

Sorting of Municipal Waste by Citizens in Slovakia

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<https://doi.org/10.53465/EDAMBA.2023.9788022551274.261-271>

Abstract. The paper focuses on the sorting of municipal waste by citizens of the Slovak Republic. Waste represents one of the biggest environmental challenges today, which affects not only Slovakia, but the whole world. Household waste, or municipal waste, is considered a particularly problematic source of waste. Its amount increases from year to year. In 2020 alone, its amount in the European Union (EU) amounted to 505 kg per person, according to data available on Eurostat, while only 48 % of it was recycled. The Slovak Republic, as an EU member state, must align its waste management policy with EU goals. At the same time, waste management, which should be environmentally friendly and use secondary materials contained in waste, is one of the critical elements of EU environmental policy. Major part of municipal waste in some EU countries still ends up in landfills and Slovakia is no exception despite the fact waste sorting is mandatory there. Just smaller part of municipal waste is recycled. The paper examines influence of selected factors on sorting of municipal waste by citizens of the Slovak Republic. It determines whether gender, age, income, household size and sufficient information about where the sorted waste ends up have some influence on sorting of municipal waste by citizens of the Slovak Republic.

Keywords: Waste Sorting, Municipal Waste, Household Waste, Waste Sorting in Slovakia.

JEL classification: *Q 53, D 10, R 11*

1 Introduction

EU waste policy aims to contribute to the circular economy by extracting high-quality resources from waste as much as possible. The legal framework for waste processing and disposal in the EU is directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste (directive on waste). Slovakia also implemented this directive into its legal order in Act no. 79/2015 Coll. on waste (waste act). So, in Slovakia and other member states, the waste management hierarchy applies, which represents the basic idea of the Waste Act and is based on the Waste Directive. According to the waste management hierarchy, waste management's main priority is

the prevention of waste. This is followed by preparation for reuse, recycling, and another recovery (e.g., energy recovery), and waste disposal is only in the last phase. So, despite the fact that much effort is devoted to collecting and recovering materials from waste, from an environmental point of view, waste prevention takes precedence over any waste treatment (landfill, energy recovery, and recycling). This is because it prevents the production and processing of products and substances that become waste [§ 6 (1) of the Waste Act].

Despite the fact that waste prevention should be a priority, it is rarely an integral part of local waste management [4, 40]. So, even if the goal of waste management in the EU is to prevent the generation of waste at the local level, they still struggle mainly with waste disposal. The solution to reducing household waste going to landfills is precisely the promotion of its separation at the source into recyclable or compostable components. Despite the fact that EU policy supports waste sorting in its member states, according to data from the European Commission [16], over 60 % of municipal waste in some EU countries still ends up in landfills.

Despite being the solution to waste management in many countries of the world, landfills represent the worst possible way to manage waste. The side effects of landfills include dust, odor, noise, the presence of pests, the risk of accidents, the creation of emissions released into the air and climate (mainly methane) and the release of waste into the soil, underground, or surface waters and marine environment. This can lead to their contamination, negative health effects and detrimental effects on biodiversity and economic activity. Another way of dealing with waste is, for example, incineration, which is also associated with air and climate pollution [42]. From this point of view, waste sorting is the key to collection and transport, disposal and resource utilization. Thus, it has become an important starting point for the implementation of the waste management strategy and for solving the complex situation with the amount of waste [18]. Recycling is one of the most effective methods used to reduce waste [28].

Waste management in Slovakia also focuses on reducing waste landfilling and recycling it. Even though landfilling should be the last possible alternative for waste management, according to the Slovak Waste Management Program for the years 2021 to 2025, it is the most common way of managing municipal waste in Slovakia. According to data available from the Statistical Office of the Slovak Republic, up to 40.7 % of municipal waste was disposed of by landfill in 2021. In 2021, 2.7 million tons of waste were created in Slovakia. The municipal waste recycling rate this year reached approx. 49 %, and only approx. 9 % was energetically recovered for electricity or heat through equipment for the energy use of waste. Based on the above, a large part of the waste in Slovakia is still landfilled, even though it is the worst possible way of handling waste.

According to the EU, the goal is for less than 10 % of waste to be landfilled by 2035. This is also why the Waste Management Program of the Slovak Republic for the years 2021 to 2025 is trying to reduce the total landfilling of waste, focusing mainly on municipal waste. The sorting of municipal waste is primarily intended to help with this. In the sorting of municipal waste, the attitudes of residents towards this issue play an important role because it is their positive attitude that can help to increase the recycling rate of this type of waste [38].

2 Literature Review

Waste sorting is mandatory in Slovakia. According § 81 (9) of the Waste Act, there is the obligation to participate in the municipal waste collection system in the municipality. By the Waste Act, paper, glass, plastics, metals, multi-layer combined materials based on cardboard, and, from 2021, also bio-waste will be sorted in Slovakia. The question is to what extent citizens fulfill this obligation, given the already mentioned amount of municipal waste that ends up in landfills (40,7 % in 2021).

The purpose of sorted waste collection is to ensure the recovery of the sorted components of municipal waste. Therefore, the level of purity of the sorted component is very important. In Slovakia, the level of municipal waste sorting is also reflected in the calculation of the fee for depositing waste at a landfill [20]. Simple access to the right information greatly supports the sorting of household waste. Residents' awareness of how to use these devices can further reduce misclassification [32]. To support sorting, information should be provided repeatedly in a way that engages people. Involvement can be achieved through personal contact, a two-way communication channel, or the inclusion of citizens in dialogues about the waste sorting system [33]. It is essential to address the existing mismatch between the technical system and the users' perspective by more actively involving citizens in discussing the problems the current system presents while helping them express what they need to make the system work better [31].

In individual studies, we can come across different factors that influence residents' attitudes toward sorting. Practical experience around the world has shown that the willingness to engage in recycling can be influenced by a number of factors [30]. One of these factors is, for example, the fact that sorting requires time and energy from people, which some are not willing to invest in [9, 25]. Separating waste for recycling also usually requires some space in the home [24, 36]. The size of the dwelling is often limited, and, moreover, it can bring a different benefit to the user than if it is used for waste sorting/storage. Houses are therefore associated with higher recycling rates than multi-family dwellings such as apartments [23, 1]. Household size, in terms of its members, is sometimes used as a proxy for time constraints: larger households offer more free time to devote to recycling [3, 39, 29].

According to some authors, household cooperation in waste sorting is influenced and driven by morality [1, 12]. The introduction of separate waste collection schemes in the absence of any financial incentive can be considered a manifestation of this fact [1]. With really strong moral preferences, individuals may even be willing to pay for recycling [12].

Many studies that evaluate recycling behavior describe the benefits that individuals get from cooperation in the form of sorting in the form of observing their own pro-environmental values [5, 23, 6]. In relation to pro-environmental preferences, the authors describe household members driven by a desire to feel good, a desire to avoid feeling guilty about not giving enough [8].

Another fact that affects the attitude of residents toward sorting can be the observance of social norms [36, 7, 35].

Some authors also investigate the policy preferences of household participation in a public good scheme [15, 11]. For example, right-wing ideology tends to be associated with a lower willingness to pay for environmental goods, environmental taxes, and environmental causes [15]. For example, research in the US has shown that Democrats and liberals have higher rates of recycling [10]. Or a survey in Sweden found that willingness to sort is higher among Green Party supporters [22].

The difference in waste management systems has a significant impact on waste sorting behavior [18]. Systems that are culturally sensitive and adapt to their users' needs are more effective over time in promoting and supporting household recycling behavior long term [26]. It is the currently available infrastructure for waste sorting and collection that creates an environment within which individual citizens then willingly perform the given behavior, i.e., sorting. So, the way this environment is configured affects this behavior. Convenient infrastructure is key to increasing the collection of sorted waste, regardless of whether it is a rural or urban area [33].

According to research, even a smaller distance to collection containers increases the amount of sorted impact. [31, 32]. It has even been shown that households with nearby collection containers separate twice as much as those with remote collection points [13]. Citizens who have trash cans near their homes are willing to recycle more types than when they have to walk longer to drop off the waste due to the inconvenience caused by carrying the large volume that waste usually has [21].

Sociodemographic factors are known to influence waste production and therefore influence waste sorting. However, there is little consensus in the literature on how these factors influence triage, so sociodemographic considerations may only be useful in specific contexts [33].

For example, higher education is believed to promote a willingness to sort waste [3, 34, 36]. Residents with higher education are more willing to accept waste sorting, while residents without higher education more often perceive the difficulty of waste sorting [27]. Regarding income, in many studies, the income variable is positive but not statistically significant [22, 23]. In the mentioned studies, the authors argue that the positive and negative effects of income work against each other. However, some studies indicate that higher acceptance positively affects recycling [39, 36]. Certain types of waste are recycled more by the higher-income group precisely because certain products (such as newspapers) are more likely to be purchased by households with a higher income [19].

In terms of age, according to studies, older people are generally the ones who recycle more [36]. Thus, older residents are more willing to sort waste, while young adults are more susceptible to the influence of family and friends, which may be related to the larger social circle of this age group [27].

In terms of gender, studies show that women's attitudes toward waste sorting are more supportive. [27, 34]. And this includes the recycling of electronic waste in collection centers [34].

According to some studies, the perceived effectiveness of the policy significantly influences the attitudes of households and their intentions to sort waste [27, 34]. Likewise, for people who sort, the question of trust is important, which concerns that the waste is effectively recycled [28].

3 Methodology

In our research we mainly focused on finding the influence of selected factors on waste separation by the inhabitants of Slovakia. So, our research question is: “Does the selected factors influence waste sorting of Slovak people?”

We decided to research the influence of 5 selected factors: gender, age, income, household size and to have sufficient information on how sorted waste is handled. We drew data for our research from a questionnaire.

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For each of the investigated variables, we established two hypotheses at the beginning of our research, null and alternative. Together, we established the null and alternative hypotheses for 5 different variables:

H01: Gender and waste sorting are mutually independent variables.

HA1: Gender and waste sorting are mutually dependent variables.

H02: Age and waste sorting are mutually independent variables.

HA2: Age and waste sorting are mutually dependent variables.

H03: Income and waste sorting are mutually independent variables.

HA3: Income and waste sorting are mutually dependent variables.

H04: Household size and waste sorting are mutually independent variables.

HA4: Household size and waste sorting are mutually dependent variables.

H05: Sufficient information about where the sorted waste ends up and waste sorting are mutually independent variables.

HA5: Sufficient information about where the sorted waste ends up and waste sorting are interdependent variables.

4 Results

Table 1. Waste sorting by gender

	<i>Sort waste</i>	<i>Don't sort waste</i>	<i>Row Total</i>
<i>Man</i>	114 (38,4 %)	19 (6,4 %)	133 (44,8 %)
<i>Woman</i>	148 (49,8 %)	16 (5,4 %)	164 (55,2 %)
<i>Column total</i>	262 (88,2 %)	35 (11,8 %)	297 (100 %)

Result:

Chi² = 1.449458 p = 0.228615

As we can see in table 1, up to 6,4 % of interviewed men do not sort waste. In the case of women, it is 5,4 %. In this case we received a value of $p > 0,05$. This means that we do not have enough evidence to reject our null hypothesis, so we accept it. Thus, our survey did not confirm the dependence of waste sorting on gender.

Table 2. Waste sorting by age

	<i>Sort waste</i>	<i>Don't sort waste</i>	<i>Row Total</i>
<i>Less than 18</i>	1	0	1
<i>18 – 20 years old</i>	33 (11,1 %)	6 (2 %)	39 (13,1 %)
<i>21 – 25-year-old</i>	74 (24,9 %)	16 (5,4 %)	90 (30,3 %)
<i>26 – 30 year old</i>	28 (9,4 %)	5 (1,7 %)	33 (11,1 %)
<i>31 – 35 year old</i>	49 (16,5 %)	5 (1,7 %)	54 (18,2 %)
<i>36 – 45 year old</i>	59 (19,9 %)	2 (0,6 %)	61 (20,5 %)
<i>46 – 55 year old</i>	13 (4,4 %)	1 (0,3 %)	14 (4,7 %)
<i>66 and more</i>	5 (1,7 %)	0	5 (1,7 %)
<i>Column total</i>	262 (88,2 %)	35 (11,8 %)	297 (100 %)

Result:

Chi² = 9.623951 p = 0.210904

As we can see in Table 2, up to 2 % of respondents aged 18-20 do not sort waste, as do 5,4 % of respondents aged 21-25, 1,7 % aged 26-30, 0,6 % aged 36 up to 45 years, 0,3 % aged 46 to 55. In this case we received a value of $p > 0,05$. This means that we do not have enough evidence to reject our null hypothesis, so we accept it. Thus, our survey did not confirm the dependence of waste sorting on age.

Table 3. Waste sorting by income

	<i>Sort waste</i>	<i>Don't sort waste</i>	<i>Row Total</i>
<i>Unemployed</i>	54 (18,2 %)	3 (1 %)	57 (19,2 %)
<i>Less than 646 euros (minimum wage)</i>	40 (13,4 %)	10 (3,4 %)	50 (16,8 %)
<i>646 euros (minimum wage)</i>	7 (2,4 %)	2 (0,6 %)	9 (3 %)
<i>647 - 1 000 euro</i>	23 (7,7 %)	4 (1,3 %)	27 (9 %)
<i>1 000 - 1 200 euro</i>	31 (10,4 %)	3 (1 %)	34 (11,4 %)
<i>1 201 - 1 500 euro</i>	29 (9,8 %)	2 (0,6 %)	31 (10,4 %)
<i>1 501 - 1 800 euro</i>	15 (5 %)	6 (2 %)	21 (7 %)
<i>1 801 - 2 000 euro</i>	12 (4,1 %)	2 (0,6 %)	14 (4,7 %)
<i>2 001 - 2 500 euro</i>	26 (8,7 %)	0	26 (8,7 %)
<i>More than 2 500 euro</i>	25 (8,4 %)	3 (1 %)	28 (9,4 %)
<i>Column total</i>	262 (88,2 %)	35 (11,8 %)	297 (100 %)

Result:

Chi² = 17.17545 p = 0.0460383

As we can see in Table 3, up to 1 % of respondents who are unemployed, do not sort waste, as do 3,4 % of respondents who earn less than the minimum wage, 0,6 % of respondents earning the minimum wage, 1,3 % of respondents whose income is between 647 – 1 000 euros, 1 % of respondents whose income is between 1 000 – 1 200 euros, 0,6 % of respondents whose income is between 1 201 – 1 500 euros, 2 % of respondents whose income is between 1 501 – 1 800 euros, 0,6 % of respondents whose income is between 1 801 – 2 000 euros and 1 % of respondents whose income is more than 2 500 euros. In this case, we received a value of $p < 0,05$. This means we reject our null hypothesis and accept the alternative. Thus, our survey confirmed the dependence of separation on the amount of income.

Table 4. Waste sorting by household size

	<i>Sort waste</i>	<i>Don't sort waste</i>	<i>Row Total</i>
<i>Live alone</i>	39 (13,1 %)	12 (4 %)	51 (17,1 %)
<i>2 members</i>	54 (18,2 %)	7 (2,3 %)	61 (20,5 %)
<i>3 members</i>	53 (17,8 %)	5 (1,7 %)	58 (19,5 %)
<i>4 members</i>	77 (25,9 %)	8 (2,7 %)	85 (28,6 %)
<i>5 members</i>	23 (7,7 %)	3 (1 %)	26 (8,7 %)
<i>6 members</i>	15 (5 %)	0	15 (5 %)
<i>7 and more members</i>	1 (0,3 %)	0	1 (0,3 %)
<i>Column total</i>	262 (88,2 %)	35 (11,8 %)	297 (100 %)

Result:

$$\text{Chi}^2 = 9.930568 \quad p = 0.1276066$$

As we can see in Table 4, 4 % of respondents, who live alone, do not sort waste, 2,3 % of respondents whose household has 2 members do not sort waste as 1,7 % of respondents whose household has 3 members, 2,7 % of respondents whose household has 4 members, 1 % of respondents whose household has 5 members, and none of the respondents whose household has 6, 7 or more members. In this case, we received a value of $p > 0,05$. This means that we do not have enough evidence to reject our null hypothesis, so we accept it. Thus, our survey did not confirm the dependence of separation on household size.

Table 5. Waste sorting by sufficient information about where the sorted waste ends up

	<i>Sort waste</i>	<i>Don't sort waste</i>	<i>Row Total</i>
<i>Yes, have enough information</i>	43 (14,5 %)	4 (1,3 %)	47 (15,8 %)
<i>No, I haven't. I want more</i>	201 (67,7 %)	21 (7,1 %)	222 (74,8 %)
<i>I don't care</i>	8 (2,7 %)	2 (0,7 %)	10 (3,4 %)
<i>I think all sorted waste ends up in a landfill</i>	10 (3,4 %)	8 (2,7 %)	18 (6,1 %)

<i>Column total</i>	262 (88,2 %)	35 (11,8 %)	297 (100 %)
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Result:

Chi² = 20.75738 p = 0.0001182234

As we can see in Table 5, 1,3 % of respondents who do not sort waste have enough information about how sorted waste is handled. 7 % of respondents who do not sort waste do not have enough information but would like to. 0,7 % of respondents who do not sort waste are not interested in it. And 2,7 % of respondents who do not sort waste think that sorted waste ends up in a landfill. In this case we received a value of $p < 0,05$. This means we reject our null hypothesis and accept the alternative. Thus, our survey confirmed the dependence of separation on sufficient information about how the sorted waste is further handled.

5 Conclusion

Sorting municipal waste is an important means of reducing the amount of waste that ends up in landfills, which is the worst possible way of managing waste. In Slovakia, more than 40 % of municipal waste is still landfilled, despite the fact that by 2035 this amount is set to be less than 10 % in line with EU targets. It is for this reason that political efforts in the field of waste management are focused on supporting the sorting of the municipal waste directly by their creators. Despite the fact that citizens in Slovakia are obliged to sort municipal waste according to the Waste Act, this is not always the case, as our questionnaire shows, in which 11,8 % said that they do not sort waste.

There are a number of studies devoted to this topic, with their authors citing various factors that influence waste sorting. We focused on some of them in our research. First, we investigated the relationship between gender and its effect on sorting; according to the study [27, 34] women have a more positive attitude toward waste sorting. However, the influence of gender on waste sorting was not confirmed in our research. Next, we investigated the relationship between age and its influence on waste sorting. In terms of age, according to studies, older people are generally the ones who recycle more [36, 27]. However, even in this case, the relationship between this variable and waste sorting was not proven. Some studies indicate the influence of income on waste sorting or that higher income positively affects recycling [39, 36, 19]. In our research, we were able to demonstrate that the amount of income affects waste sorting.

On the contrary, the dependence between household size and sorting was not proven, despite the fact that according to some studies [3, 39, 29] it is precisely in multiple households that they tend to have more time and energy for sorting. Since there are more members among whom this activity can be divided. Time and energy are also considered important factors influencing waste sorting. On the contrary, we managed to demonstrate the impact of sufficient information about where the sorted waste ends up. This is in line with the study of Minelgaitė and Liobikienė [28], according to which the issue of trust that the waste is effectively recycled is important for people who sort. We consider this finding to be important information for policymakers, who could

focus more attention on promoting awareness in this direction. As our research has also shown, there are still people (6,1 % of our respondents) who think that sorted waste ends up in a landfill anyway, which, of course, can be a significant reason for their lack of interest in participating in separation.

Of course, our research focused only on a few selected factors that can have an impact on the sorting of waste by residents. So there is still a lot of place to focus on others in more detail in the future.

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