Environmental Research & Technology, Vol. 4 (2), pp. 126-133, 2021

Environmental Research & Technology

http://dergipark.gov.tr/ert

RESEARCH ARTICLE

Waste management and zero waste practices in educational institutions

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ABSTRACT

In this study, the situation of waste management and zero waste applications in educational institutions was investigated in Turkey. For this purpose, the wastes collected and separated within the scope of zero waste and the wastes collected without separating them in trash cans were determined at certain periods and the total amount of waste generated per unit time and per person was calculated for an engineering faculty, vocational school, high school and primary school. A questionnaire study was conducted to determine the viewpoints of the students studying at the engineering faculty on zero waste management. According to the obtained data, the amount of waste collected in the faculty was calculated as 184 kg day^{-1} and only 27 kg day^{-1} of this amount is being recycled. Considering all types of waste in the whole schools, waste generation rates were found to be 17,6, 32,3, 93,7 and 113 g person^{-1} day^{-1} respectively for primary school, high school, vocational school, and engineering faculty. One of the important results obtained in the study is that the necessary training and awareness-raising activities in zero waste implementation are very important, and every stage from the reduction of the number of trash cans to the correct placement of zero waste sets requires detailed planning.

Keywords: Waste management, zero waste, educational institution

1. INTRODUCTION

According to the Waste Management Regulation of Turkey, waste refers to any substance that is or has to be disposed of or discarded to the environment by the manufacturer or the person who actually owns it [1]. Waste generation is a part of human existence. Differences in the quality, quantity and composition of the waste are associated with various factors such as cultural, economic, social and financial situation [2]. Waste management is carried out by using methods, such as collection, transport, storage, processing, recovery, disposal to minimize harmful environmental effects.

In developed countries, it is imperative to develop waste management strategies for each institution. In the USA, 80% of colleges and universities are using waste reduction and recycling strategies based on waste characterization studies. For example, at Brown University, a waste management program has been implemented since 1972 and currently 31% of waste is recycled. In the USA, it was stated that 53% and 30% of the total waste was recycled in Colorado State University and Florida University, respectively [3]. In the other hand, waste management is a basic public health service that is often neglected and faces a number of problems in developing countries [2, 4, 5]. Various researchers have stated that the most problematic functional element faced by waste management in developing countries is related to increased waste generation, high waste management costs, rapid population growth, insufficient infrastructure and insufficient expertise [6-9].

"Zero Waste", an important component of waste management today, is a philosophy that expresses the goal of collecting and recycling separately at the source in case of occurrence of waste, and provides a holistic waste management from source to disposal. The zero waste philosophy is considered to be the one of the most holistic innovation for the twenty-first century to reach a true sustainable waste management system understanding. The term "zero waste", which was first introduced in 1973 to save natural resources from chemicals, has become a

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Received 27 February 2021; Received in revised form 26 April 2021; Accepted 18 May 2021
Available Online 25 May 2021
Doi: https://doi.org/10.35208/ert.887751

This paper has been presented at 5th International Symposium on Environment and Morals, 2020, Istanbul, Turkey

management approach that has become both an aim and a goal to overcome waste problems nowadays. Zero waste target has been adopted as part of waste management strategies in many cities around the world [10].

Although there are many studies in the literature on the management of domestic or municipal waste, the number of studies on the education sector is limited [11, 12]. Mainly, among institutions and organizations, especially educational units are the institutions that are obliged to act responsibly towards the environment due to their ethical and moral concerns and are expected to be leaders in the environmental protection actions [13]. Campus waste characterization studies are relatively low cost when carefully planned [14, 15]. Studies have indicated that the waste generated in educational institutions has a very high recycling potential and 55-90% of the waste stream in universities can be recycled [15-18].

In Turkey, "Zero Waste Regulation" came into force on 12.07.2019 [19]. The purpose of the regulation is to regulate the procedures and principles regarding the minimization and prevention of waste generation, establishment of an effective collection system for separate collection of waste at its source, and establishment of an effective zero waste management system in order to ensure the recycling/recovery of waste. In the calendar of "points to be implemented" specified in the annexes of the regulation, the transition year for "educational institutions with more than 250 students", which is the subject of this study, is stated as 31 December 2020. Looking at the practices in Turkey, in educational institutions, in this sense, it is seen that start realization of studies and awareness-raising activities.

In the study, the amount of waste collected and separated within the scope of zero waste and the amount of waste collected without separation was determined at certain periods in an engineering faculty, a vocational school, a high school and a primary school. With the data obtained, the total amount and type of waste generated per unit time and per person in each school was calculated. Studies were carried out in most densely populated districts of Tekirdağ, which is one of Turkey's big cities. A questionnaire study was also conducted to determine the viewpoints of the faculty students on zero waste management.

2. MATERIALS AND METHOD

2.1. Study area and educational institutions

The study was carried out in Tekirdağ province in the Marmara Region of Turkey. Tekirdağ is located at northwest of Turkey and north of the Sea of Marmara. The province, which has a developed transportation network, had an agriculture-based industry until 1970, but after 1970 it industrialized rapidly, especially some districts. According to 2020 data, the city has a population of 1.081,065 [20]. In Tekirdağ, domestic solid wastes have been disposed in the Solid Waste Regular Storage Facility of Tekirdağ Metropolitan Municipality since 2018.

There are 32 kindergartens, 149 primary schools, 137 secondary schools, 95 high schools and 44 private schools in Tekirdağ [21]. Tekirdağ Namık Kemal University (TNKU), which also plays an important role in population movements within the city boundaries, continues its educational activities with a total of 44 units.

Within the scope of the study, waste management was examined in 4 educational institutions with different student profiles: primary school (PS), high school (HS), vocational school (VS) and engineering faculty (EF) affiliated to TNKU. Detailed evaluations were made in the EF. General waste management information of these institutions is given in Table 1.

2.2. Waste weighing

Waste weighing was carried out 8 times in the EF, in weeks with different characteristics (including the weeks of exams). In the other 3 schools, one week weighing process was carried out. Weighing procedures were carried out at different periods in each school between January-March 2019.

The collected wastes were weighed at the end of the relevant week, and all the weeks of weighing were selected from the weeks when the student population was dense. Weighing operations were done with a 1,000 kg capacity, 200 g precision, 80x90 cm platform size Weighing Scale-7516. In the study, both wastes from zero waste sets and wastes from trash cans were evaluated under 4 categories. The categories considered in the classification are given in Table 2. Organic waste measurements were carried out only in EF. Separation and weighing operations were carried out at 15 points in EF, 6 points in VS and HS, and 7 points in PS.

Table 1. Information on waste management in studied educational institutions

Education Institution	Number of students	Number of Staff*	Zero Waste Set number	Number of Recycling Bins	Number of Trash Cans	Zero Waste Bins Emptying Frequency
Engineering Faculty (EF)	3911	149 (4)	7	13	243	One time per week
Vocational School (VS)	600	63 (3)	6	-	35	One time per ten days
High School (HS)	853	60 (11)	7	-	48	One time per week
Primary School (PS)	1178	52 (5)	-	4	60	One time per week

** The value in parentheses is the number of servants responsible for the collection and transportation of wastes at the school.*

Table 2. Waste categories

Category	Definition
Paper	Colored and colorless paper, notebooks, books, cardboard
Plastic	PET bottle, HDPE and other plastics
Glass	All glass materials
Metal	Aluminum cans, cans, iron and non-aluminum materials
E-waste	Electronic wastes
Other	Wastes remaining after all other wastes have been separated

The steps followed during weighing were: (i) Preparation of a suitable container and weighing instrument, (ii) determining the weight of the empty box, (iii) filling the box with segregated garbage and (iv) weighing the box with the garbage.

The formula used for determination of waste generation is:

$$WG=\frac{(W_T-W_b)}{p\ x\ t_s}\ (\text{kg per capita}^{-1}\ \text{day}^{-1}) \quad (1)$$

where W_b and W_t are the weights of the box when it is empty and full, respectively. p is the number of people at the time of waste collection; and ts is the period the waste is collected.

The following determinations were made for the obtained data within the scope of the study:

- The total amount of waste generated per unit time and the amount of waste per person
- Waste amount thrown into zero waste sets/recycling boxes
- Whether the wastes thrown into zero waste sets/recycling boxes are thrown into the right boxes
- Amount of waste thrown into trash cans
- Amount of recyclable wastes thrown into trash cans

2.3. Survey study

The survey has been conducted only in the engineering faculty. A total of 305 students, 103 women and 202 men, from 8 different engineering departments, participated in the 9-question survey. There were two groups of questions in the questionnaire. In the first group of questions, there were 7 questions and one of the "Yes/No/Partial" answers was expected from the students. The second group of questions, consisting of 2 questions, was formed in 5 options to understand general knowledge and tendency. The obtained information was evaluated according to the department and gender of the students.

3. RESULTS

According to the findings obtained from waste separating and weighing studies, the estimated daily waste amounts for each school, from zero waste sets, recycling bins and garbage bins are given in Table 3 on the basis of waste types.

3.1. Engineering faculty (EF)

Waste amounts in zero waste sets, recycling bins and trash cans on 8 different weeks were determined in the EF (Table 3). According to the results a total of approximately 184 kg of waste per day was collected and only 33 kg of it was separated. The total separation rate of the paper-cardboard wastes was only 26% in the faculty. Plastics were collected separately in the rate of 39% and metals by 42%. The separation rate of glass wastes was very high with 97%.

In the study, it was determined whether the wastes thrown into each zero waste box were in the correct boxes. In Fig 1, the matching of waste types detected in each zero waste box is given. In the figure, percentages painted in blue refer to waste thrown into the correct boxes, and percentages painted in red refer to waste thrown into the wrong boxes. Accordingly, 68-100% of the waste collected in the paper-box was paper or cardboard. The wastes in the paper-box were "Other" group and "Plastic" group, respectively, apart from paper. It has been determined that the waste collected in boxes for plastic is between 80-100% plastic. The most common type of wrong waste thrown into plastic boxes was paper. It was determined that 63-100% correct separation was achieved in boxes for glass and the highest amount of plastic and paper waste was disposed in these boxes after glass waste. Correct collection rates in boxes for metal have fallen down to 30% and the most plastic wastes has been thrown into these boxes.

The separation of waste types thrown into trash cans according to the weighing point is given in Figure 2. It was observed that there were recyclable wastes in trash cans, and especially paper and plastics in classrooms were thrown into trash cans. The paper wastes in the trash cans were generally lecture notes, and the plastic wastes were PET water bottles. As seen in Fig 2, 38% of the wastes thrown into trash cans in classrooms was paper waste, 49% was plastic waste and only 10% was non-recyclable wastes. In academic staff offices, 52% of the wastes were non-recyclable, 38% paper and approximately 10% plastic waste.

Table 3. Total daily waste amount and types in schools

School	Waste type	Trash Cans (g day^{-1})	Zero waste sets (g day^{-1})	Recycling boxes (g day^{-1})	Total (g day^{-1})
Engineering Faculty (EF)	Paper	21.612	5.975	1.494	29.080
	Plastic	10.819	5.401	1.350	17.570
	Glass	611	13.535	3.384	17.530
	Metal	1.837	1.054	264	3.154
	Other	115.300	763	191	116.255
	Total	150.180	26.727	6.682	183.590
Vocational School (VS)	Paper	5.325	1.209		6.534
	Plastic	2.500	694		3.194
	Glass	-	7.589		7.589
	Metal	-	23		23
	Electronic+Battery	-	200		200
	Other	18.358	1.591		19.950
	Total	26.183	11.306		37.489
High School (HS)	Paper	4.851	928		5.780
	Plastic	2.091	1.373		3.465
	Glass	-	3.735		3.735
	Metal	-	105		105
	Other	1.817	0		1.817
	Total	8.759	6.142		14.902
Primary School (PS)	Paper	1.743		4.654	6.398
	Plastic	697		2.211	2.908
	Glass	-		1.607	1.607
	Metal	1.260		579	1.839
	Other	237		0	237
	Total	3.937		9.051	12.988

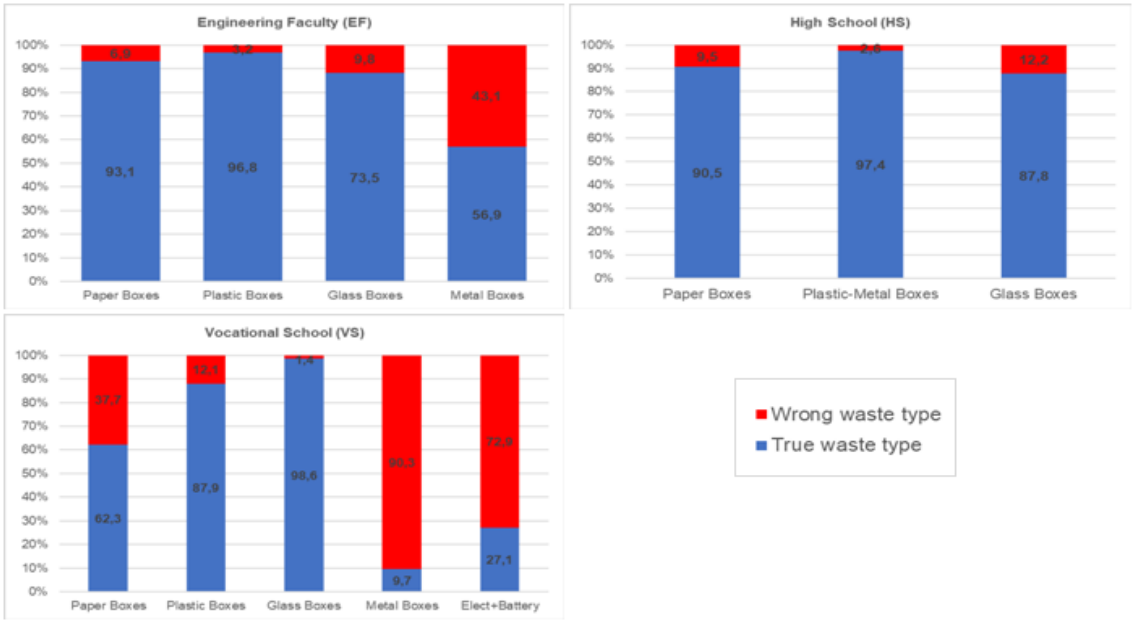

Fig 1. Average correct separation rates in zero waste sets

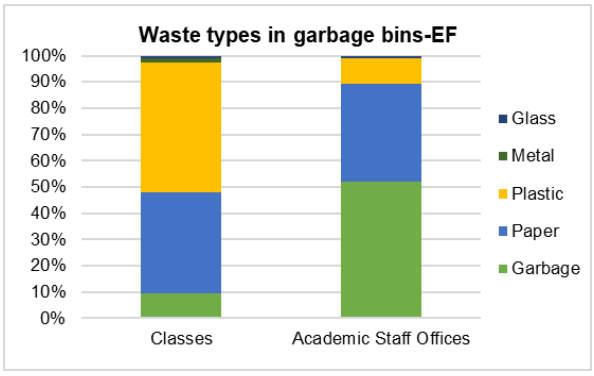

Fig 2. Separation rates in trash cans - Engineering Faculty (EF)

3.2. Vocational school (VS)

The daily total amounts of wastes in the VS are given in Table 3. As can be seen, "electronics+battery wastes" were also included in the zero waste sets in the school. Accordingly, approximately 38 kg of waste was collected in the school and 11 kg of this was separated. 60% of the collected waste was glass waste and 10% is paper waste in zero waste sets.

In Fig 1, the matching of waste types detected in zero waste bins in VS with the relevant waste bins is given. Accordingly, it was determined that 40% -90% of the waste collected in the box of paper was paper, and the highest amount of plastic waste was disposed in these boxes except paper. It was observed that the large amount of waste collected in plastic and glass boxes was generally collected in the correct box. Metal and electronics+battery boxes have often been the ones with the most unsuccessful separation. Waste with recyclable potential, other than garbage, has also been identified in trash cans in the school. According to the average values, 20% of the waste accumulated in the trash cans was paper and 10% was plastic waste.

3.3. High school (HS)

Total amounts of waste collected in zero waste and trash cans in the HS are given in Table 3. Accordingly, approximately 15 kg of waste was collected in the school and 6 kg of it was separated and recycled. Plastic and metals were collectively collected in zero waste bins at the school. 60% of the wastes collected in all zero waste bins were glass, 15% paper and 22% plastic waste. Wastes with recyclable potential, other than garbage, have also been identified in garbage cans. According to the average values, 55% of the waste accumulated in trash cans was paper and 24% was plastic waste.

The result of determining whether the wastes thrown into the zero waste sets were in the correct boxes is given in Fig 1. Accordingly, a correct distinction was made between 70-100% in the box for paper, and 98% in the box for plastic+metal. The correct separation rate for the glass was 80% and above.

3.4. Primary school (PS)

In PS, total amounts of waste are given in Table 3. Recyclable waste is collected in a single box throughout the school. Accordingly, a total of approximately 13 kg of waste was collected at the school and only 9 kg of it was recycled. 51% of the collected waste was paper, 24% plastic and 18% glass waste. Because of there was only one box, the correct waste separation study in the school could not be done.

3.5. Survey study

Two groups of questions were formed in the questionnaire. Yes/No/Partial answers were given to the 1st group question. Questions and answers, given by the whole population, are given in Fig 3. Accordingly, 99% of the participants stated that recycling is important, 53% of them discard their wastes in appropriate waste bins and 59% of them use the recycling bins during their time at school. 55% of the participants think that the zero waste application is not applied correctly at their school.

Looking at the answers given to the 2nd part of the questionnaire (Fig 3b), 90% of the participants stated that the waste that cannot be recycled is "Vegetable and fruit wastes"; 70% of them stated that the most important item to be recycled is "plastic bottle".

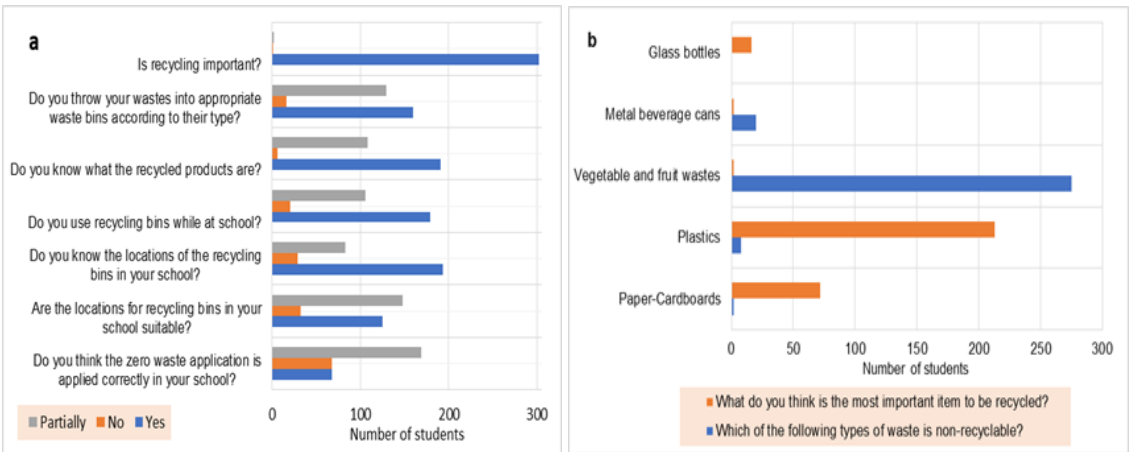

Fig 3. Some of the questions and answers given (a): Part 1 (b): Part 2

In the questionnaire answers, a comparison was made between the departments of students and the answers of women and men. In general, faculty students have a significant knowledge and desire on zero waste and recycling; it can be said that environmental engineering students gave more accurate answers, as expected, especially in some knowledge-based questions, and that environmental engineering and female participants were more sensitive about throwing waste into recycling bins.

4. DISCUSSION

The daily amount of wastes collected from 4 educational institutions and calculated/estimated daily values per person are given in Table 4. The daily total weighing data was divided by the school population to obtain the daily amount of waste generated per person. Since the number of people in the institutions at the time of weighing changed depending on the education period (weeks of exam, class, holiday, etc.), the occupancy rate was taken as 60-80% for all schools. Considering all types of waste in the whole school, the daily waste amount per person was found to be 113 g person^{-1} day^{-1} for the EF. This value has been calculated as 93.7, 32.3 and 17.6 for VS, HS and PS respectively.

As can be seen from Table 4, the highest amount values of waste per person and daily waste collected per person is obtained for the EF. The values obtained for high school and especially primary school are very low. The reason for this was thought to be that students in primary school spend most of their time during the lesson hours due to their age groups, leave the school at the end of the lesson, have low socialization opportunities and therefore do not create individual waste in common areas.

Waste generation rates, obtained in this study, were compared with various studies in the literature, and general values of Turkey, Istanbul and Tekirdag (Table 5). As can be seen, there are various values in the literature. The faculty campus based on this study is a small, and socializing places are few. Therefore, the values obtained for faculties and vocational schools are generally low compared to other campus values. However, some campus values appear to be in line with the research [16, 22-24]. The values obtained for HS and PS remain at below these levels. On the country and provincial basis, waste generation rates remain at very high levels as expected. It can be said that approximately 10% of per capita waste generation for a university student is realized within the campus.

Considering the variability of the literature studies and the results of this study together, it was determined that the comparison of the amount of waste generated in educational institutions should be made together with the information about the size and population density of the campus.

Table 4. Total and per capita waste in schools

School	Collecting Type	Total Waste (kg day^{-1})	Waste generation rates (g per capita^{-1} day^{-1})
Engineering Faculty (EF)	Zero waste sets	26,7	16,5
	Recycling boxes	6,7	4,1
	Trash Cans	150,2	92,5
	Total	183,6	113
Vocational School (VS)	Zero waste sets	11,3	28,3
	Trash Cans	26,2	65,5
	Total	37,5	93,7
High School (HS)	Zero waste sets	6,1	13,3
	Trash Cans	1,8	19
	Total	14,9	32,3
Primary School (PS)	Recycling boxes	9,1	12,3
	Trash Cans	3,9	5,3
	Total	12,9	17,6

Table 5. Waste generation rates in literature studies

University/Region		Waste generation Factor (g day^{-1} capita^{-1})	Reference
University of Northern British Columbia		59	[22]
University of Berkeley		210	[24]
Universiti Teknologi Malaysia		830	[25]
University of Dar es Salaam, Tanzania		193	[16]
Water Resources Institute, Tanzania		83	[16]
METU Ankara Campus		400	[26]
Gazi University		309	[27]
Mersin University		80	[23]
Tekirdag/Corlu province		1150	[28]
Turkey		1170	[20]
Istanbul		1140	[29]
This study	Primary school	18	
	High School	32	
	Vocational school	94	
	Engineering Faculty	113	

5. CONCLUSIONS

Zero waste management is an integrated system that includes the process from the prevention of waste generation to the collection of all wastes generated separately at their source according to their characteristics and types and sending them to licensed waste processing facilities. In Turkey, in July 2019 the "Zero Waste Regulation" was established and has taken many steps starting from the relevant state institutions. According to the regulation, educational institutions are among the institutions that should primarily switch to zero waste practice. Waste management is more important and easier to implement, given the educational institutions, the types of waste that are generated, the availability of trained staff and students, and the institutions that should lead the society.

Within the scope of this study, a research has been carried out on the zero waste application in 4 educational institutions at different levels and the level of this application in terms of waste separation. According to the information obtained, waste generation per capita and success in correct waste separation increases as the education level increases. At this point, it was thought that the duration of students' staying at school and socializing was directly related to the time of waste generation. On the other hand, considering the primary, secondary and high schools studied, it is understood that there is a lower level of participation in the zero waste application at the administrative level, especially in public schools.

Another result obtained is that the strategies to be determined in the application of waste separation at the source are very important for the efficiency of the application. It is most important to carry out the necessary training and awareness studies in the institution where the zero waste application will start, and to reduce the number of garbage bins where all waste is disposed together. No garbage bins should be placed in areas where most of the waste types generated are recyclable, especially in classrooms. Correct location of zero waste bins is one of the most important issues. It is thought that providing an income for institutions by recycling the wastes and using the income to be obtained in activities that will increase the awareness of students will also increase the efficiency of zero waste practices.

ACKNOWLEDGMENT

We would like to thank Tekirdağ Namık Kemal University administration and students, Çerkezköy OSB Vocational and Technical Anatolian High School administration and Kapaklı Industrialists Primary School Management for their support and assistance in completing this study.

This study is presented in "5th International Symposium on Environment and Morals (ISEM2020)" as oral presentation in September 2020.

REFERENCES

[1]. Resmî Gazete, Atık Yönetimi Yönetmeliği (Waste Management Regulation), Number: 29314, 02.04.2015, Republic of Turkey Ministry of Environment and Urbanization. 2015.

[2]. A.O. Coker, C.G. Achi, M.K.C. Sridhar and C.J. Donnett, "Solid Waste Management Practices at a Private institution of Higher Learning in Nigeria," *Procedia Environmental Sciences*, Vol. 35, pp. 28-39, 2016.

[3]. C.A. Vega, S. Ojeda-Benítez and M.E. Ramirez-Barreto, "Solid waste characterization and recycling potential for a university campus," *Waste Management*, Vol. 28, pp. 21–26, 2008.

[4]. N. Addo-yobo Felix and A. Mansoor, "Households: passive users or active managers?

The case of solid waste management in Accra Ghana," *International Development Planning Review, Liverpool University Press*, Vol. 25 (4), pp. 373–389, 2003.

[5]. M.E. Kasseva and S.E. Mbuligwe, "Ramifications of solid waste disposal site relocation in urban areas of developing countries: a case study in Tanzania," *Resources, Conservation & Recycling*, Vol. 28, pp. 147–161, 2000.

[6]. L.A. Manaf, M.A.B. Samah and N.I.M. Zukky, "Municipal solid waste management in Malaysia: Practices and challenges," *Waste management*, Vol. 29, pp. 2902-2906, 2009.

[7]. M.O., Saeed, M.N. Hassan and M.A. Mujeeb, "Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia," *Waste management*, Vol. 29, pp. 2209-2213, 2009.

[8]. I.A. Al-Khatib, M. Monou, A.S.F. Abu Zahra, H. Q. Shaheen and D. Kassinos, "Solid waste characterisation, quantification and management practices in developing countries. A case study: Nablus district–Palestine," *Journal of Environmental Management*, Vol. 91, pp. 1131-1138, 2010.

[9]. A.E. Adeniran, A.T. Nubi and A.O. Adelopo, "Solid waste generation and characterization in the University of Lagos for a sustainable waste management," *Waste Management*, Vol. 67, pp. 3–10, 2017.

[10]. A.U. Zaman, "A comprehensive review of the development of zero waste management: lessons learned and guidelines," *Journal of Cleaner Production*, Vol. 91, pp. 12-25, 2015.

[11]. E. Baldwin and W. Dripps, "Spatial characterization and analysis of the campus residential waste stream at a small private Liberal Arts Institution," *Resources, Conservation and Recycling*, Vol. 65, pp. 107– 115, 2012.

[12]. E. Fagnani and J. Roberto Guimaraes, "Waste management plan for higher education institutions in developing countries*: The Continuous Improvement Cycle model," Journal of Cleaner Production*, Vol. 147, pp. 108-118, 2017.

[13]. R. Lozano, R. Lukman, F.J. Lozano, D. Huisingh and W. Lambrechts, "Declarations for sustainability in higher education: becoming better leaders, through addressing the university system," *Journal of Cleaner Production*, Vol. 48, pp. 10-19, 2013.

[14]. M.A.J. Felder, R.J. Petrell and S.J.B. Duff, "A solid waste audit and directions for waste reduction at the University of British Columbia, *Canada*," *Waste Management & Research: The Journal for a Sustainable Circular Economy*, Vol. 19, pp. 354-365, 2001.

[15]. C. Armijo de VQega, S.O. Benitez and M.E. Ramirez-Barreto, "Solid waste characterization and recycling potential for a university campus," *Waste Management*, Vol. 28, pp. 21-26, 2008.

[16]. S.E. Mbuligwe, "Institutional solid waste management practices in developing countries: a case study of three academic institutions in Tanzania," *Resources, Conservation and Recycling*, Vol. 35, pp. 131–146, 2002.

[17]. I.G. Mason, A. Oberender, and A.K. Brooking, "Source separation and potential re-use of resource residuals at a University campus," *Resources, Conservation and Recycling*, Vol. 40, pp. 155–72, 2004.

[18]. R. Moreira, T.F. Malheiros, J.F. Alfaro, T.B. Cetrulo and L.V. Ávila, "Solid waste management index for Brazilian Higher Education Institutions," *Waste Management*, Vol. 80, pp. 292–298, 2018.

[19]. Resmî Gazete, Sıfır Atık Yönetmeliği (Zero Waste regulation), Number: 30829, 12.07.2019, Republic of Turkey Ministry of Environment and Urbanization, 2019.

[20]. TUIK, (2016), Databases, Environment Statistics, Available: http://www.tuik.gov.tr/PreTabloArama.do?metod= search &araType=vt, [accessed 30 January 2021].

[21]. Republic of Turkey Ministry of Education, Available: https://www.meb.gov.tr/ (accessed 10 January 2021).

[22]. A. Gallardo, N. Edo-Alcon, M. Carlos, and M. Renau, "The determination of waste generation and composition as an essential tool to improve the waste management plan of a university," *Waste Management*, Vol. 53, pp. 3-11, 2016.

[23]. M. Yalvaç, M. Gündogdu, and E. Gündogdu, "Mersin Üniversitesi Çiftlikkoy Kampusu Katı Atık Karakterizasyonu ve Maliyet Analizi," Mersin: Mersin Üniversitesi, 2014.

[24]. Office of Sustainability and Energy, 2016. Waste, from Berkeley sustainability and energy, Available: http://sustainability.berkeley.edu/waste, (accessed 20 September 2020).

[25]. I. S. Zen, D. Subramaniam, H. Sulaiman, A. L. Saleh, W. Omar, and M.R. Salim, "Institutionalize waste minimization governance towards campus sustainability: A case study of Green Office initiatives in Universiti Teknologi Malaysia," *Journal of Cleaner Production*, Vol. 135, pp. 1407-1422, 2016.

[26]. E. Bahçelioglu, E.S. Bugdaycı, N.B. Dogan, N. Simsek, S.O. Kaya, and E. Alp, "Integrated Solid Waste Management Strategy of a Large Campus: A Comprehensive Study on METU Campus, Turkey", *Journal of Cleaner Production*, Vol. 265, pp.121715, 2020.

[27]. R. Oztürk, and G.Y. Isıldar, "Gazi üniversitesi Beşevler Kampüsü katı atıklarının geri kazanım potansiyeli". In: 2nd International Sustainable Buildings Symposium, pp. 752, 2015.

[28]. E. Tinmaz and I. Demir, "Research on solid waste management system: To improve existing situation in Çorlu Town of Turkey," *Waste Management*, Vol. 26(3), pp. 307-314, 2006.

[29]. N. Aydın, "Materials Flow Analysis as a Tool to Improve Solid Waste Management: A Case of Ankara," *Doğal Afetler ve Çevre Dergisi*, Vol. 6 (1), pp. 90-97, 2020.