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RESEARCH ARTICLE

Investigation of variation of the recyclable solid waste amounts in Küçükçekmece district of Istanbul

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ABSTRACT

It is known that the amount of solid waste changes depending on the economical and cultural living conditions and also seasonal changes. In this study, the variation of recyclable solid waste amounts was investigated for the Istanbul Küçükçekmece district which has a high density of population and industrial activity. The recyclable solid wastes generated in study area were categorized as packaging wastes, waste batteries, waste vegetable oils and electronic waste and the variation of the amounts of these waste groups was investigated based on time between 2010-2015 years. When the amounts of recyclable and recycled packaging wastes were investigated, it showed a significant increase by years. While the amount of recycled packaging wastes was 3,876 tons for the year 2010, it reached to 77,601 tons in the year 2015 with a 20 fold increase. In the period of the study, it is seen that packaging wastes form a large amount of the total wastes by analyzing the percent distribution of examined waste groups. The reason of that could be the simplicity of the recycling and reuse opportunities of packaging wastes. Recycling and reuse opportunities of the waste vegetable oils and e-wastes are new developing applications for this district. It is thought that the recycling ratio of this type of wastes will increase with the developments and improvements on waste management and collection systems.

Keywords: Küçükçekmece, Recycle, Reuse, Solid waste management

1. INTRODUCTION

The amount of waste generated in cities increase with population growth, urbanization and rapid economic development [1- 4]. In addition to the continuous increase in organic waste production, one of the biggest challenges facing the world recently is the effective use of organic wastes as well as recyclable wastes including plastics, tires and other recyclable municipal solid wastes [5]. Although the recycling of such waste has the primary priority, it is also a requirement to reduce the volume of these wastes [6,7]. Recycling is the process of converting wastes to secondary raw materials following physical and chemical processes. It is also called as the conversion of the recyclable materials such as cardboard, plastic, paper, glass and metal to a raw material or product after passing through multiple processes. Prior to conversion process, the separation of wastes is needed according to their types [8]. Energy production from recyclable wastes is significant in terms of economic benefits [9].

Packaging is any material used to contain, protect, handle, transport and present raw materials or goods. Packaging waste includes all the materials including the wastes defined in Regulation on the Management of Packaging Waste and the other non-recyclable materials. Packaging waste includes boxes, pallets, crates, bags, sacks, tapes, disposable foodservice packaging and also items being used to handle or support the products being sold or to be sold [10]. Reducing landfilling of plastics is one of the important priorities of The European Circular Economy package [11]. It was achieved largely by the legislations on recycling of postconsumer plastic packaging waste [12,13]. However, the rates of recycled plastics are still much lower than the production. The amount of annually traded waste plastics in the world in 2012 was about 15 million tons which is lower than 5% of globally produced plastics goods [14,15]. Landfilling

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and incineration processes can take place to reduce the environmental effects of such wastes, on the other hand unsanitary disposal or uncontrolled burning of plastics can lead to serious environmental issues [16].

Waste battery is called as battery which has completed its useful lifetime or unusable as a result of damage. Waste batteries should never be mixed with household waste. Therefore, waste batteries should not be disposed to the household trash [17]. The outer cover of waste batteries corrodes by time and the chemical materials and metals inside the battery spreads to soil and then into water. Heavy metals such as mercury and cadmium which is forming environmental pollution, damage living creatures consuming these contaminated foods. Different types of waste batteries should be separated according to their chemical structure [18,19, 20]. There are no waste battery recycling facility yet in use in Turkey. 'Regulation on the Management of Waste Batteries and Accumulators' was published by the Ministry of Environment and Forestry for the collection of waste batteries and accumulators on August 31, 2004. The responsibilities of battery manufacturers and importers and product distributors were defined by the Regulation [17].

Vegetable oil wastes when they are discharged to sewage or water bodies, cover the water surface and damage the water system. It accelarates the oxygen depletion in water by blocking the oxygen transfer from air to water. It leads to cloggings in pipes and increase in operational costs in waste water treatment plants. Vegetable oil wastes is responsible from the 25 % of total water pollution. The oil waste reaching to water bodies (sea, lake and river), harms fish, birds and the other creatures [21]. The used oils must be collected separately from other wastes. It also should not be discharged to the receiving environment such as sewage, soil and sea.

Electronic waste (e-waste) is the type of waste generated from the completing of the life of electronic instruments and finishing the duration of use. E-wastes are commonly composed from computers, printers, phones, fax and photocopy machines, wires and medical equipments [22]. The quick consumption of electric and electronic equipments to catch the technological innovations escalates the trade of these goods and it results in increase in the amount of electronic waste [23, 24, 25]. The rapid development of technology today provides alternative materials and low cost recycling methods. The electronic instruments renewed by developing technology is defined as waste and they are used as secondary raw materials with the higher order compliance for recycling. Almost all of the E-wastes can be recovered with available recycling methods in order to prevent to cause major problems because of their toxic composition [22, 25].

In this study, the variation of the amount of recoverable waste collected in Küçükçekmece province for 5 years period was examined. It is requested to collect and recycle the recoverable wastes separately from municipal solid wastes within the scope of the regulations applied in our country. With this study, it was tried to understand whether the waste collection policy observed after the regulations came into effect is effective.

2. MATERIALS AND METHOD

2.1 Study area

Küçükçekmece district is located on the western side of Istanbul province. Küçükçekmece district having 37.75 km2 area and 47.33 km perimeter, is located on major highways as Transit European Motorway (TEM-E80) and D100 (E5) that provide the Asia-Europe connection, as well as is located on the railway network which is centered in Sirkeci and extending to Europe. Istanbul Küçükçekmece district which has a high density of population and industrial activity. According to population data of 2015, 761,064 people live in the Küçükçekmece district [26]. The location of Küçükçekmece district in Istanbul province is shown in Fig 1.

Fig 1. Location of Küçükçekmece district in Istanbul

2.2 Collection of the data

The data of this study was formed by the arrangement of the data of domestic and industrial waste amounts reported regularly by the relevant units of the municipality on daily, weekly, monthly and yearly basis. In order to interpret the changes, the life styles of the population, the indoor and outdoor events held in the district, guest population of the district and the use of recreational areas are evaluated meticuolusly depending on the dates

3. RESULTS & DISCUSSION

The amount of packaging wastes collected by municipality shows large increases by the years in Küçükçekmece district boundaries (Fig 2). While the amount of recycled packaging waste amount is 3876 tons for the year of 2010, it is reached to 77601 tons with a 20 fold increase in the year 2015. The reason for this increase in the amount of packaging waste collected is thought to be the development of packaging waste collection policies for municipalities within the scope of the "Packaging Waste Control Regulation", which was enacted in 2011. For this purpose, district municipalities have placed recycle bins in many places of the city. In addition, public awareness-raising activities have begun to be implemented. When the collected packaging waste quantities were evaluated, an average of 35180 tons of packaging waste was collected during the 6-year period. The amount of packaging waste collected per

person, which was 5.56 kg capita^{-1} yr^{-1} in 2010, has reached 102 kg/capita/yr value in 2015. In Fig 3, the composition of collected packaging wastes is displayed. It is composed from %12 plastics, %1 metals and %87 paper and cardboards. In a study held in Eskisehir which is one of the metropolitan city of Turkey, the percent weight distribution of recyclable packaging wastes have been found as 50% paper and cardboard, 6.3% metal, 12.45% glass, and 28.1% plastics [27]. In another study conducted in Turkey basis, it is stated that the amount of recyclable wastes (as % weight) consist of 40–65% organics, 11.6-51.4% paper-cardboard, 8.3-40 % plastics, 1.6-17.1% metal and 3.3-17.1% glass [28]. Compared to the values in literature, the amount of paper as a component of packaging wastes collected in Küçükçekmece appears to be above the average of Turkey.

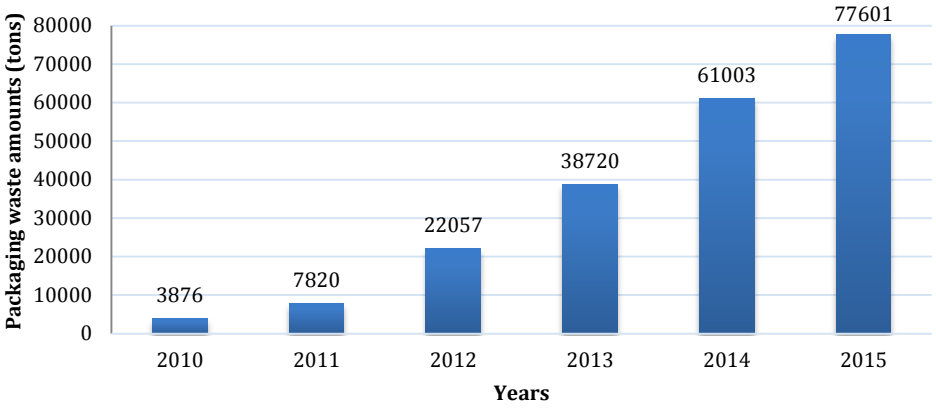

Fig 2. Recycled packaging waste amounts

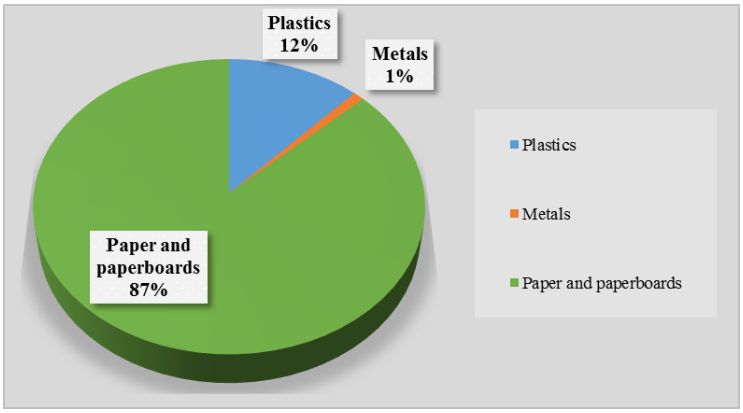

Fig 3. Material based distribution of collected packaging wastes

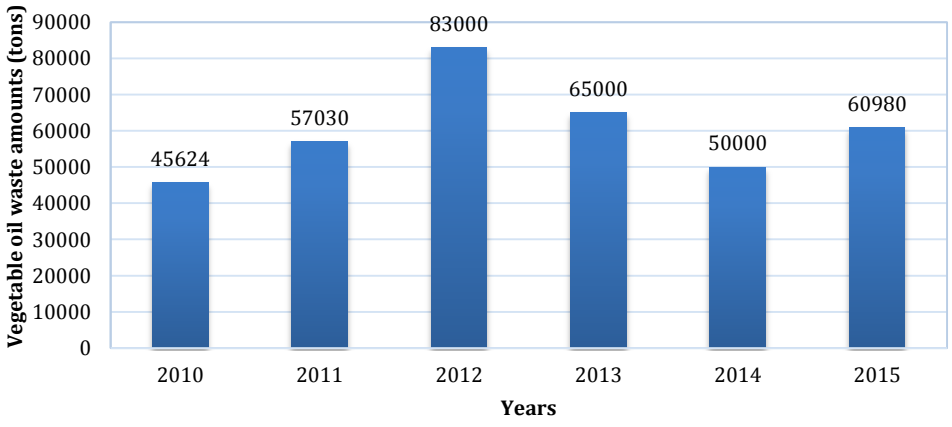

Fig 4. Recycled vegetable oil waste amounts

The amount of vegetable oil waste collected in Küçükçekmece district boundaries is showed fluctuations by the years (Fig 4). It has an increasing trend between the years 2010 and 2012, and it is reached to the highest value of the last six years in the 2012 year. There has been a decline in the years 2012-2014, then it is increased to 60,980 tons value in 2015. The regulation on "Control of Vegetable Waste Oils" was published in 2015. Prior to this regulation, it is considered that the amount of waste oil collected varies from year to year because there is no legal obligation to collect vegetable waste oils. As a legislative regulation on the collection of vegetable waste oils has started to be implemented by the year 2015, it is conceived that the amount of vegetable waste oil collected in 2015 is increased compared to the previous year. According to data of the 6 year period, the average amount of vegetable waste oil collected is 60.27 tons yr^{-1}. It is seen that the amount of vegetable waste oil collected in 2010 is 65 kg $capita^{-1}$ yr^{-1} and it reaches 80 kg $capita^{-1}$ yr^{-1} value in 2015.

As seen from the Fig 5, the amount of waste batteries collected in the Küçükçekmece district boundary was followed by a scattered trend by the years. It has the lowest value in 2009 with 3660 kg and the highest in 2013 with 7635 kg. The average annual amount of waste batteries collected was determined as 5333 tons for the 7 years period between 2009-2015. It is observed that the amount of waste batteries collected, which was 5.4 kg $capita^{-1}$ yr^{-1} in 2009, increased to 6.95 kg $capita^{-1}$ yr^{-1} in 2015. The lack of forceful regulations and efficient recycling applications leads to lower recycling amounts of wastes, for instance only about 2 percent of waste batteries were recycled in China [29-31]. Although it is estimated that the amount of waste batteries collected in the Küçükçekmece district is considerably less than the amount of waste batteries used, it is seen that the amount of waste batteries recovered in years is increasing gradually.

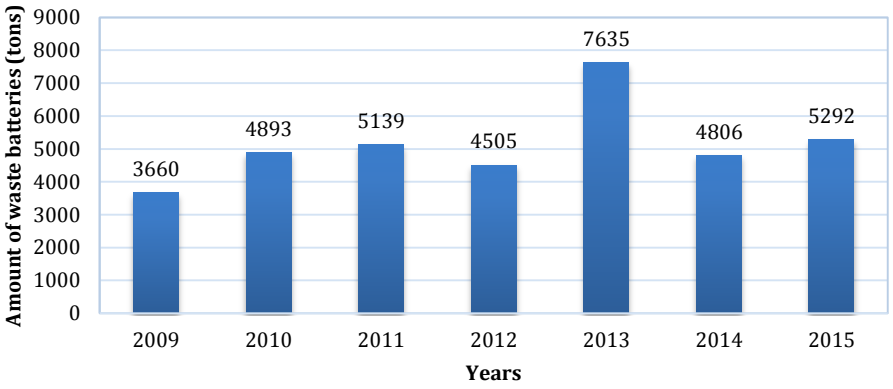

Fig 5. Amounts of recycled waste batteries

In Fig 6, the amount of electronic waste collected in the Küçükçekmece district, has followed a trend of ups and downs by the years. It is observed that an average of 1028 tons of electronic waste are collected annually over a period of 5 years between 2011 and 2015. While it has the lowest value as 600 tons in 2011, and it reached the highest value as 1,838 tons in the year of 2014. To put it another way the amount of collected electronic waste, which was 0.84 kg $capita^{-1}$ yr^{-1} in 2011, increased to 1.44 kg $capita^{-1}$ yr^{-1} in 2015. The largest producer of e-waste is the United States of America (USA) and the People's Republic of China (PRC), however when the per-capita electronic waste is calculated, Norway has the highest e-waste generation value with 28.3 kg. The waste production of Turkey with 503,000 tonnes ranks 17th place among other countries [32]. According to these values, it can be seen that the amount of e-waste recovered in Küçükçekmece is quite low.

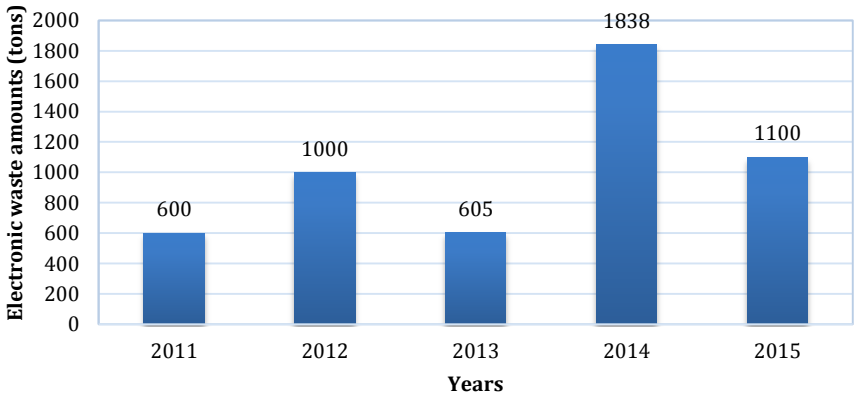

Fig 6. Amounts of recycled electronic wastes

The percent distribution of recycled waste quantities collected is shown in Table 1. From Table 1, it can be seen that the collected amount of waste vegetable oil has the lowest percentage of total recoverable waste. The amount of packaging waste collected increases over the years. The amount of packaging waste in recyclable wastes collected in 2010 was 44.0 % while it reached 92.3 % in 2015.

Table 1. Percent distribution of collected recyclable waste groups between years 2010-2015

Years	Packaging wastes (%)	Waste batteries (%)	Waste vegetable oils (%)	Electronic waste (%)
2010	44.0	55.5	0.5	0.00
2011	57.4	37.8	0.4	4.4
2012	79.8	16.3	0.3	3.6
2013	82.4	16.2	0.1	1.3
2014	90.1	7.1	0.1	2.7
2015	92.3	6.3	0.1	1.3

4. CONCLUSIONS

Examining the results, it can be said that a fairly stable and successful waste collection policy has been applied to the collection of packaging waste for Küçükçekmece-Istanbul. However, for the other types of recyclable wastes examined in this study, the amount of waste collected was found to be fluctuating around years. In the years that Küçükçekmece Municipality has organized training programs in order to raise public awareness, a significant increase is seen in the amount of recycled packaging waste, waste batteries, electronic waste and vegetable oil waste. It is thought that recycling awareness will be enhanced and lead to concrete results with periodical training programs in primary and secondary education institutions located in the district. In the period of this study, it is revealed that the amount of packaging wastes constitutes the major part of the examined waste groups according the percent distribution of total recyclable wastes. The possible cause of that could be the separation and collection of packaging wastes is easier and the recycling and reuse opportunities are more common. Recycling and reuse applications for the other examined waste groups like vegetable oils and e-wastes are not well known in this district. Therefore it is expected that the recycling rate of such waste will drastically increase with the innovations on waste management and collection.

REFERENCES

[1] K.O. Boadi, M. Kuitunen, "Environmental and health impact of household solid waste handling and disposal practices in third world cities: the case of the Accra Metropolitan Area, Ghana", *Journal of Environmental Health*, Vol. 68 (4), pp. 32-36, 2005.

[2] G.N.K. Rockson, F. Kemausuor, R. Seassey, E. Yanful, "Activities of scavengers and itinerant buyers in Greater Accra, Ghana", *Habitat International*, Vol. 39, pp. 148-155, 2013.

[3] B. Xue, X. Chen, Y. Geng, X. Guo, C. Lu, Z. Zhang, C. Lu, "Survey of officials' awareness on circular economy development in China: based on municipal and county level", *Resources, Conservation and Recycling – Journal*, Vol. 54 (12), pp. 1296-1302, 2010.

[4] P. Zheng, K. Zhang, S. Zhang, R. Wang, H. Wang, "The door-to-door recycling scheme of household solid wastes in urban areas: a case study from Nagoya, Japan", *Journal of Cleaner Production*, Vol. 163, pp. 366-373, 2017.

[5] J. Haydary, D. Susa, J. Dudáš, "Pyrolysis of aseptic packages (tetrapak) in a laboratory screw type reactor and secondary thermal/catalytic tar decomposition", *Waste Management*, Vol. 33 (5), pp. 1136–1141, 2013.

[6] A. Solak, P., Rutkowski, "The effect of clay catalyst on the chemical composition of bio-oil obtained by co-pyrolysis of cellulose and polyethylene", *Waste Management*, Vol. 34 (2), pp. 504–512, 2014.

[7] J.E. Rodríguez-Gómez. Y.Q. Silva-Reynoso, V. Varela-Guerrero, A. Núñez-Pineda, C.E. Barrera-Díaz, "Development of a process using waste vegetable oil for separation of aluminum and polyethylene from Tetra Pak", *Fuel*, Vol. 149, pp. 90–94, 2015.

[8] Ministry of Environment and Urban Planning, Recycling Applications on Waste Management, 2012.

[9] C. Guler, Z. Cobanoglu, Katı atiklar, 1st ed., Ankara, 1994.

[10] Regulation on the Management of Packaging Waste, Ministry of Environment and Urban Planning, 2011.

[11] European Commission, Communication from the commission to the *European parliament*, COM 614 December 2nd, 2015.

[12] European Parliament, European Parliament and Council Directive 94/62/EC, 1994.

[13] M.T. Brouwer, E.U.T. van Velzen, A. Augustinus, H. Soethoudt, S. De Meester, K. Ragaert, "Predictive model for the Dutch post-consumer plastic packaging recycling system and implications for the circular economy", *Waste Management*, Vol. 71, pp. 62–85, 2018.

[14] C.A. Veilis, "Global recycling markets - plastic waste: a story for one player – China", Report prepared by FUELogy and formatted by D-waste on behalf of International Solid Waste Association - Globalisation and Waste Management Task Force, *ISWA*, Vienna, 2014.

[15] H. Dahlbo, V. Poliakova, V. Mylläri, O., Sahimaa, R. Anderson, "Recycling potential of post-consumer plastic packaging waste in Finland", *Waste Management*, Vol. 71, pp. 52–61, 2018.

[16] G. Song, H. Zhang, H. Duan, M. Xu, "Packaging waste from food delivery in China's mega cities", *Resources, Conservation & Recycling*, Vol. 130, pp. 226–227, 2018.

[17] http://www.tap.org.tr, Avaliable:(2018)

[18] A. Agarwal, P. Pathak, D. Mishra, K.K. Sahu, "Solvent mediated interactions for the selective recovery of cadmium from Ni-Cd battery waste", *Journal of Molecular Liquids*, Vol. 173, pp.77-84, 2012.

[19] K. Provazi, B.A. Campos, D.C.R. Espinosa, J.A.S. Tenorio, "Metal separation from mixed types of batteries using selective precipitation and liquideliquid extraction techniques", *Waste Management*, Vol. 31 (1), pp. 59-64, 2011.

[20] H. Mahandra, R. Singh, B. Gupta, "Recycling of Zn-C and Ni-Cd spent batteries using Cyphos IL 104 via hydrometallurgical route", *Journal of Cleaner Production*, Vol. 172, pp.133-142, 2018.

[21] http://cevreonline.com, Avaliable: (2018)

[22] L. Zhang, Z. Xu, "A review of current progress of recycling technologies for metals from waste electrical and electronic equipment", *Journal of Cleaner Production*, Vol.127, pp.19-36, 2016.

[23] A. Kumar, M. Holuszko, D.C.R. Espinosa, "E-waste: an overview on generation, collection, legislation and recycling practices", *Resources, Conservation and Recycling – Journal*, Vol. 122, pp. 32-42, 2017.

[24] C.R. de Oliveira, A.M. Bernardes, A.E. Gerbase, "Collection and recycling of electronic scrap: a worldwide overview and comparison with the Brazilian situation", *Waste Management*, Vol. 32 (8), pp. 1592-1610, 2012.

[25] P. Dias, A. Machado, N. Huda, A.M. Bernardes, "Waste electric and electronic equipment (WEEE) management: A study on the Brazilian recycling routes", *Journal of Cleaner Production*, Vol. 174, pp. 7-16, 2018.

[26] TURKSTAT, 2015, http://www.tuik.gov.tr, Available: (2018)

[27] M. Banar, Z. Çokaygil, A. Ozkan, "Life cycle assessment of solid waste management options for Eskisehir, Turkey" , *Waste Management*, Vol. 29 (1), pp. 54–62, 2009.

[28] N.G. Turan, S. Çoruh, A. Akdemir, O.N. Ergun, "Municipal solid waste management strategies in Turkey", *Waste Management*, Vol. 29 (1), pp. 465–469, 2009.

[29] K. Huang, J. Li, Z. Xu, "Enhancement of the recycling of waste Ni–Cd and Ni–MH batteries by mechanical treatment", *Waste Management*, Vol. 31 (6), pp. 1292-1299, 2011.

[30] W. Yang, "Problems exposed in the domain of recycling and using of battery in China", *Environment*, Vol. 1, pp. 68–71, 2007.

[31] M. Zhang, J. Peng, Y. Cao,"Technological development of waste battery recovery and treatment", *Environmental Sanitation Engineering*, Vol. 16, pp. 18–21, 2008.

[32] A.A. Gunduzalp, S. Guven, "Atık, çeşitleri, atık yönetimi, geri dönüşüm ve tüketici: Çankaya belediyesi ve semt tüketicileri örneği", *Hacettepe University E-Journal of Sociological Research*, (http://www.sdergi.hacettepe.edu.tr/makaleler/Atik-Cesitleri-Yonetimi-GeriDonusumVeTuketici.pdf), pp. 1-19, 2016.