

Driving Forces on Household Solid Waste Management Behaviors: A Research for the City of Izmir, Türkiye

Elif Duyuşen Güven¹, Görkem Akıncı,^{1,2*} Dilara Temel¹

¹Dokuz Eylul University, Department of Environmental Engineering, Tinaztepe Campus, 35390 Buca, İzmir, Türkiye.

²Dokuz Eylul University, Science and Technology Implementation and Research Center, Tinaztepe Campus, 35390 Buca, İzmir, Türkiye.

*Correspondence: gorkem.akinci@deu.edu.tr

SUBMITTED: 23 November 2022; REVISED: 20 January 2023; ACCEPTED: 24 January 2023

ABSTRACT: The proper solid waste recycling process starts at the houses with the attendance of the individuals. The presented study includes comprehensive research on the individuals' shopping and waste generation behaviors, awareness of waste management issues, readiness and willingness for source separation, and their self-evaluation and self-annoyance about waste generation. The current study was conducted by administering a detailed questionnaire to 300 people in Zmir, Türkiye's third largest city. The relationships between the answers given and the main factors affecting waste production were determined statistically. Principal component analysis (PCA) identified the key drivers of public behavior associated with waste generation and separation at the source. Through environmental sensitivity, including proper waste management behaviors, age is discovered to be a significant factor. Family phenomena, including stable life and family budgets (32.58%), awareness of people about their inappropriate and disproportionate behaviors towards consumption and waste generation (21.28%), and the impositions of urban life (9.37%) were found to be the major factors influencing waste management habits.

KEYWORDS: Public participation; waste management; solid waste recycling behavior; public awareness; principal component analysis (PCA).

1. Introduction

Solid waste recycling is the critical factor for sustained municipal solid waste management (MSW) on a global scale. It is known that, on a global scale, about 70% of the total collected urban solid waste ends up in non-sanitary and sanitary landfills and, 19% is recycled and 11% is used for energy recovery. At the same time, it is predicted that the number of people who do not receive waste management services will reach 5.6 billion by 2050 [1]. Since source separation starts at home, building a sustainable recycling system highly requires individuals' participation in curbside recycling programs. A number of variables influence the residents' participation in the recycling programs. Besides the demographic properties such as age, educational situation, and income levels of the participants, researchers indicated some other variables such as the legal enforcements for solid waste management, waste recycling facilities, provision of the collection container, collection frequency and day, the presence of economic

incentives, the type of residences, public awareness and knowledge, and the level of trust between the citizens and the program operators [2–11].

Individuals' waste recycling behaviors may be influenced by factors such as residents' level of knowledge and engagement with recycling, economic benefits, social effects, collection frequency, and family life styles [7, 12]. Feo and Gesi conducted a comprehensive investigation in the Salerno District in southern Italy and analyzed the people's environmental knowledge towards municipal solid waste management. The youngest and oldest citizens showed the lowest level of awareness for each district, and high education levels did not involve a high level of environmental awareness [13]. The goal of another study performed in Iran was to find factors preventing the participation of residents in source separation and recycling programs and to evaluate the respondents' willingness to pay for solid waste management services. The majority of the respondents showed inadequate knowledge and practice, and the working group seemed to be unhappy with the waste collection services, and they were less willing to pay for them [14]. Another study aimed to examine residential behaviors and attitudes towards biological municipal solid waste management in Dublin (Ireland). The majority of the respondents did not compost at home, depending on aesthetic considerations and facility-related constraints such as space limitations [15]. Zhang et al. (2012) conducted a study in Shanghai, China, to examine the economic and social factors that influence the public's willingness to pay for MSW separation. Lack of separation awareness and public education, low neighborhood participation, insufficient source separation systems, and mixed transportation of the wastes were the main obstacles to source separation [16]. A typical public awareness study was completed in China in 2020 with 268 participants in 10 cities. The factors affecting the public's waste management behavior, recycling knowledge, and willingness to participate were also investigated. In the study, we found that public awareness of proper waste management behavior and recycling knowledge was insufficient. While age is the most important sociodemographic factor affecting public awareness of HSW recycling, it has been observed that white-collar workers in working life, residents with higher education levels, and participants aged 20–50 exhibit less environmentally responsible behavior. In addition, manual workers, those with lower levels of education, those with higher monthly incomes, and older people tend to have poorer knowledge of HSW recycling [4]. In one of the articles, it is aimed to explore women's knowledge, attitudes and practices (KAP) towards municipal solid waste (MSW) management in Tehran, Iran. The results showed that an average of 70% of women had adequate knowledge and attitudes. A training was given to the working group on the subject, and after the face-to-face training, it was seen that the participants positively affected their practices on solid waste recycling and resource allocation [17]. In Greece, Ponis and his colleagues (2017) performed a study to discover the factors influencing the generation of household food waste and found that household behaviors towards shopping and eating habits were the significant food waste determinants [18]. Another study was conducted in the Athens metropolitan area (Greece) in order to link the households' family characteristics with the food waste prevention behaviors. Cooking habits were found to be positively related to better leftover handling, with the level of discomfort associated with food waste production motivating people to reduce food waste [8]. In Borås, Sweden, a close drop-off collection system for the recyclable wastes provided a significant decrease (28%) of packaging and newsprint in the residual waste, and an important decrease (70%) was also determined in the miss-sorted fraction in food waste bags with the use of new information stickers [19].

A study in Palestine aimed to investigate the barriers to recycling behaviors and make proposals to encourage the local population to increase participation in domestic solid waste recycling. The impacts of primary demographic data such as gender, level of education, age, and type of residence on recycling behaviors were recorded and investigated. A lack of awareness and knowledge about waste separation and storage practices was discovered to be the most significant barriers to proper solid waste recycling behaviors. Besides, any motivational payouts for recycling practices were found to be encouraging for people's active participation in the system [20]. In the study, which was conducted with 848 participants in Guilin, Guangxi Zhuang Autonomous Region, China, an extended Theory of Planned Behavior (TPB) model was used to analyze how people's attitudes, subjective norms, perceived behavioral control, and situational factors affect overall waste management behavior. The findings showed that individuals' attitudes and situational factors were the main predictors of their behavioral intentions. Intention and "perceived behavioral control" (awareness of waste management, source separation is easily adaptable to the recycling system, and waste management facilities are adequate) play an important role in predicting the behavior of separated domestic solid waste management [21]. Table 1 summarizes some of the previous literature studies on the socio-economic characteristics, behaviors, and habits of individuals who are influential in the source separation and solid waste management systems. Studies say that there are various relationships between the socio-economic status of people and their opinions, attitudes, and practices towards waste management; therefore, it is essential to conduct regional research revealing the participant profile to build effective source separation systems and ensure sustainability for proper waste management practices.

Although there are improving legal arrangements for proper solid waste management in Türkiye, landfilling is still the main waste disposal method [22]. According to the Turkish Statistical Institute's data, by the end of 2018, more than 32 million tons of waste were collected, but only 12% of the waste contributed to the economy through a variety of recycling and recovery operations [23]. In July 2019, the Zero Waste Regulation came into force, which focuses on resource conservation and waste recycling in Türkiye. This arrangement obligates all municipalities and public and private institutions in the country to establish their waste management systems by the end of 2022. The systems should involve source separation and separate collection of the recyclable wastes, with periodic reporting to the web-based system of the Ministry of Environment, Urbanization, and Climate Change [24]. In the coming period, a significant increase in the waste recycling rate is expected to gradually occur in Türkiye.

Despite the increasing laws and regulations on waste management in Türkiye, there are no studies highlighting the factors that affect the waste production of individuals or the factors that cause individuals to volunteer to participate in waste recycling. The current study focuses on people's shopping and waste production behaviors and habits, as well as their awareness, readiness, and self-assessment about waste management and waste recycling phenomena. Izmir, which is the 3rd largest metropolis in Türkiye, is chosen as the study area. The aim of the study is to achieve a detailed understanding of the waste generation behaviors of people and to find the driving forces behind waste generation, waste management, and recycling practices. These issues were investigated with a structured questionnaire, where the outputs were statistically evaluated by regression analysis and principal component analysis (PCA) in order to find out the major and common factors affecting individual waste generation and management behaviors.

Table 1. Studies on socio-economic factors influencing public participation for source segregated waste collection systems.

Country /City	Program	Factors	Impact	Ref
Canada, Ontario (2013)	Source separated organics collection, recyclables collection residual waste collection, semi-annual yard waste collection	Age, gender, household size, years at current address Food shopping and preparation habits; beliefs, policies, attitudes regarding waste and food Family lifestyles, food awareness, waste awareness, convenience lifestyles	Education and skill building studies could be useful for individuals Food waste is primarily a social issue Food waste policies should consider regional studies	[7]
Salerno, Italy (2010)	Source separation for 11 different components	Age, sex, occupation, education, cultural attitudes (habits of Tv watching, newspaper and book reading, internet), awareness related with municipal solid wastes, public opinion on waste management system	Lowest awareness was observed in the youngest and oldest participants Better awareness was obtained with higher cultural habits High education level did not show high environmental awareness	[15]
Shanghai, China (2012)	Source separation classified as 4 categories, according to treatment facilities	Age, gender, household population, education level, income level, occupation, years at current address, awareness and knowledge on MSW source separation, behaviours and actions regarding household waste separation, opinions to the suggested MSW source separation system, willingness to pay for MSW management system	Low separation awareness and public education, low neighborhood participation affect the behaviours of the respondents, willingness to pay for the system was directly related to income level and household population,	[18]
Abadan, Iran (2015)	Household wastes are mixed, daily collected, and disposed together with other kinds of waste	Age, gender, occupation, education, knowledge, attitudes and practices on SW reduction, source separation and recycling and SW collection	Recycling behavior significantly relates to household waste demeanor; Knowledge, attitude, and practice are significant predictors of recycling behavior; education level and occupation were two significant factors affecting residents' willingness to pay for the waste management system	[16]
Ramallah Al-Bireh district, Palestine (2019)	Disposal in landfills or in open dumps;	Gender, education, age, type of residence on recycling were studied.	Financial incentives, lack of information and awareness about recycling processes poor recycling facilities were detected as the strong barriers towards solid waste recycling behaviours.	[20]
Athens, Greece (2016)	Not mentioned	Education level, household location and income, family structure, waste prevention related behaviours (shopping planning, food storage, portioning, labelling, leftovers), cooking involvements	Food waste prevention is enhanced by the education levels of the respondents, cooking involvements and the feeling of annoyance about generating food waste.	[8]
Trabzon, Türkiye (2012)	Mixed collection	Age, education, occupation, income level, social insurance, household population, knowledge and behaviors of individuals towards SWM	Majority of the study group believe that source separation is significant, however only one third of them separate their wastes. Nearly all of the respondents of different socio-economic groups find it difficult to use different trashcans for source separation.	[20]

2. Materials and Methods

2.1. Data collection.

The survey took place in the urban areas of Izmir city by using a designed questionnaire that was implemented via face-to-face interviews. Crowded areas such as shopping malls, squares, and bazaars at different points of the city were selected for the interviews. These were the locations where people from all demographic structures of society could be found. The voluntary interviewees were selected randomly, and 300 respondents were obtained in the research who fully completed the questionnaire. The survey study was completed in approximately 30 days.

2.2. Structure of the questionnaire.

There are six sections in the questionnaire, consisting of forced-choice and scaled questions (Supplementary Materials Table 1). The first section includes the demographic data of the respondents, including age, education level, household population, and economic conditions. People were asked what income level they felt themselves to be at rather than the amount of their income at this stage because it was feared that participants would be uncomfortable declaring their salaries and thus provide incorrect answers. The second section was about the shopping behaviors of the participants. The respondents were asked about their most frequently used shopping places, where and how frequently they were shopping, and the shares of food and detergent materials in their shopping cart. The third section questioned the participants' waste generation habits, such as the daily waste generation amount, the frequency of producing food waste, and the ratio of food waste and packaging waste in the total daily waste. The fourth section aimed to reveal the participants' awareness and consciousness of waste management. Here, participants were asked if there was any intervention with waste before waste collection, how municipal waste was managed, what the appropriate disposal method was, and how separate collection practices should be. Section five of the questionnaire was designed to assess individuals' readiness and willingness to separate household solid waste at the source. In this part, the participants answered the questions "Have you ever separated your wastes at the source?" "Do you think source separation and collection will be successful?" and "Would you take part in source separation practice?" The final section (Section 6) aimed to highlight the participants' self-evaluation and self-annoyance about their waste generation habits. In this part, the respondents were asked if they knew the concepts of "expiration date" and "best before date." Then, they were asked how much they were annoyed about generating food waste. Finally, the participants responded to questions about how they evaluate their consumption and waste generation habits.

2.3. Statistical evaluation.

Responses from 19 questions were scaled for the statistical evaluation; regression analysis was conducted to define their inter-correlations, and factor analysis was achieved. Statistical analyses were performed using SPSS 24.0 for Windows (IBM Inc., Chicago, IL, USA). The input variables were the numbers scaled from 1 to 5, arranged in correlation with the responses to the questionnaire (Supplementary Materials Table 1). The Pearson correlation coefficient was calculated for regression analysis. Principal component analysis (PCA) was used to identify

the major factors influencing the waste management behaviors by applying Varimax rotation with Kaiser normalization. The data set was checked for the availability of sample size by using KMO and Barlett's Test. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was found to be 0.557, while the significance of Bartlett's Test of Sphericity was 0.0001; therefore, the sample size was found suitable to be evaluated by using PCA.

3. Results and Discussion

3.1. Socio-economic characteristics of the respondents.

Table 2 presents demographic data, where 83% of the participants were under the age of 40 and more than 63% had a bachelor's degree or more. The average number of residents in the households was calculated at 3.13, indicating that the majority of the study group were family members. Here, 51% of the participants were at the middle-income level, where 32% categorized themselves below this level and 17% were above.

3.2. Shopping behaviors.

It is expected that shopping habits and waste generation are related since consumption is directly related to shopping [25]. Here, 57% of the participants stated that they did their shopping in chain markets, while the rate of shopping from open farmers' markets (district bazaars) is 21.7%. For this case, this value is 35% for respondents with low income levels. This may depend on the price advantages of farmers' markets due to their lower operational expenses such as rental costs, utilities, etc. It was seen that 73% of the people did grocery shopping at least once a week, and 90% of the participants declared that 50% or more of their shopping list was food items. The ones with 75% food in their shopping carts were those with high incomes. This could be related to purchasing more and/or a wider variety of food than is actually required as a result of rising welfare. On the other hand, 80% of the participants stated that the share of cleaning materials in their shopping was in the range of 33%–10%. This shows that food and cleaning materials have considerable shares in shopping carts.

Table 2. The socio-economic information of the respondents.

Question	Response	Number	Incidence (%)
Age	18-25	123	41
	26-40	126	42
	41-55	39	13
	56-70	12	4
Education level	Primary school	13	4
	Secondary school	10	3
	High school	81	27
	Undergraduate	177	59
	Postgraduate	19	7
Income level	High income	8	3
	High to middle income	44	14
	Middle income	154	51
	Middle to low income	74	25
	Low income	20	7
Household population (person)	1	24	8
	2	67	23
	3	94	31
	4	76	25
	More than 4	39	13

3.3. Waste generation.

In this section, the respondents were first asked about their daily domestic waste in their houses. The mean value of the total responses was 2.82 kg/day per household; therefore, personal waste generation in the houses can be calculated as 0.90 kg/day/capital. This value is consistent with the data of the Turkish Statistical Institute for the urban solid waste generation, which is reported as 1.16 kg/day/capital [26]. A large share of this value belongs to household waste. It was observed that the income level, age, and education of participants were the only parameters not influencing the daily waste generation. For the study group, the average food waste of household waste was 35%. The frequency with which food waste was generated increased with income level. Besides, 67% of the respondents aged over 56 declared that their food waste production was negligible, while this ratio was only 30% for the youngest respondents. The share of cooked food in food waste is decreasing with increasing age; 83% of the participants over 56 years of age gave the response "about 10%," while this rate is only 42% for the age range of 18–25. The percentage of cooked food waste was also found to be associated with the economic conditions and decreased with decreasing income level. 74% of low-income level participants answered this question as 10%, whereas only 25% of high-income level participants gave the same response (Figure 1).

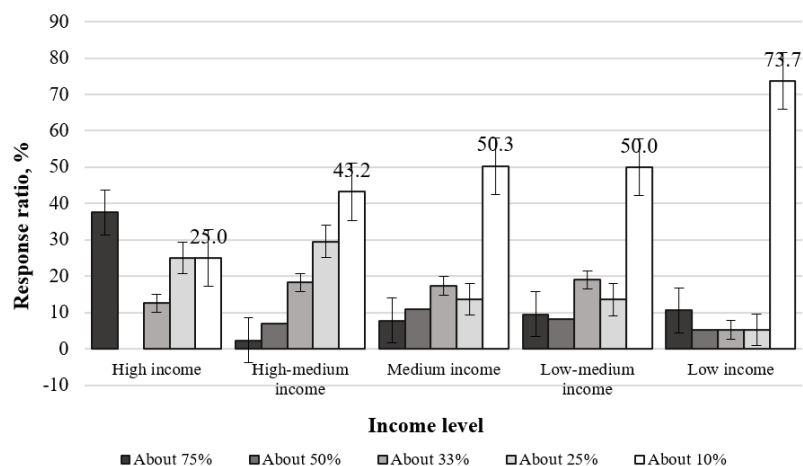


Figure 1. The results of the question “How much of the food waste is cooked food ?”-distribution according to income level.

3.4. Awareness and consciousness for waste management.

In this part, people's background knowledge on waste management has been evaluated. At first, the participants were asked if they knew about the impact of the scavengers on source separation. In Türkiye, commonly, street pickers (who work individually or for the subcontractor companies of the municipalities) collect the uncontaminated recyclable wastes from the street containers before the municipal services; however, 13% of the respondents were unaware of their presence. Afterwards, the participants answered the question of how domestic waste management was implemented in their city; while 17% of the participants believed wastes were dumped in uncontrolled sites, and 10% thought that wastes were disposed of in sanitary landfill facilities, As of the end of 2018, 84.7% of municipal solid waste collected in the province of Zmir was disposed of in sanitary landfills [27]. Surprisingly, 43% of the undergraduate respondents did not have knowledge about this issue. This finding is consistent with the findings of Feo and Gesi [13]. Later, the participants were asked how sustainable waste

disposal management should be. According to the answers given, 31% of the participants thought that separate collection and sanitary landfilling were appropriate methods. Here, it was recognized that unawareness increased with decreasing education level, since 33% of primary school graduates gave the answer "no idea," while postgraduates proposed more detailed and comprehensive methods. Lower education levels in the public have a negative impact on waste management awareness, and this finding is in agreement with the studies implemented in the developing communities having similar education levels, income levels, and cultures. [2, 28, 29].

3.5. Readiness and willingness for source separation.

Respondents were first asked about their household waste source separation experiences, which 71% of individuals replied that they did not have. The level of income and age of the participants had an impact on the answers given. The proportion of people with no waste separation experience showed an increasing trend as the income level decreased. In addition, 59% of the participants between the ages of 18 and 25 have never made any waste resource allocation, and this ratio has decreased to 25% in the age group over 56, which shows that environmental awareness develops with age. (Figure 2). This finding is in line with the study conducted in China, which states that there is low environmental awareness between the ages of 20 and 50 in the literature [4].

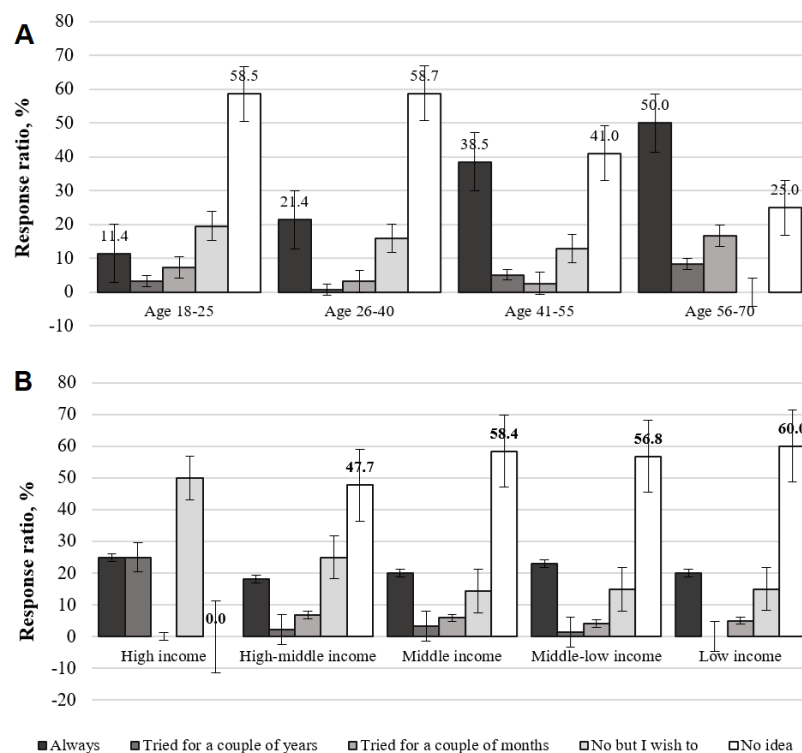


Figure 2. The participants' experience of separate waste collection-responses distribution according to age (A) and income level (B).

For the participants' idea of the best separate collection system, 6% of them did not express an opinion. Here, 29% of the participants preferred that the wastes be divided into five bins (food wastes, paper and pulp, plastics, glass, and metals). This was advocated by high-income level participants at a rate of 50%, while this rate dropped to 21% for low-income level participants. With decreasing education level, the answer for the two-bin collection system (food waste and

packaging waste), which is the most basic and simple separate collection, increased. The ratio of primary school graduates who gave the same answer was 54%, while it decreased to 26% for postgraduates (Figure 3).

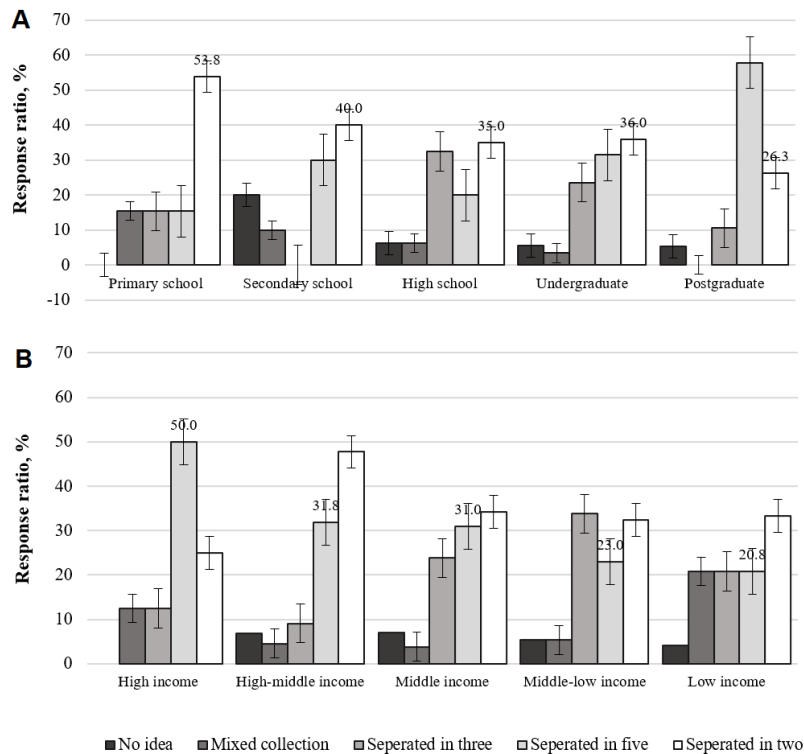


Figure 3. The results of the question “How should be an effective separate collection system?”-distributions according to education level and income level.

In this part, participants were also asked for their beliefs on whether the separate waste collection system would be successful. Here, 58% of the people responded positively to this question, and 28% believed that success was probable. Here, 58% of the people responded positively to this question, and 28% believed that success was probable. In the survey, only 7% of the participants had a positive belief or opinion on the subject. At the next question in this section, the participants answered whether they would take part in the separate collection practice. Here, 53% of the respondents expressed that they would definitely take part, while 35% showed a moderate willingness for participation. Beliefs in resource allocation and the willingness of participants are good indicators for the success of future comprehensive waste management practices, which is a key factor in ensuring adequate material flows to sustain the circular economy.

3.6. Self-evaluation & self-annoyance about waste generation habits.

Individuals' self-assessments related to waste management issues were investigated. At first, it was examined whether the participants knew the concepts "expiration date" and "best-before date." Here, 68% of the participants stated that they knew the concepts well and constantly checked them while shopping, while 25% of the people did not know the difference properly. Since consumption habits are directly related to waste generation, participants evaluated their consumption habits. The majority (59%) of the study group stated that their consumption habits were up to their needs, and 38% of the participants declared they had excess consumption

habits. Being uncomfortable with producing food waste was also asked, and 67% of the participants stated that they were annoyed a lot, while 24% stated that they felt moderately uncomfortable. It was astonishingly discovered that participants over the age of 56 expressed greater annoyance toward food waste generation. Lastly, the participants thought about how much trash they made. 13% of them said they made a lot of trash, while 40% said they made the right amount.

3.7. Statistical correlations.

The correlations among all the responses scaled for the demographic data (DD), shopping and waste generation habits (SH and WG), readiness and willingness (RW), and self-evaluation and self-annoyance (SESA) are given in the correlation matrix, which is presented in Supplementary Materials Table 2. For the correlations between DD, there was a significant inverse relationship between age and education level ($r: -0.302$, $p < 0.01$). It gives an insight about the structure of the survey participants. The education level of the older age participants is lower than those in the younger age group. Another significant inverse correlation was seen between education level and household population ($r: 0.152$, $p < 0.01$). In the relationship between SH, a high significant positive correlation was found between age and detergent purchasing habit ($r: 0.105$, $p < 0.01$) while a high significant negative correlation was observed between education level and detergent shopping rate ($r: -0.158$, $p < 0.01$). This situation shows that the detergent shopping rate is related to permanent settlement of the people of different ages. For the relationships between DD and WG, significant negative correlations for age-the frequency of food waste generation and age-ratio of cooked food waste in waste ($r: -0.109$, $p < 0.01$; $r: -0.162$, $p < 0.01$) were detected. This situation can be explained by the sensitivity of older people to create food waste. Wang et al. [4] also mentioned the environmental sensitivity increasing with age. Similarly, there was a significant inverse correlation between age and the packaging ratio in the waste ($r: -0.195$, $p < 0.01$), which can be explained by the older generation's preference for shopping from farmer's markets that include less packaged products. A significant positive correlation between the household population and the daily amount of waste is an expected finding ($r: 0.297$, $p < 0.01$). There was a significant positive correlation detected between age and separate collection experience ($r: 0.254$, $p < 0.01$), and another statistically meaningful correlation was determined between the education level and opinion of ideal separate collection system ($r: 0.160$, $p < 0.01$) showing that more comprehensive separate collection system consisting of more than two components was supported by highly educated participants. Elevating their environmental awareness of people with higher education has been emphasized in many studies in the literature [3, 4, 5, 20]. In the study, a negative correlation was found between age and consumption habits ($r: -0.138$, $p < 0.01$) showing that people consume less with increasing age. At the same time, the significant positive correlation detected between increasing age and discomfort in creating food waste revealed the sensitivity of the older generation to squandering ($r: 0.192$, $p < 0.01$).

The significant correlation ($r: 0.167$, $p < 0.01$) between shopping frequency and share of food supplies in grocery shopping shows that frequent shopping is mostly done for fresh food. On the other hand, the significant negative correlation ($r: -0.326$, $p < 0.01$) between the ratio of food items and detergent items in grocery shopping shows that these are the basic items in grocery shopping; as one increases, the other decreases. The frequency of grocery shopping is

significantly correlated with waste generation ($r:0.168$, $p<0.01$). The rate of food shopping and amount of consumption were also found to be significantly correlated ($r: 0.150$, $p<0.01$). This can be explained by consuming a higher variety of food products (such as packaged and canned meals or junk food and drinks) than basic nutritional supplies.

Significant positive correlations were determined among the daily waste production, the ratio of packaging wastes in the bulk waste ($r:0.149$, $p<0.01$) and the frequency of food waste generation ($r:0.167$, $p<0.01$). In addition to that, a strong positive relationship was observed between the frequency of food waste generation and the presence of cooked food in the waste ($r:0.310$, $p<0.01$). This indicates that food waste is largely composed of leftover, unconsumed cooked food rather than uncooked products such as rotten raw vegetables and fruits. The frequency of food waste generation was found to be related to consumption habits ($r:0.215$, $p<0.01$) and waste generation habits ($r:0.194$, $p<0.01$). Food constitutes the largest consumption item for people, and most of the waste generated from houses is food-based. This finding is consistent with Türkiye's average biodegradable waste interval of 40-80% and a recent study [30, 31] that found 52% biodegradables in zmir city municipal waste. Similarly, significant correlations were determined between the rate of cooked food and consumption behaviors ($r:0.156$, $p<0.01$) and waste generation habits ($r:0.165$, $p<0.01$). This situation can be explained by the fact that people living in the Mediterranean region prefer daily cooked fresh food in their diets and do not want to consume the previous day's meals [32, 33]. It may depend on the high daily average temperature of the region, which causes rapid deterioration of the leftovers from the previous days.

Positive and significant correlations were obtained between separate waste collection experience, awareness of an effective waste separation method, conviction that separate collection would be successful, and willingness to engage in this type of practice. This situation reflects the sensitivity, belief in the subject, and volunteerism of the people involved in the source separation. A significant relationship was observed between the separate waste collection experience and the knowledge of the consumption dates of the products ($r:0.180$, $p<0.01$), showing an expected level of awareness. On the other hand, there is a correlation between the separate collection experience and the annoyance of food waste generation ($r:0.154$, $p<0.01$). In addition, as this experience increases, people find themselves more successful in their waste generation habits, as evidenced by the significant negative correlation between these two components ($r:-0.225$, $p<0.01$). There is also a significant relationship between the extent of people's views on collecting waste separately and their consumption habits ($r:0.181$, $p<0.01$). Besides, people's discomfort about food waste production increases with their readiness to participate in the separate collection system ($r:0.153$, $p<0.01$). Finally, as expected, consumption habits are significantly found to be correlated with waste generation habits ($r:0.266$, $p<0.01$). This situation reveals that as consumption increases in society, an elevation in waste production becomes significant as a consequence.

3.8. Factor Analysis.

Principal component analysis (PCA) was carried out to identify the major factors influencing waste generation behaviors. The variances explained by principal components (PCs) accounted for 63.183% of the total variance in the analysis (Supplementary Materials Table 3), and six principal components were extracted as shown in the rotated component matrix (Table 3).

Table 3. Rotated component matrix for the response parameters.

Principal components	Rotated Component Matrix ^a					
	PC1	PC2	PC3	PC4	PC5	PC6
Variance explained	12.05	11.547	10.578	9.951	9.735	9.321
Age	0.787					
Education level	-0.571					
Source separation experience	0.528					0.491
Level of annoyance towards food waste generation	0.499			0.452		
Cooked food ratio in the food waste		0.795				
Food waste generation frequency		0.693				
Household population			0.803			
Amount of daily waste per household			0.765			
Shopping frequency				0.753		
Ratio of food supplies in grocery shopping				0.637		
Idea about effective separate collection system					0.863	
Evaluation on personal consumption behaviors		0.454			0.564	
Ratio of packaging waste in generated waste						0.858

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

^a Rotation converged in 7 iterations.

The first principal component (PC1) explains 12.05% of the total variance, and the highest factor loading coefficient was obtained for age (0.787), where separate waste collection experience (0.528) and annoyance towards food waste generation (0.499) were also loaded along with education level (-0.571). Since participants' ages, experience of separate waste collection, and sense of annoyance are in the same component, this factor presents the influence of the transition to a stable period of life, where possible, where previous economic experiences have brought discomfort about food waste production. Out of the three components, the participants' education level, which has a negative sign, corresponds to the fact that education in Türkiye has increased with decreasing age over the last few decades [34]. The level of annoyance was a strong motivational factor for separate collection, and this finding is in agreement with a study conducted in Greece [8]. High factor loading coefficients were obtained for the cooked waste ratio (0.795) and food waste generation frequency (0.693) in PC2, as well as the consumption behaviors (0.454), explaining 11.547% of the total variance. Here, respondents with high consumption routines admit that they produce food waste, most of which is cooked meals. People accept that they consume food unconsciously, which is mostly related to their shopping habits. The factor here can be stated as the awareness of people about their consumption, shopping, and waste generation behaviors. The household population (0.803) and amount of daily waste generated (0.783) were highly loaded in PC3, which explained 10.578% of the total variance. The amount of waste generated per household is expected to rise as the population grows. Based on the household population and waste amount data, the daily personal waste generation (PWG) rate was calculated. It was found that, as the household population increases, there is an exponential decrease in the PWG ($r = 0.979$). This result indicates that crowded households are more attentive in terms of shopping behaviors; therefore, PWG is lower than average. This factor is evaluated as the influence of being a family on the efficient use of income sources and waste production. PC4 explains 9.95% of the total variance and is mainly loaded with shopping frequency (0.753), the ratio of food supplies (0.637), and the level of annoyance (0.452). It is understood that frequent shopping is mostly done for food supplies. According to the 2019 results of the household budget survey, food and non-alcoholic beverage expenditures are as high as 20.8% across Türkiye [35]. In this study, 86% of participants assumed they were in the middle or lower income brackets; thus, the discomfort in producing food waste is primarily due to economic concerns rather than environmental concerns. The main

factor represented by PC4 can be counted as the budgetary effect. The significant impact of people's budgetary power and income level on waste generation behavior, as revealed in this study, is also indicated by studies conducted in the past years [2, 4, 6]. PC5 is loaded with the comprehensiveness of an ideal separate collection system (0.863) and the evaluation of personal consumption behaviors (0.564), where 9.735% of the total variance is explained. Here, people in urban life confess that they consume more than they need, while they propose comprehensive source separation systems. This approach of the participants can be explained by their desire to partially get rid of the feeling of guilt created by their inappropriate shopping habits. Finally, in PC6, a high factor loading coefficient for packaging waste ratio (0.858) and waste separation experience (0.491) were found together, explaining 9.371% of the total variance. Separate waste collection has become more common as people generate more packaging waste in their homes. This is an indicator of urban life, and it points to the increasing use of packaged products, and as a consequence, these wastes become noticeable. Because of the high volume of products consumed and waste generated, the experience of separate waste collection is now available to people living in cities.

4. Conclusions

In the current study, conducted in Izmir, Türkiye, living as a family is the primary factor that positively affects waste generation and management behaviors. The transition to a more stable life with increasing age, as well as economic factors such as family budgets, are determining factors in waste generation and management behaviors. The evaluations of this survey study showed that waste generation behaviors and environmental sensitivity towards waste recycling are mainly related to the life development and experiences of people and are not strictly dependent on their educational level. People's environmental sensitivity is also affected by their own awareness of how they behave in ways that are too much or too little in terms of consumption and waste. The willingness to collect waste separately at the source is independent of age, education level, and income. In our country, where family living is common, it is critical that the institutions in charge of transitioning to waste management services based on separate collection at the source determine residents' attitudes, bring and introduce proper waste source separation facilities, and persuade the public to participate.

Competing Interest

The author declares that there is no conflicts of interest.

Appendix A. Supplementary data

The following is the supplementary data related to this article: [Supplementary Materials](#)

References

- [1] Nanda, S.; Berruti, F.(2021). Municipal solid waste management and landfilling technologies: a review. *Environmental Chemistry Letters* 19, 1433–1456 (2021). <https://doi.org/10.1007/s10311-020-01100-y>.
- [2] Sultana, S.; Islam, M.S.; Jahan, F.; Khatun, F. (2021). Awareness and Practice on Household Solid Waste Management among the Community People. *Open Journal of Nursing*, 11, 349–366. <http://doi.org/10.4236/ojn.2021.115031>.

- [3] Meng, X.; Tan, X.; Wang, Y.; Wen, Z.; Tao, Y.; Qian, Y. (2019). Investigation on decision-making mechanism of residents' household solid waste classification and recycling behaviors. *Resources, Conservation and Recycling*, 140, 224–234. <https://doi.org/10.1016/j.resconrec.2018.09.021>.
- [4] Wang, H.; Liu, X.; Wang, N.; Zhang, K.; Wang, F.; Zhang, S.; Wang, R.; Zheng, P.; Matsushita, M. (2020). Key factors influencing public awareness of household solid waste recycling in urban areas of China: A case study. *Resources, Conservation and Recycling*, 158, 104813. <https://doi.org/10.1016/j.resconrec.2020.104813>.
- [5] Zen, I.S.; Noor, Z.Z.; Yusuf, R.O. (2014). The profiles of household solid waste recyclers and non-recyclers in Kuala Lumpur, Malaysia. *Habitat International*, 42, 83–89. <https://doi.org/10.1016/j.habitatint.2013.10.010>.
- [6] Tuoyo, O.J.A.; Hasnain, S.A. (2015). Analysis of public participation in sustainable waste management practice in Abuja, Nigeria. *Environmental Management and Sustainable Development*, 4, 180–193. <http://doi.org/10.5296/emsd.v4i1.7269>.
- [7] Parizeau, K.; Massow, M.V.; Martin, R. (2015). Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. *Waste Management*, 35, 207–217. <https://doi.org/10.1016/j.wasman.2014.09.019>.
- [8] Abeliotis, K.; Lasaridi, K.; Chroni, C. (2016). Food waste prevention in Athens, Greece: The effect of family characteristics. *Waste Management & Research*, 34, 1210–1216. <https://doi.org/10.1177/0734242x16672318>.
- [9] Drimili, E.; Herrero-Martin, R.; Suardiaz-Muro, J.; Zervas, E. (2020). Public views and attitudes about municipal waste management: Empirical evidence from Athens, Greece. *Waste Management & Research*, 38, 614–625. <https://doi.org/10.1177/0734242x20911708>.
- [10] Olukanni, D.O.; Pius-Imue, F.B.; Joseph, S.O. (2020). Public Perception of Solid Waste Management Practices in Nigeria: Ogun State Experience. *Recycling*, 5, 8. <https://doi.org/10.3390/recycling5020008>.
- [11] Zezhou, W.; Yan, Z.; Qiaohui, C.; Hao, W. (2021). Attitude of Chinese public towards municipal solid waste sorting policy: A text mining study. *Science of the Total Environment*, 756, 142674. <https://doi.org/10.1016/j.scitotenv.2020.142674>.
- [12] Castagna, A.; Casagrande, M.; Zeni, A.; Girelli, E.; Rada, E.C.; Ragazzi, M.; Apostol, T. (2013). 3R'S From citizens point of view and their proposal from a case-study. *UPB Scientific Bulletin Series D*, 75, 253–264.
- [13] Feo, G.D.; Gisi, S.D. (2010). Public opinion and awareness towards MSW and separate collection programmes: A sociological procedure for selecting areas and citizens with a low level of knowledge. *Waste Management*, 30, 958–976. <https://doi.org/10.1016/j.wasman.2010.02.019>.
- [14] Babei, A.; Alavi, N.; Goudarzi, G.; Teymouri, P.; Ahmadi, K.; Rafiee, M. (2015). Household recycling knowledge, attitudes and practices towards solid waste management. *Resources Conservation and Recycling*, 102, 94–100. <https://doi.org/10.1016/j.resconrec.2015.06.014>.
- [15] Purcell, M.; Magette, W. (2010). Attitudes and behaviours towards waste management in the Dublin, Ireland region. *Waste Management*, 30, 1997–2006. <https://doi.org/10.1016/j.wasman.2010.02.021>.
- [16] Zhang, W.; Che, Y.; Yang, K.; Ren, X.; Tai, J. (2012). Public opinion about the source separation of municipal solid waste in Shanghai, China. *Waste Management & Research*, 30, 1261–1271. <https://doi.org/10.1177/0734242X12462277>.
- [17] Zand, A.D.; Heir, A.V.; Tabrizi, A.M. (2020) Investigation of knowledge, attitude, and practice of Tehranian women apropos of reducing, reusing, recycling, and recovery of urban solid waste. *Environmental Monitoring and Assessment*, 192, 481. <https://doi.org/10.1007/s10661-020-08445-5>.

- [18] Ponis, S.; Papanikolaou, P.A.; Katimertzoglou Ntalla, C.A.; Xenos, K.I. (2017). Household food waste in Greece: A questionnaire survey. *Journal of Cleaner Production*, 149, 1268–1277. <https://doi.org/10.1016/j.jclepro.2017.02.165>.
- [19] Rousta, K.; Bolton, K.; Lundin, M.; Dahlen, L. (2015). Quantitative assessment of distance to collection point and improved sorting information on source separation of household waste. *Waste Management*, 40, 22–30. <https://doi.org/10.1016/j.wasman.2015.03.005>.
- [20] Kattoua, M.G.; Al-Khatib, I.A.; Kontogianni, S. (2019). Barriers on the propagation of household solid waste recycling practices in developing countries: State of Palestine example. *Journal of Material Cycles and Waste Management*, 21, 774–785. <https://doi.org/10.1007/s10163-019-00833-5>.
- [21] Ma, J.; Hipel, K.W.; Hanson, M.L.; Cai, X.; Liu, Y. (2018) An analysis of influencing factors on municipal solid waste source-separated collection behavior in Guilin, China by Using the Theory of Planned Behavior. *Sustainable Cities and Society*, 37, 336–343. <https://doi.org/10.1016/j.scs.2017.11.037>.
- [22] Kale, C.; Gökçek, M. (2020). A techno-economic assessment of landfill gas emissions and energy recovery potential of different landfill areas in Turkey. *Journal of Cleaner Production*, 275, 122946. <https://doi.org/10.1016/j.jclepro.2020.122946>.
- [23] Waste amount according to disposal method. (accessed on 23 January 2020) Available online: http://www.tuik.gov.tr/PreTablo.do?alt_id=1019. (in Turkish)
- [24] Official Gazette (2019). Zero Waste Regulation. Legislation enacted by Ministry of Environment and Urbanization. Gazette No: 30829, Ankara, Türkiye (in Turkish).
- [25] Janssens, K.; Lambrechts, W.; VanOsch, A.; Semeijn, J. (2019). How Consumer Behavior in Daily Food Provisioning Affects Food Waste at Household Level in the Netherlands. *Foods*, 8, 428. <https://doi.org/10.3390/foods8100428>.
- [26] Waste disposal amounts by disposal methods (tonnes/year) Izmir city in 2018. (accessed on 23 January 2020) Available online: <https://biruni.tuik.gov.tr/medas/?kn=119&locale=tr>. (in Turkish)
- [27] Database for Municipal waste statistics for Türkiye in 2018. (accessed on 23 January 2020) Available online: <https://data.tuik.gov.tr/Kategori/GetKategori?p=cevre-ve-enerji-103&dil=1>. (in Turkish).
- [28] Yasmin, S.; Rahman, M.I. (2017). A Review of Solid Waste Management Practice in Dhaka City, Bangladesh. *International Journal of Environmental Protection and Policy*, 5, 19–25. <https://doi.org/10.11648/j.ijepp.20170502.11>.
- [29] Shahzadi, A.; Hussain, M.; Afzal, M.; Gilani, S.A. (2018). Determination the level of knowledge, attitude, and practices regarding household waste disposal among people in rural community of Lahore. *International Journal of Social Sciences and Management*, 5, 219–224. <https://doi.org/10.3126/ijssm.v5i3.20614>.
- [30] Akinci, G.; Guven, E.D.; Gok, G. (2012). Evaluation of waste management options and resource conservation potentials according to the waste characteristics and household income: A case study in Aegean Region, Türkiye. *Resources, Conservation and Recycling*, 58, 114–124. <https://doi.org/10.1016/j.resconrec.2011.11.005>
- [31] Bölükbaş, A.; Akıncı, G. (2018). Solid waste composition and the properties of biodegradable fractions in Izmir City, Türkiye: an investigation on the influencing factors. *Journal of Environmental Health Science and Engineering*, 16, 299–311. <https://doi.org/10.1007/s40201-018-0318-2>.
- [32] Radd-Vagenas, S.; Kouris-Blazos, A.; Singh, M.F.; Flood, V.M. (2017). Evolution of Mediterranean diets and cuisine: Concepts and definitions. *Asia Pacific Journal of Clinical Nutrition*, 26, 749–763. <https://doi.org/10.6133/apjcn.082016.06>

- [33] Chatzopoulou, E.; Caroch, M.; Di Gioia, F.; Petropoulos, S.A. (2020). The beneficial health effects of vegetables and wild edible greens: The case of the Mediterranean diet and its sustainability. *Applied Sciences*, 10, 9144. <https://doi.org/10.3390/app10249144>
- [34] Turkish educational statistics, 2020. (accessed on 23 January 2020) Available online: <https://data.tuik.gov.tr/Kategori/GetKategori?p=egitim-kultur-spor-ve-turizm-105&dil=1>. (in Turkish).
- [35] Household Consumption Expenditures, 2019. (accessed on 23 January 2020) Available online: <https://data.tuik.gov.tr/Bulten/Index?p=Hanehalki-Tuketim-Harcamasi-2019-33593>. (in Turkish).



© 2023 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).