cause of environmental destruction is the Mamak landfill (Özaslan, 2014). Mamak landfill is a large solid waste landfill with an area of 26.6 hectares (Güngör and Torunoğlu, 2022). Since it is thought that the Mamak landfill may cause negative effects such as epidemic disease, pollution of natural resources, visual pollution, bad odours, the release of gases causing the greenhouse effect into the atmosphere and the danger of explosion, urgent improvement research has been started. Mamak landfill has been transformed into a recyclable solid waste reclamation centre by Ankara Metropolitan Municipality through a project with ITC, which started its operations in 2002.

The first scientific study on the municipal solid waste problem in Ankara started with a report prepared by TUBITAK in 1983. In this study, the wastes produced in Ankara are acidic (4.5<PH<5.8), have low (12-17) carbon/nitrogen ratio and low (250-360 kcal/kg) calorific value. Therefore, it was determined that landfilling is the most appropriate solution (Arıkan et al, 2004).

Table 1. Mamak District Population between 2007-2022 (TUIK, 2022)

Year	Mamak Population	Male Population	Female Population
2022	687.535	340.915	346.620
2021	682.420	340.018	342.402
2020	669.465	333.567	335.898
2019	665.978	332.512	333.466
2018	647.252	323.710	323.542
2017	637.935	318.309	319.626
2016	625.083	313.174	311.909

2015	607.878	304.502	303.376
2014	587.565	394.672	292.893
2013	568.396	284.830	283.566
2012	559.597	282.464	277.133
2011	558.223	284.649	273.574
2010	549.585	281.036	268.549
2009	532.873	271.531	261.342
2008	520.446	263.156	257.290
2007	503.663	254.647	249.016

2.3. Zero Waste Target

In Turkey, waste disposal and urban cleaning services were implemented by municipalities to protect environmental health from 1930 to 2017. Since 2017, the "Zero Waste Project" has been launched by the Ministry of Environment, Urbanisation and Climate Change and implemented in all public institutions. If the zero-waste target is introduced as a culture in all living spaces and made compulsory with legal support, the rate of achieving this goal is very high (Erdur, 2019).

In order to ensure the effectiveness of the Zero Waste Project, plastic bags have been charged since 2019. It was observed that the amount of plastic shopping bags used in 2019, 2020 and 2021 decreased by approximately 65%. With this reduction, 550,000 tonnes of plastic waste and 22,746 tonnes of greenhouse gas emissions were prevented (Anonymous, 2019).

With the Zero Waste Project launched in 2017, the recovery rate was 13% and reached 27.2% as of June 2022. These rates are important in terms of reducing the negative effects of climate change, protecting raw material resources and using them efficiently. Total economic gain reached 62.2 billion TL. In addition, 3.9 million tonnes of greenhouse gases were prevented (Table 2) (Anonymous, 2019).

Table 2. Zero Waste Project in Figures (2017-2022) (Ministry of Environment, Urbanisation and Climate Change General Directorate of Environmental Management)

Recovery Rate	27,2 %
Economic Gain	62,2 billion TL
Energy Saving	530 million kwh
Water Saving	572 million m ³
Storage Space Saving	69 million m ³
Greenhouse Gas Emissions Prevented	3,9 million tonnes
trees saved	347 million
Barrel of Oil Saving	87 million units
Raw Material Savings	650 milyon tonnes
Recovery Amount/Ratio	
Plastic Bags	550.000 tonnes
Paper/Cardboard	20,4 million tonnes
Plastic	5.4 million tonnes
Glass	2.3 million tonnes
Metal	0.5 million tonnes
Organic et al.	5.2 million tonnes
Wastewater treatment rate	4.2 %

3. FINDINGS

3.1. Mamak Municipality Solid Waste Management Works

In the Republic of Turkey, metropolitan municipalities and other municipalities are assigned for solid waste management activities, establishment, construction, operation or commissioning of solid waste disposal facilities. Mamak district solid waste management activities are carried out by Mamak Municipality Directorate of Cleaning Affairs. Solid domestic wastes generated in the settlements within

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the municipality boundaries are collected on a daily basis and these wastes are transported to solid waste landfills within the framework of a waste management plan. Garbage containers have been placed in places deemed necessary so as not to spoil the appearance of the district. The streets and avenues of Mamak district are cleaned within a plan and co-operation is made with Ankara Metropolitan Municipality on environmental cleaning. Work is being carried out within the scope of the zero waste project. In this context, Mamak Municipality 1st Class Waste Collection Centre was put into service. Inspections are carried out in the enterprises within the borders of Mamak, and it is ensured that these enterprises make contracts with collectors who have storage permits or licensed recycling facilities. In Mamak district, necessary warnings are given to individuals who harm the environment, and those who do not comply with the rules are treated within the legal framework. Cleaning of 23 market places established within the borders of Mamak district is carried out in a regular plan and programme. The public is informed about used batteries and accumulators, and waste batteries and accumulators are collected separately from other solid wastes and delivered to transport companies. Training and awareness-raising activities on environment and cleanliness are carried out for both citizens and municipal employees (Mamak Municipality Directorate of Cleaning Affairs Regulation on Establishment, Duties, Authorities, Responsibilities and Working Principles, 2021).

According to the Municipal Law No. 5393 and Metropolitan Municipality Law No. 5216, the responsibility of collecting and transporting solid wastes to transfer stations belongs to district municipalities. With the "Smart Waste Collection System" developed by Mamak Municipality, the fullness, cleanliness and collection systems of garbage containers can be monitored online on maps. This system records online how long it takes for the collection vehicles to reach which neighbourhood and whether the garbage in the containers has been collected or not. Thanks to the system, the complaints of the residents of the district can be intervened immediately, and it will be possible to monitor whether the garbage removal hours are observed or not. In the system, empty containers from which waste has been collected will be indicated with a green light and full containers from which waste has not been collected will be indicated with a red light. Container occupancy will be monitored and municipalities will be able to save fuel and time. A specially developed navigation panel will be used to determine the best route to the waste container with a dynamic routing programme. Since municipalities allocate a large part of their budgets to collection and transport, this system is an important application in waste management to increase recycling rates and reduce costs arising from solid waste (Mamak Municipality, 2020).

Mamak 1st Class Waste Collection Centre serves on Mamak Samsun road on an area of 1562 m² within the scope of Zero Waste project. With the support and contributions of the Ministry of Environment, Urbanisation and Climate Change, 14 categories of waste are accepted to this facility, which was opened with the aim of recycling recyclable wastes to the economy, ensuring their disposal and preventing pollution caused by wastes. These waste types are paper, glass, plastic, wood, cardboard, metal, electronic materials, leaded batteries, textiles, fluorescent and mercury-containing wastes, accumulators, waste medicines, vegetable waste oils, household hazardous wastes (such as solvents, paints, sprays), end-of-life tyres. The resident population can bring their wastes themselves or call the Mamak ALO ATIK line to express their requests and complaints and have their wastes collected from their addresses (Mamak Municipality, 2021).

3.2. Mamak Municipality Education and Awareness Raising Activities

Mobile Recycling Information and Awareness Bus (ATİKO) was designed for children by Mamak Municipality Cleaning Affairs Directorate for zero waste awareness raising activities. It was delivered to the Directorate of Culture and Social Affairs ready for educational activities. ATİKO continues its education and awareness-raising activities with the understanding of My Future is in My Hands - We are reshaping the world of the future with the recycling and waste project (2022-2023).

In 2022, various environmentalist projects were put into operation in cooperation with the textile company and Mamak Municipality in order to raise awareness of citizens on waste management. Within the scope of the smiling recycling of textile project, the protocol signed for the collection of textile/clothing wastes (article 4.2.16), since reuse cannot be made in order not to cause the spread of the risk of disease transmission due to COVID-19, 1000 gift clothes vouchers were given to 1000 children in need instead of reuse. (500 presentations were made at this festival.) All expenses were covered by the textile recycling company.

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In May 2022, education and awareness-raising activities were carried out with university students (Gazi-Odtü- Hacettepe- environmental communities) by distributing brochures and packaging waste collection bags on recycling waste door-to-door.

3.3. ITC Integrated Solid Waste Management Systems

ITC Integrated Solid Waste Management Systems started its operations in 2002. As the first target of the system, the rehabilitation of wild landfills such as the Mamak landfill is carried out and the effects on human and environmental health are minimised. Problems such as bad odour, slipping and explosion risk are eliminated thanks to works such as collecting leachate and landfill gas. ITC Integrated Solid Waste Management Systems The units in the Mamak facility include pre-separation, biomethanisation, composting, energy production, waste derived fuel (WDF) production and 2nd class landfill operations. Daily 1,500 tonnes/day of municipal solid waste reaches the Mamak facility.

Mixed household wastes are divided into 3 groups as organic, recyclable and residual waste in a pre-sorting system. Recyclable wastes such as glass, plastic, aluminium and metal are sent to licensed recycling facilities for recycling. Biodegradable wastes such as vegetables, fruits, park/garden wastes, which constitute more than 50% of household wastes, are also sent to biomethanisation facilities. The remaining wastes are processed according to their calorific value and used as waste derived fuel (WDF). At the end of all these processes, the remaining pulp and a certain amount of biodegradable waste are disposed of in the 2nd class landfill site. Biogas from the biomethanisation system and landfill gas collected from landfills are used to generate electricity in power generation plants. The heat generated during biogas production is utilised in greenhouses. In these greenhouses, tomatoes, strawberries, orchids and cucumbers are grown without using fossil fuels. In ITC facilities, the waste heat generated during energy production is also used to heat greenhouses, biomethanisation tanks, administrative and social buildings in some facilities, and residential and shopping centres near some facilities (Cem, 2020).

3.4. Solid Waste Potential of Mamak District

The amount and composition of municipal solid wastes may vary depending on population density, geographical characteristics, climate, socio-economic status, seasonal changes, per capita income level. For 2021, the average amount of solid waste collected daily in Ankara is 5,000 tonnes and the average amount of waste generated per person is 1.03 kg/day. There are 13 privately operated transfer stations in the province. There are 2 landfills operating in Mamak and Sincan districts of Ankara. As of 2021, waste characterisation for Ankara is shown in the figure (Ankara Directorate of Environment, Urbanisation and Climate Change, 2021).

The solid waste potential generated in Mamak district between 2013-2022 is expressed numerically in the table. Monthly change of 2022 waste tonnages of Mamak district is shown in Table 4.

Mamak district solid waste characterisation studies were carried out on 01.10.2021 and 04.10.2021 at Mamak Solid Waste Area. The studies were carried out on municipal wastes transported by 4 vehicles bringing waste from 3 regions of the district with low, middle and high income levels and the bazaar area, and the results obtained are given below.

According to the information obtained as a result of one-to-one interviews with the responsible personnel of Mamak Municipality Directorate of Cleaning Affairs, 'Street Collectors' pose a problem in solid waste management. Street collectors cause problems such as collecting the wastes on the spot without complying with hygiene rules, in unhealthy conditions, using unsuitable hand and storage tools, and causing environmental and visual pollution by spreading the garbage around. Failure to ensure occupational health and safety, unregistered economic value obtained from waste, and precarious work also come to the fore (Ekşi, 2017).

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Table 3. Mamak district solid waste amounts collected between 2013-2022 (Mamak Municipality Directorate of Cleaning Affairs, 2022)

Amount of Waste Collected between 2013-2022 (Mamak Municipality Directorate of Cleaning Affairs, 2022)									
Year	Domestic waste kg	Packaging waste kg	Textile waste kg	Vegetable oil waste kg	Pharmaceutical waste kg	Battery kg	Electronic waste kg	Hazardous waste fluorescents kg	Hazardous waste cartridges kg
2013	Archive record could not found.	2.795.017		8.770					
2014	Archive record could not found.	4.075.430		17.480					
2015	160.220.480	4.120.660		3.100		2.730			
2016	160.480.830	5.631.480				1.759			
2017	162.980.010	6.903.120				469,50			
2018	179.601.600	12.620.680				5.057,90			
2019	175.378.585	7.102.020				560,19			
2020	191.306.170	1.225.320				1.338,20			
2021	184.018.310	2.505.740	17.172	1.947	239	253	77	550	50
2022	172.796.800	818.710	363.400	3.372	6	20	15	-	350
TOTAL	1.386.782.780	47.971.377	380.572	34.669	245	12.187,79	92		400

Table 4. Mamak district solid waste amounts collected between 2013-2022 (Mamak Municipality Directorate of Cleaning Affairs, 2022)

2022 WASTE TONNAGES									
Month	Domestic waste kg	Packaging waste kg	Textile waste kg	Vegetable oil waste kg	Pharmaceutical waste kg	Battery kg	Electronic waste kg	Hazardous waste fluorescents kg	Hazardous waste cartridges kg
January	14.134.000	7.940	50	260					50
February	13.110.000	30.920	19.890	170					50
March	13.790.000	62.660	33.980	135					

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April	13.756.000	71.200	48.760	0					
May	14.081.680	120.070	45.780	0	6		15		50
June	14.793.900	68.080	33.210	400					
July	15.662.620	55.490	30.770	265					
August	16.339.000	80.240	29.500	300					100
September	14.874.600	86.360	35.710	250					
October	14.866.800	99.700	40.140	556					
November	14.146.450	60.730	25.610	386					
December	13.241.750	75.320	20.000	650		20			100
TOTAL	172.796.800	818.710	363.400	3.372	6	20	15		350

Table 5. 2021 Mamak district solid waste characterisation study results (Ankara Metropolitan Municipality, 2021)

Solid waste component	Income levels				Average net quantity	Average
	low	middle	high	bazaar		
Biodegradable waste	190,50 kg	254 kg	200,50 kg	118,50 kg	190,88 kg	47,66%
Paper	18,50 kg	2,50 kg	7 kg	17 kg	11,25 kg	2,81%
Cardboard	6,50 kg	3 kg	15 kg	55 kg	19,88 kg	4,96%
Plastic(Recycable)	7,50 kg	10 kg	8 kg	6,50 kg	8 kg	2%
Plastic(non-recycable)	44,50 kg	37 kg	46,50 kg	89 kg	54,25 kg	13,55%
Glass	12,50 kg	17 kg	20,50 kg	8 kg	14,50 kg	3,62%
Iron metal	0 kg	1 kg	0,50 kg	2 kg	0 kg	0%
Non-ferrous metal	0,50 kg	1,50 kg	1 kg	7 kg	2,50 kg	0,62%
Waste Electrical and Electronic Equipment	0,50 kg	0 kg	0 kg	0 kg	0,13 kg	0,03%
Hazardous Waste	0 kg	0 kg	0 kg	0 kg	0 kg	0%
Park and Garden Waste	10 kg	6,50 kg	0 kg	0 kg	4,13 kg	1,03%
Other non-combustibles	1 kg	0 kg	3 kg	0 kg	1 kg	0,25%
Other combustibles	120 kg	164 kg	76 kg	16 kg	94 kg	23,47%
Others	0 kg	0 kg	0 kg	0 kg	0 kg	0%
TOTAL	412 kg	496,50 kg	378 kg	319 kg	400,50 kg	100%

4. CONCLUSION, DISCUSSION AND SUGGESTIONS

Solid waste potential can vary greatly between countries and between urban and rural areas depending on geographical, climatic, socio-economic and seasonal factors. According to the results of the solid waste characterisation study of Mamak district, the highest amount of biodegradable waste is

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47.66% in Mamak. Looking at the values in the table, the amount of recyclable waste is around 14.1%. It is estimated that street waste collectors have an effect on the rate of recyclable waste.

It is thought that the employment of street waste collectors as registered waste workers will be beneficial in terms of improving the waste management process. As a result, it is foreseen that the registration of street waste collectors in coordination with the municipality and private sector, making their work more systematised and improving their working conditions will reduce the problems in waste management. In addition, it is thought that the inclusion of street waste collectors in the system will ensure efficiency in the separate collection of waste.

It is thought that the Smart Waste Collection System will make a great contribution to the municipalities in terms of enabling individuals to use it actively in daily life and to monitor the wastes accumulated instantly on this system in an online manner, and it is considered that such projects will positively affect the activities carried out within the scope of combating waste.

By developing the Smart Collection System, it is thought that it will be beneficial in encouraging citizens to contribute to recycling by establishing a smart mobile application system that will provide information on how the waste should be separated, the location and distance of the containers where the separated wastes will be left, for those who cannot take their wastes to the waste centre, they can contact the waste teams through the application and get their waste picked up and earn money points in return.

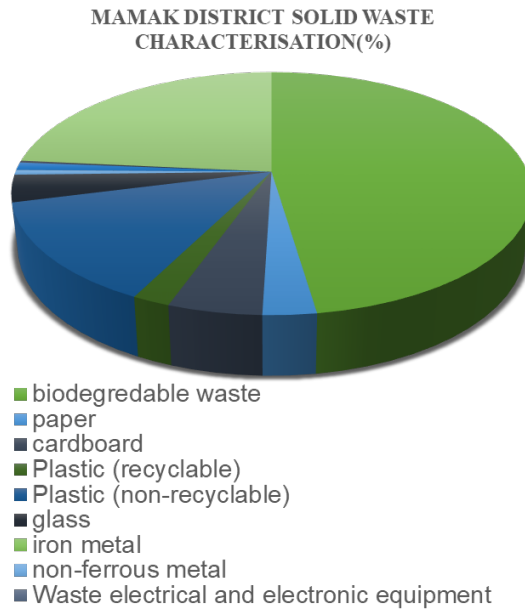


Figure 2. 2021 solid waste characterisation of Mamak district

When the training and awareness-raising activities of Mamak Municipality are examined, it is seen that important activities are carried out for a sustainable future and an environmentally friendly waste management. Increasing such activities and organisations, focusing on and supporting awareness raising activities by citizens will contribute to the formation of zero waste culture.

When the activities of ITC Integrated Mamak Facilities are analysed, it is seen that the management of wastes and the sustainability of the energy produced from waste are environmentally important. It is seen that the organic waste potential in Ankara is high and it is aimed to add value to the wastes by converting these wastes into energy. It is ensured that the energy need is met without harming the environment. It is important to support the use of renewable energy by developing innovative technologies through research and development activities.

Waste management continues to maintain its importance at global and national level. For sustainable and effective waste management and minimisation of waste, it is important that all interactions such as industry, legislators, science, private sector and waste generators meet on a common ground and work together. From an environmental, social and economic perspective, which are the three basic elements of sustainability, waste is a very important concept to manage in all three elements.

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Considering waste as a secondary resource, creating new employment areas both in terms of economic and environmental benefits and sociological aspects, and the interaction of these three basic elements are considered to be a subject that should be examined in future studies.

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