Societal Involvement in Household Waste Sorting Behavior in the Context of the Circular Economy: A Case Study of Poland

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Abstract: Population growth and the increasing demand for raw materials with the expanding amount of waste in the environment have resulted in the need to change the production–consumption model based on a one-way flow of materials (from raw materials through products to waste). An alternative to the linear model of production and consumption is the circular economy model (CE), which assumes more efficient use of resources, waste recovery (including municipal waste), and the reuse of materials. One of the important elements of this system is recycling, which will not efficiently function without public participation in the waste sorting system. The aim of the survey study was to examine the motivation, knowledge, and behavior of Polish respondents regarding the sorting of household waste and related problems. The survey results showed that almost 90% of respondents declared waste sorting, mostly because of the threat to the environment (34%) and the desire to contribute to the recycling process (34%), despite respondents' problems with assigning certain types of waste to appropriate containers. This indicates the need for further education in this area, which should be conducted primarily online—the main sources of information about waste sorting, according to the respondents, are social media (33%) and websites (22%). The research results can help in designing educational campaigns both at the national (Ministry of the Environment and non-governmental organizations) and regional (municipal) levels, as these results indicate in which areas citizens have the most problems with waste separation.

Keywords: circular economy; household waste; consumer behavior

1. Introduction

Waste is an inherent side effect of human functioning in the environment. Both as a result of the increasing world population and living standards, the amount of waste generated is constantly growing. The rapid increase in waste is an extremely dangerous problem worldwide. This growth is much more rapid than any other pollutant, which will not continue without an impact on people's health [1]. Therefore, the system of the linear economic model, the so-called 'take, make, and dispose', has become ineffective, especially in the context of both increasing waste and resource depletion [2]. An alternative has become the circular economy (CE) model, based on the principle of reduce, reuse, and recycle (3R) [3]. The legal definition of the circular economy has been set out in Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment as an economic system whereby the value of products, materials, and other resources in the economy is maintained for as long as possible, enhancing their efficient use in production and consumption, thereby reducing the environmental impact of their use and minimizing waste and the release of hazardous substances at all stages of their life cycle, including through the application of the waste hierarchy [4]. The circular economy can also be defined as an economic model focused on the efficient, long-term use of resources and minimizing

waste production [5]. As Kirchherr et al. [6] point out, the CE replaces the concept of 'end of life' with the reduction in and the alternative use, recycling, and recovery of materials in production/distribution and consumption processes. This concept can be implemented both at the micro level (products, companies, and consumers), the meso level (eco-industrial parks), and the macro level (city, region, nation, and beyond). A circular economy might be recognized as a tool for sustainable development. Most of all, it is a pro-environmental concept that allows the population to consume, but in a much more productive way—with an obligation to reuse and recycle—to be able to lengthen and/or maximize the circle of life of the product. It may not only be economically beneficial but also reputationally beneficial [1]. The real concept of the circular economy is believed to have emerged in the 1960s, but in the 1970s, one could observe the 3R rule, which had become popular and even regulated by governments. It did not include waste sorting explicitly, but the pollution problem had been seen and the rule 'polluter pays' was established. Waste management and recycling, as a part of the circular economy concept, became popular between the 1980s and 1990s. It was mostly about voluntary projects for waste management and recycling by businesses [7]. What also should be noted is the pioneering successful project conducted in West Germany in the 1970s, which considered glass sorting by citizens in a deposit system. A very similar idea was managed in France between 1973 and 1975. In the 1980s and 1990s, French politics focused more on rationalizing resource recovery than on the environmental aspects of sorting, but it was a big step towards activating French society [8]. The first European Union (EU) direction taken in the name of the circular economy was the First Action Plan enacted by the European Commission in 2015. Its aim is to help EU countries to transit themselves from a linear to a circular economy [2]. This roadmap sets out priorities for the transition to a circular economy and covers product design, production, consumption, and waste management [9]. The next step undertaken in this direction was the European Green Deal in 2020. A big part of it is not only achieving climate neutrality by 2050 but also restoring biodiversity in an efficient circular economy with the reuse of waste and residues. The proposals also focus on consumption and production behavior changes through reuse and recycling, as well as waste management [2].

One of the significant components of waste management in the context of the CE is the effective management of municipal waste. According to the definition adopted by the Organisation for Economic Cooperation and Development (OECD), 'municipal waste covers household waste and waste similar in nature and composition to household waste' [10]. In European Union countries, in 2020, an average of 4813 kg of waste was generated per person, of which 505 kg was municipal waste [11,12]. Although municipal waste constitutes only approximately 10% of all waste, it is a prime concern in the EU waste policy. This is indicated by the development of EU legislation aimed at both minimizing the generation of waste and recycling it appropriately [13] as well as reducing the amount of municipal waste sent to landfill by 2035 [14].

The factors influencing the degree of municipal waste recirculation, both in EU countries and beyond, are primarily regulations, infrastructures, and consumer engagement [15,16]. Therefore, the lack of appropriate regulations (or lack of coherence in legislation), the lack of waste sorting infrastructure, and the lack of public involvement in the waste sorting system will be significant problems on the way to the transition to the circular economy. For example, the analysis conducted by Pavolová et al. [17] showed that the main problem in the implementation of the CE in Slovakia is primarily the lack of a uniform municipal waste management system—there are significant differences between the regions on how the circular economy is being conducted, and there are different fees in each region. Dagilien et al. [18] indicate that in the case of Lithuania, the main hurdles to the implementation of a circular economy in the area of municipal waste are primarily the reluctance of residents to sort their waste, lack of information about sorting, especially in rural areas, and abandoning waste in places not adapted for it (so-called homeless waste). However, insufficient development of infrastructure was one of the barriers to shaping pro-ecological behavior in the research conducted by Ratner et al. [19]. A lack of

infrastructure at the appropriate level did not allow for the use of pro-ecological behavioral patterns, even though the respondents understood which patterns were correct and were aware of their importance. Appropriate infrastructure is motivating for citizens from South Korea to sort waste. Automatic sorting systems in a central facility, private companies that take the waste from the households, and hygienic conditions in the place where citizens are supposed to leave the waste are the most important factors, especially for the younger generation, to participate in the waste sorting system [20].

In addition to consistent legal regulations and appropriate infrastructure, as Knickmeyer [21] points out, the effectiveness of recycling systems will depend on public participation in this system. However, public behavior will be significantly influenced, in addition to economic factors, with social factors such as the level of knowledge and information, attitude and environmental concern, moral and ethical norms, and demographic determinants (such as age, gender, and education) [21–23]. At the same time, the impact of economic factors on citizens' attitudes seems to be varied and not obvious. Some studies indicate that the economic factor will be the one encouraging citizens to recycle more, but others indicate that economic incentives do not change the degree of sorting carried out by households and moral motivation has a greater impact [24,25]. The knowledge that results from having clear and readable information is considered one of the most significant factors driving recycling [26]. It should be noted that this knowledge will concern not only the methods of waste sorting but also the environmental and health consequences resulting from inappropriate ecological behavior. There are also a number of studies on the relationship between demographic factors and involvement in the waste sorting system. The most frequently analyzed variables are gender, age, education, and income [27–29]. It should also be noted that individual consumer behavior will influence the collective attitude of society. This, in turn, can even influence the regulatory authority towards enforcing regulations and can also lead to a movement towards circular behavior [30].

Therefore, the aim of the study was to examine the motivation, knowledge, and behavior of Polish respondents regarding the sorting of municipal waste and related problems in this area. In our research, we focused not only on answering the question of whether the respondents sort their waste or not but also identifying which factors determined their decision. Moreover, through appropriately designed questions, the greatest problems for respondents in the waste sorting system were noted. In addition, attempts were made to obtain an overview of the respondent's level of knowledge about waste sorting and where to receive information about it. The research results can help in designing educational campaigns both at the national (Ministry of the Environment and non-governmental organizations) and regional (municipal) levels, as they indicate in which areas citizens have the most problems with waste separation.

2. Materials and Methods

2.1. Description of the Research Area

Poland is located in Central Europe and has 38.8 million inhabitants (in 2021). The country has been a member of the EU since 2004. In 2021, 121 million tons of waste were generated in Poland, of which 11.3% was municipal waste (13.7 million tons). Although the total amount of waste generated in Poland in the years 2000–2021 systematically slightly decreased (137.7 million tons in 2000 and 121.4 in 2021), the amount of municipal waste increased (Figure 1) [31].

On average, a resident of Poland generated 360 kg of municipal waste in 2021, which is 16 kg more than in 2020 [32]. Of all municipal waste generated in 2021, 39% was intended for landfilling, 27% was recycled, 13% was subjected to composting or fermentation processes, and 21% was subjected to thermal transformation with energy recovery [32]. Although the share of separately collected waste in the total waste collected in Poland is increasing year by year and in 2021 amounted to 40% of the total municipal waste generated, 60% of municipal waste is still mixed waste [31].
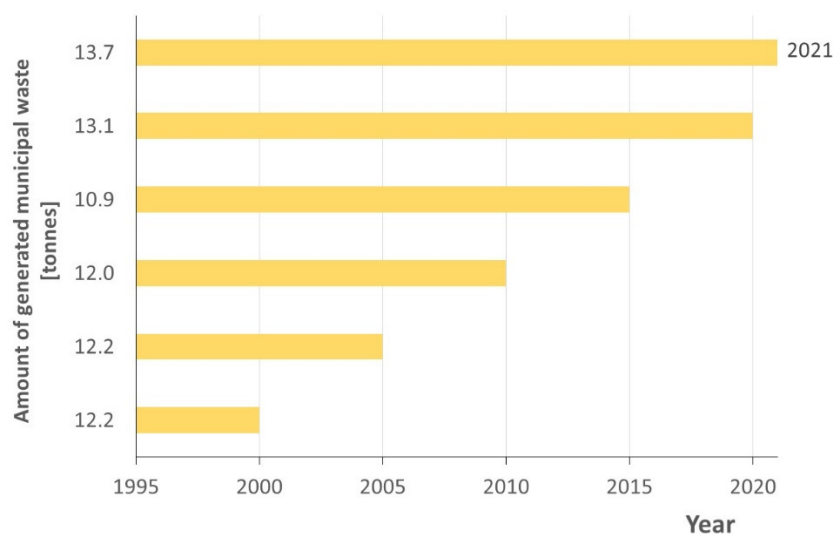
Figure 1. Amount of municipal waste generated in Poland in 2000–2021 (developed on the basis of [31]).

Municipal waste management in Poland is based on the provisions of two basic legal acts:

- Act of 14 December 2012 on waste [33];
- Act of 13 September 1996 on maintaining cleanliness and order in municipalities [34].

The first of these legal acts contains the most important principles regarding waste management in Poland, taking into account EU regulations, among others: the obligation to apply the EU waste hierarchy, implementation of the principles of prevention and precaution, 'polluter pays', and the principles of comprehensive environmental protection. The principle of planning was reflected in the obligation to develop waste management plans at both the national and provincial levels. The main assumptions of the National Waste Prevention Program adopted in 2016 and valid until 2022, in the field of municipal waste, included, among others:

- Reducing the amount of waste generated;
- Increasing the share of separately collected waste in the municipal waste stream (and thus reducing the share of mixed waste) by introducing a uniform waste sorting system and covering all property owners with the system;
- Increasing the level of recycling and reducing the level of municipal waste stored at landfill sites;
- Increasing public awareness of the proper management of municipal waste [32].

In June 2022, the Ministry of the Environment published the draft of the new National Waste Prevention Program 2028. The new National Waste Prevention Program 2028 was adopted on 12 June 2023. The main problems regarding municipal waste management indicated in the program include:

- Too high a share of mixed waste in all municipal waste generated;
- A lack of sufficient educational activities on the proper method of segregating municipal waste and, consequently, too low a level of knowledge and public awareness on this subject;
- The problem of illegal dumps;
- An insufficient number of PSZOKs (points of selective collection of municipal waste) and waste processing installations;
- An increase in costs related to municipal waste management;
- Too small a share of producers in the costs of managing waste generated from their products [35].

Following the provisions of the Act of 13 September 1996 on maintaining cleanliness and order, municipalities are obliged to manage municipal waste [34]. The said Act specifies the tasks and obligations of the commune and property owners regarding maintaining cleanliness and order in the communes and the conditions for carrying out activities in the field of collecting municipal waste from property owners and managing this waste. Both collecting municipal waste and ensuring selective collection of municipal waste are the responsibility of municipalities. Pursuant to the provisions of the Act, the commune is to ensure selective waste collection at least for such fractions as paper, metals, plastics, glass, multi-material packaging waste, and bio-waste and their appropriate level of recovery, including recycling [34]. To these waste fractions, pursuant to the Regulation of the Minister of Climate and Environment of 10 May 2021 on the method of selective collection of selected waste fractions (until 2021: Regulation of the Minister of the Environment of 29 December 2016 on the detailed method of selective collection of selected waste fractions), appropriate colors of containers have been assigned:

- paper—blue;
- metals, plastics, and multi-material packaging waste—yellow;
- glass—green;
- bio-waste—brown [36].

In addition, there is unsegregated (mixed) municipal waste, which should be placed in black containers. The introduction of such a waste fraction division system results from the implementation of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives [37]. According to Article 11 of the directive, each state was obliged to create a separate waste collection system by 2015, covering at least such fractions as paper, metal, plastic, and glass. In addition, in each member state, from 31 December 2023, bio-waste must be separated and recycled and cannot be mixed in other fractions of waste. At the same time, the directive obliges member states to introduce a system of selective collection of hazardous waste from households by 1 January 2025. In Poland, both the bio-waste and hazardous waste segregation systems have been in operation for many years. The commune is obliged to create selective municipal waste collection points, the so-called PSZOKs, to which residents can dispose of waste such as used tires, used batteries and accumulators, unnecessary electrical and electronic equipment, furniture, and other large-sized waste or chemicals [34]. The commune's task is also to build, maintain, and operate installations for the processing of municipal waste, including municipal installations. Municipalities are also obliged to conduct educational activities in the field of proper municipal waste management, including proper waste sorting [34]. The costs of collecting waste from property owners, transport, collection, recovery (including recycling), and the disposal of waste are borne by residents (property owners) in accordance with the 'polluter pays' principle.

Due to the need to transform the linear economy into a circular economy by EU countries, Poland is obliged to adopt/issue legal acts aimed at introducing changes as soon as possible. As a result, in 2019, the Polish government adopted the document The Roadmap for Transformation Towards a Circular Economy. The map covers five areas: sustainable industrial production, sustainable consumption, bioeconomy, new business models, and the implementation, monitoring, and financing of the circular economy [38]. The actions included in the document are aimed at maximizing the value of raw materials, resources, materials, and products, as well as reducing the amount of waste generated and managing the waste generated in accordance with the EU waste management hierarchy [38]. One of the elements of the circular economy is also ecological education. The map indicates that ecological education is crucial for the transformation towards the circular economy. This education should include:

- Changing consumer behavior in the field of waste management;
- Dissemination of practical knowledge in the field of sustainable development;
- Consumption (including food waste);
- Increasing consumer interest in developing knowledge about products and producers [38].

2.2. Characteristics of yjr Survey

In accordance with the provisions of the previously mentioned Act of 1996, residents, as producers of municipal waste, are obliged to selectively collect the municipal waste they generate in accordance with the principles contained in legal regulations. Therefore, in order to examine citizens' knowledge and attitudes regarding the sorting of municipal waste, a survey was conducted. The main research tool used in the study was an anonymous questionnaire containing closed questions, with the option of selecting one or more answers. The survey questionnaire contained 26 questions. The first part included questions aimed at examining the reasons for Polish citizens' involvement in the selective collection of municipal waste and determining the most effective sources of knowledge about waste sorting. The second part contains questions testing knowledge about waste sorting. The third part contained questions examining citizens' attitudes regarding waste sorting. The last part of the questionnaire included the characteristics of the respondents. Before conducting the actual study, a pilot study was conducted on a group of 30 people. In order to reach as many potential responders as possible from various regions of Poland, the survey was posted on Facebook and sent by e-mail to adults from the contact lists available to the study authors. These people were asked to complete the questionnaire and to send a copy of the blank questionnaire to other people on their own contact lists (snowball method). In order to include people from the oldest age group who rarely use computers, the survey questionnaires were printed, and face-to-face research was conducted with these people. The survey research was conducted in January–February 2022. Adult Polish citizens living in the country were eligible to take part in the study. The size of the representative sample was calculated at 384 (assumptions: 38,265 citizens) [39].

Interrelationships between qualitative variables were determined using the Chi^2 test. In all calculations, the significance level was $p < 0.05$. The calculations were performed using the package StatSoft. Inc. (Hamburg, Germany) STATISTICA (data analysis software system) version 13.3.

3. Results

In the survey, of the 700 respondents who correctly completed the survey questions, 74.9% (524) were women, and 25.1% (176) were men. The study population relied on the following age groups: 49% of participants were between 18 and 29, 26% were between 30–39, and 14% were between 40–49 years of age. The smallest group were people between 50 and 59 years of age (5%) and people older than 59 (8%). The majority of respondents had higher and secondary education (59 and 31%, respectively). The respondents mainly lived in cities with over 500,000 inhabitants (38%). People living in villages constituted 19%. Almost 68% of respondents lived in blocks of flats, while 32% lived in single-family houses. The survey data came from citizens from all over Poland, and the two voivodeships from which the respondents mainly came were: the Pomeranian Voivodeship and the Masovian Voivodeship.

3.1. Knowledge and Behavior of Respondents Regarding the Sorting of Household Waste

Of the 700 respondents, as many as 626 (89.6%) declared that they participated in the process of selective waste collection. When asked to explain the reasons for such an attitude, respondents who declared that they did not sort waste indicated a lack of publicly available containers for selective waste collection or their too small volume (which often causes them to overflow), as well as a lack of conditions for sorting waste at home (Figure 2a). At the same time, all respondents were asked whether they believed that waste sorting was important. As many as 98% of all respondents believe that sorting waste is important because it enables the processing and use of secondary raw materials into new materials (589 responses) and also reduces the emission of pollutants into the soil, air, and water (526 responses). Respondents who declared that they sorted waste when asked about their motivation most often indicated fear of the environmental threat posed by waste (34%) and the desire to contribute to the recycling of waste generated (34%) (Figure 2b).
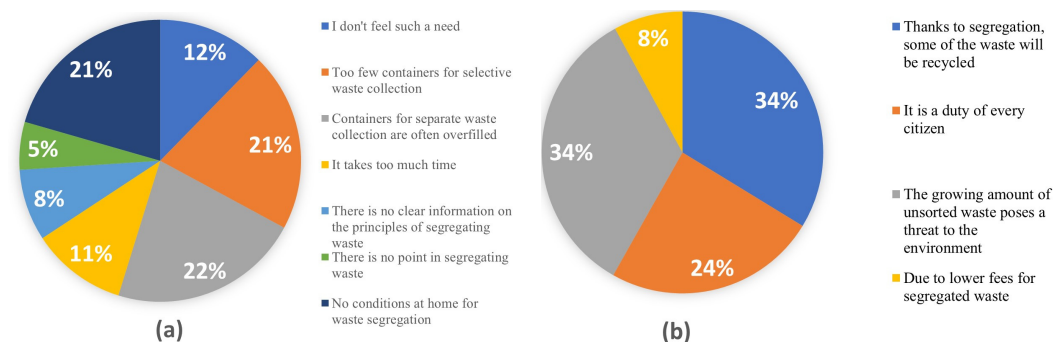
Figure 2. Reasons why respondents (**a**) do not sort waste and (**b**) sort waste.

Respondents who declared that they sorted waste were asked what fractions they most often sorted it into. The fraction most frequently segregated by respondents was glass, followed by plastics (and metals) and paper. The respondents indicated that the main problems that arise in connection with waste sorting are a lack of publicly available containers for selective waste collection (19.9%), a lack of space at home for waste sorting containers (19.1%), a lack of appropriate waste sorting habits (8.6%), and a lack of time (7%). Moreover, as many as 33% of respondents indicated that they did not believe in the proper functioning of the waste sorting system.

At the same time, we conducted analyses to indicate whether demographic determinants such as age, place of residence, or the type of buildings in which respondents live have an impact on the sorting of waste. The first hypothesis was that the age of the respondents influenced their sorting of waste. The statistical analysis showed that age was a statistically significant predictor of waste sorting (Chi^2 = 15.6322, p = 0.0036). Younger respondents are much more willing to participate in waste segregation than older people. However, in the research conducted by Wang et al. [29], age variables had no significant effects on waste disposal behaviors, as in the research conducted by Botetzagias et al. [28]. The second hypothesis was that the type of development in which the respondents lived (a block of flats or a single-family house) had an impact on the respondents' segregation of waste. This hypothesis was confirmed (Chi^2 = 7.6780, p = 0.0056). Over 94% of people living in a single-family house declared that they segregated waste, while in the case of respondents living in blocks of flats, this percentage was lower. However, the hypothesis that the respondents' place of residence (village/city) has an impact on their segregation of waste was not confirmed. The distribution of answers to the above question was not dependent on the place of residence of the participant (city size/village) to a statistically important extent (Chi^2 = 4.0847, p = 0.3947).

In the next stage, respondents were asked about their knowledge of dealing with certain types of waste. The types of waste were selected in a manner that may cause difficulties in sorting, e.g., juice packaging, receipts, light bulbs, broken glasses, glasses, heat-resistant dishes, or animal waste (bones and meat). It was also checked whether the respondents had knowledge about the relationship between a specific waste fraction and the appropriate color of the container into which it should be thrown away. The results are presented in Table 1.

Throwing receipts into a paper container is one of the most common mistakes made when sorting waste. According to the sorting rules, they should be thrown into a mixed waste container because they are printed on thermal paper, which is not recyclable. As many as 31% of respondents answered this question incorrectly. Due to their properties, light bulbs are considered hazardous waste, so they should not be thrown into glass or mixed waste containers. The proper course of action to deal with this type of waste is to take it to the special points in DIY stores, PSZOKs, or donate it during mobile hazardous waste collection (OZON). As many as 90% of respondents had knowledge in this area and gave the correct answer to this question. Although milk or juice cartons are called 'cartons', they are actually multi-material packaging and therefore should be placed in a

plastic and metal container, not in a paper container. As many as 81% of respondents had correct knowledge in this area. Animal waste (bones and meat) should be thrown into a mixed waste container. Only waste of plant origin should be placed in the bio-waste waste container. The vast majority of respondents (77%) correctly answered the question about disposing of animal waste. The respondents definitely showed the least knowledge when answering the question about throwing away broken glasses, glasses, and heat-resistant dishes. As many as 38% of respondents believe that this waste should be placed in a glass waste container. They should be placed correctly in the mixed waste container because only packaging glass (bottles, glass cosmetic containers, or jars without their contents) should be thrown into the glass waste container. The vast majority of respondents were able to match the appropriate waste fraction to the color of the container.

Table 1. Knowledge of the respondents regarding the handling of selected types of municipal waste (n—number of respondents).

According to your knowledge, what should be done with a broken light bulb? (more than one answer allowed)		
Return it to the PSZOK or special points, e.g., in DIY stores	629	65.7%
Dispose of in a mixed waste container	58	6.1%
Hand in at a mobile collection site for hazardous waste	234	24.4%
Dispose of in a metal and plastic container	16	1.7%
Discard in a glass container	20	2.1%
Where, according to your knowledge, should an empty milk or juice carton be disposed of? (n = 700)		
Dispose of in a mixed waste container	87	12.4%
Dispose of in a metal and plastic container	564	80.6%
Into a paper container	49	7%
Where, according to your knowledge, bones and meat should be disposed of? (n = 700)		
Dispose of in a mixed waste container	541	77.3%
Into a bio-waste waste container	159	22.7%
Where, according to your knowledge, should broken glasses and casserole dishes be disposed of? (n = 700)		
Dispose of in a mixed waste container	431	61.6%
Discard in a glass container	269	38.4%
Where, according to your knowledge, receipts should be disposed of? (n = 700)		
Into a paper container	218	31.1%
Into a mixed waste container	480	68.6%
Into a bio-waste waste container	2	0.3%

PSZOK—point of selective collection of municipal waste.

In order to obtain information on the question regarding which age group has the highest level of knowledge of the principles of waste sorting, the answers to the above questions were scored. Then, these results were summed and grouped to make it easier to compare the results and interpret them. The maximum number of points to be scored for questions regarding knowledge of waste sorting was seven points. A point for the question relating to knowledge of the colors of containers was awarded if at least half of the answers to this question were correct. In the case of obtaining from zero to two points, the knowledge of the principles of municipal waste sorting was considered to be at a low level. If respondents obtained three to five points, their level of knowledge of sorting principles was considered to be at an average level. However, people who scored six and seven points

according to the above scale are classified as people with a high level of knowledge of the principles of waste sorting. Of all respondents, as many as 59% (413 people) had a high level of knowledge of the principles of waste sorting. Approximately 34% of respondents (238 people) had an average level of knowledge in this area. Only 7% of respondents (49 people) had a low level of knowledge in waste sorting. It was analyzed whether the distribution of answers depended on the level of education of the respondents. In the next stage, we hypothesized that the level of education of the respondents had an impact on their knowledge of waste sorting. The statistical analysis showed that there is a statistical relationship between the respondents' level of education and their level of knowledge in the field of proper waste sorting (Chi^2 = 120.64, p = 0.0000). Respondents with higher education had a high level of knowledge about waste segregation, while respondents with primary and vocational education had a low level of knowledge in this area.

The obtained results were also related to the age of the respondents. It was found that the age group of 18–29 (almost 32%) of respondents and respondents aged 30 to 39 (18.3%) had a high level of knowledge in the field of waste sorting.

The next part of the survey concerned respondents' attitudes, i.e., proper waste management. The questions concerned the types of waste that have the largest share in the total amount of municipal waste (bio-waste: 33.9% in 2021) and those whose improper disposal may pose a particular threat to the environment (pharmaceuticals, batteries and accumulators, and paint residues).

Of all respondents, only 24% of them indicated that they do not segregate bio-waste and place it in a mixed waste container (Table 2). Of the 77 respondents who throw bio-waste into their own composter, as many as 85% of respondents live in single-family houses. Comparing the obtained results, people living in single-family houses sort bio-waste more often than people living in multi-family blocks of flats. Among people living in single-family houses, the percentage of people who did not separate bio-waste was 10%, while among people living in blocks of flats, it was about 30%.

Table 2. Attitudes of the respondents regarding the handling of selected types of municipal waste (n—number of respondents).

What Do You Do with Vegetable and Fruit Waste (Including Peelings)? (n = 700)		
I throw it into the mixed waste container	171	24.4%
I throw it away in a bio-waste waste container in a plastic bag	84	12%
I throw it away in a bio-waste waste container in a bio-waste bag	49	7%
I throw it into the composter	77	11%
I throw it into the bio-waste waste container without a bag (loose)	216	31%
I throw it away in a bio-waste waste container in a compostable bag	80	11.4%
I throw it away in a bag prepared by the waste collector	23	3.2%
What do you do with batteries and accumulators? (more than one answer allowed)		
I throw it into the mixed waste container	35	3.5%
I give it to a PSZOK	139	13.7%
I throw it away in a specially marked battery container (at school, the office, and stores)	607	59.9%
I give it to the supermarket (with household appliances)	152	15.0%
I give it away during a road collection of hazardous waste	68	6.7%
I throw it into a metal and plastic container	12	1.2%

Table 2. *Cont.*

What do you do with expired medicine? (n = 700)		
I take it to a pharmacy or an appropriate point	581	83%
I throw it into the mixed waste container	119	17%
I throw it into the bio-waste container	0	-

PSZOK—point of selective collection of municipal waste.

Batteries and accumulators are classified as hazardous waste and should not be thrown into municipal waste containers. Batteries and accumulators found among municipal waste pose a threat to the environment. Therefore, their proper collection is very important. Of the respondents who took part in the survey, as many as 96% of them gave the correct answer, indicating that they give batteries to PSZOKs either during mobile waste collection or throw them away in special containers located, e.g., in stores (Table 2). In the case of unnecessary/expired medicines, 83% of respondent dispose of this type of waste correctly by taking it to pharmacies or special points of collection.

Due to their hazardous properties, paints should not be thrown away with municipal waste. Leftover paints or expired paints should be handed over to PSZOKs or during a mobile hazardous waste collection. In this study, almost 30% of respondents provided answers indicating their incorrect behavior (Figure 3a).
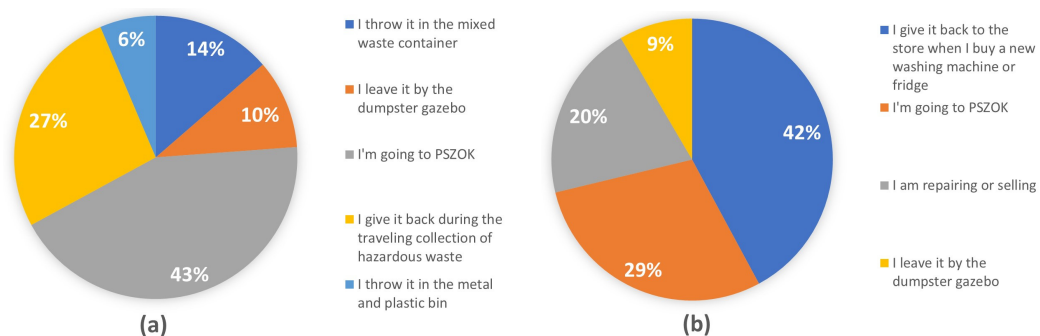
Figure 3. What do you do with (**a**) leftover paint in cans and (**b**) a broken washing machine or fridge? PSZOK—point of selective collection of municipal waste.

E-waste is a specific type of waste because, on the one hand, it contains valuable materials that can be recovered in recycling processes, and, on the other hand, it contains harmful substances and chemicals (mercury, lead, cadmium, etc.) [40]. In the survey, over 70% of respondents indicated that they return electronic waste such as broken washing machines or refrigerators to the store when shopping for new ones or to PSZOKs. However, 9% incorrectly leave them next to garbage sheds. It is interesting that 20% of respondents have them repaired or sell them (Figure 3b).

3.2. Sources of Information on Waste Sorting Preferred by the Respondents

Due to the fact that, as Xiao et al. [41] point out, citizens who are better informed are more likely to participate in the waste sorting system than those who are not so well informed, in our research, respondents were also asked where they obtain information about the correct methods of separating waste. Analyzing the results, it should be stated that the main sources of information on waste sorting are social media sites such as Instagram or Facebook (33%) and websites (22%) (Figure 4). In recent years, many educational accounts have been created on these platforms, presenting knowledge in the field of environmental protection in a very accessible way for Internet users, such as the Facebook group 'Zero Waste Polska' or the waste-related account 'The Waste Lady' on Instagram.
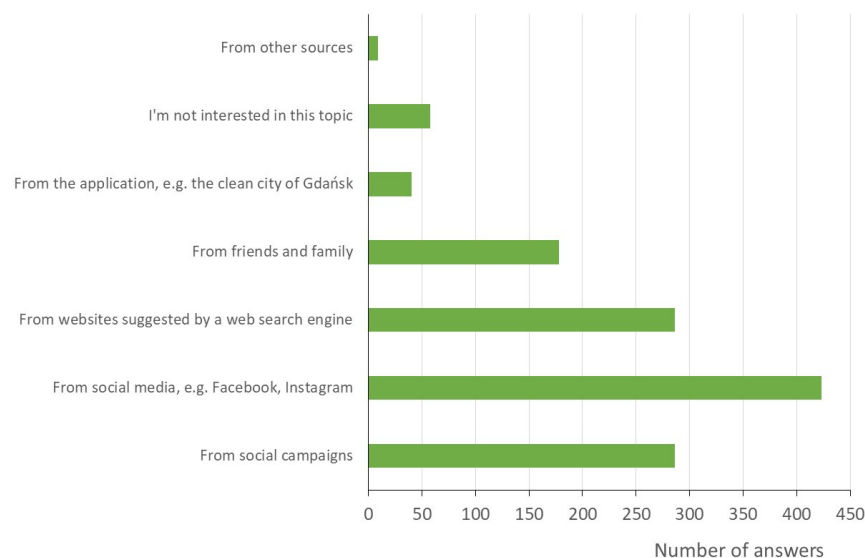
Figure 4. Sources of information from which respondents obtain information on waste segregation.

4. Discussion

4.1. Knowledge and Behavior of Respondents Regarding the Sorting of Household Waste

In this study, almost 90% of respondents declared that they sort waste. This result is comparable (96%) with results obtained by Ober and Karwot [42] in their research on the Polish population. More than 10% of respondents do not sort waste, and this result is similar to the one obtained by Voća and Ribić [43] in a survey conducted among the inhabitants of Zagreb (Croatia) (10.7%). Although previous research conducted by Czajkowski et al. [44] indicates that economic reasons are the most important factor determining the separation of waste by respondents (70%); in this survey, the economic factor was the least important factor motivating respondents to sort waste. The difference between the results obtained in these studies and those obtained by Czajkowski et al. [44] may have occurred due to the fact that our research was conducted 10 years later. Undoubtedly, the ecological awareness of residents has increased over this period. At the same time, in the research conducted by Ober and Karwot [42] on the pro-ecological behavior of Poles, the three most important motivational factors in pro-ecological behavior were care for their own and their family's health (80%), care for the natural environment (61%), and financial factor (65%). Research conducted in 2014 on a group of Swedish and Bulgarian students showed that 86% of Swedish students and 56% of Bulgarian students stated that they sorted waste in their households [45]. In research conducted by Wang et al. [46] among residents of ten cities in China, only 15.1% of respondents indicated that they sort their waste. The main way to dispose of household solid waste was to throw it into the mixed waste bin (68.1%). However, there are cities in China where the participation of residents in the waste segregation system is higher. In survey research conducted by Xiao et al. [41] on a group of residents of Xiamen city in China, 53.3% of them indicated that they always sorted waste, while 37.9% did so occasionally and 8.6% never sorted recyclables. This is probably the result of the short practice of waste sorting (the first government regulations on the classification and management of municipal waste in China were implemented on 1 April 2010) as well as the lack of a uniform waste segregation system into fractions. On the other hand, in eight cities in China, including Xiamen, pilot projects for the segregation of municipal waste have been operating since 2000 [41,47], while in Bangkok (Thailand), 66% of the respondents stipulated that they had sorted waste for recycling regularly. The respondents indicated economic reasons as the essential factor for sorting waste (43.6%), while environmental benefits were the reason for 40.6%. However, the main obstacles to waste sorting, as in our research, were a lack of sorting bins at home (21.9%), a lack of storage space (20.4%), and no time to sort waste/no interest in sorting waste (19.5%) [26].

Even though almost 90% of respondents indicated that they segregate waste, they do not separate it into all necessary fractions. The research results are similar to those obtained by Zarębska and Zarębski [48] in Poland. These studies were conducted in 2015–2016 and showed that 75% of respondents segregated waste, but 30% of them segregated only some fractions. As we mentioned earlier, in Poland, the basic segregation of municipal waste is based on five fractions: glass, plastic and metal, paper, bio-waste, and mixed waste. Moreover, in accordance with legal regulations, waste such as batteries and accumulators, medicines, chemicals, and unnecessary electronic equipment are also segregated. The respondents indicated that they most often segregate glass, plastic, and metal as well as paper. These are waste fractions that pose few problems during collection; containers for these fractions should be in every garbage shed and most often, they are large in volume. The least frequently separated waste fraction was bio-waste. This may be due to the fact that bio-waste containers require more frequent emptying and may be a source of unpleasant odors in homes, which may discourage citizens from separating this waste fraction. This result is interesting because, according to data from the Central Statistical Office, the largest share in the stream of municipal waste collected separately in 2021 was bio-waste (33.9%), followed by glass (14.4%), paper (10.1%), and plastic and metals (9.8%) [31]. The differences may result from the fact that the bio-waste fraction includes not only food leftovers or vegetable and fruit waste (including peelings) but also mown grass, leaves, and branches of trees and shrubs. Most of the respondents who took part in the study live in apartment blocks and therefore do not generate waste from gardens. In addition, bio-waste constituting municipal waste includes plant parts from the maintenance of green areas, municipal/city parks, and cemeteries.

Similar results regarding segregation into individual fractions were obtained by Pucherová et al. [49] and Voća and Ribić [43] in their research. The three most frequently segregated fractions by residents of Nitra city in the Slovak Republic were plastics (89.8%), paper (87.4%), and glass (80.1%), the same as for residents of Zagreb in Croatia (packaging—77.9%, paper—77.4%, and glass—74.1%) [43,49]. Among Lithuanian citizens, 5–6% of respondents admitted that they never sort waste, while two-thirds stated that they sort wastepaper, plastic, and glass always or often [50]. In the Slovak Republic, Croatia, Lithuania, and Germany, responses are collected by fraction. This division is similar to the basic fractions in Poland: paper, plastics, and metals (packaging), glass, bio-waste, mixing (residual) municipal waste, and other (including the hazardous waste fraction such as batteries and accumulators, electrical waste, and expired medicine) [43,49–53]. This is due to the fact that each of these countries belongs to the EU and was obliged to introduce selective waste collection systems based on the provisions of the previously mentioned Directive 2008/98/EC [37].

In the case of people who indicated that they did not segregate waste (10.4%), the main reason was a lack of publicly available containers for selective waste collection (21%) or their too-small volume (which often causes them to overflow) (22%), as well as a lack of conditions for sorting waste at home (21%). In previous studies conducted by Czajkowski et al. [44], Polish respondents indicated that the main reason for not sorting waste is a lack of faith in the sense of separating waste at home (38%), the process being too time-consuming (23%), it taking up too much space (20%), or that it is too expensive (19%). At the same time, 98% of respondents stated that segregating waste is important. This means that 8% of respondents are aware of how necessary it is to sort items and yet they do not do it.

The analysis of the results obtained in the survey showed that almost 60% of respondents had a high level of knowledge regarding waste sorting. In research conducted by Czajkowski et al. [44], over 80% of Polish respondents stated that they knew how to segregate waste. However, of those surveyed in China, only 9.2% indicated that they had a good level of knowledge in the field of waste sorting, and 71.7% said that they had only heard about household solid waste recycling [29]. These results are similar to those obtained by Babaei et al. [54]. In this survey, among Abadan residents (Iran), only 10.3% indicated that they had knowledge about source separation and recycling, and one of the main reasons as

to why they did not participate in the waste sorting process was a lack of awareness about recycling programs (89.7%). In Poland, ecological education includes society as a whole and takes place as part of education programs at various stages of education in kindergarten and school. Pro-ecological school education takes place as part of various subjects. Research conducted by Mróz et al. [55] regarding teachers' inclusion in ecological issues in schools showed that only 50.85% of lower school teachers declared that they regularly include this issue in the educational program. In the case of high schools, this result was even lower and amounted to 41.61%. At the same time, studies have shown that ecology issues are more often raised by teachers working in village schools than those working in town and city schools. However, a survey among Polish school students implemented as part of the program 'School students in the face of climate change' (part of the Visegrad Project) showed that only 13.85% of respondents are satisfied with the quality of ecological education at school, and as many as 59.01% are not satisfied with it. In addition, 62.5% of school students stated that climate change problems are not discussed during lessons. At the same time, respondents pointed out that ecological education should take a practical form, e.g., joint actions, such as cleaning the planet, outside classes, and Oxford debates and not just take the form of lectures. School students also emphasized the need to educate their parents and entire families [56]. The problem of a lack of ecological education also applies to higher education. Both in the study programs educating teachers and educating those in other professions, there is a lack of pro-ecological subjects (except for the fields of strictly environmental or ecological studies). For example, in the case of education of pharmacists in the education standard, there is no program content regarding both the impact of the wrong way to deal with expired/unnecessary drugs on the environment as well as the obligation to inform patients about the right ways of dealing with unnecessary drugs. The problem with the lack or too little ecological education in the Polish education system is primarily due to the fact that this system is mainly directed toward the transfer of knowledge or professional skills and not shaping attitudes. Therefore, it would be important to introduce a subject on the broadly understood ecology at various levels of education. On the other hand, Korsunova et al. [57], who investigated knowledge and awareness about circular economy amongst Finnish young adults, indicate that even educated students from ecologically progressive countries still do not observe the whole picture of many relations and dependence between the whole system of interconnections in the circular economy. This happens despite the fact that Finland is one of the pioneers in moving towards the direction pointed by the European Union and there are more financial resources channeled into ecology school education. Thus, this must be a sign to put more work and energy into this subject in all European Union countries and more.

Bio-waste waste such as vegetable and fruit waste should be properly disposed of in a bio-waste waste container. It is not only important which container this type of waste should be thrown into but also how it is thrown away. The most desirable method is to dispose of all bio-waste waste in bulk or in a compostable bag. One of the desirable options is also throwing bio-waste waste into your own composter, but this option is feasible and preferred by people living in single-family houses. Approximately 24.4% of respondents indicated that they throw bio-waste into a mixed waste container. These results are much more advanced compared to the results obtained by Xiao et al. [41] in China. Among Xiamen city residents, as many as 73.5% of respondents disposed of food waste with other garbage, despite the fact that there has been a pilot waste segregation program in place since 2000. This program includes the segregation of waste into recyclable ones (such as paper, glass, metal, plastics, and texts); bio-waste; harmful waste (including batteries and accumulators, electronic products, and expired drugs); and others [47].

In the survey conducted by Pucherová et al. [49] among residents of the city of Nitra (Slovak Republic), respondents indicated that they most often throw bio-waste from the garden and household into mixed waste containers (33.5%). A similar number of respondents (31.4%) segregate bio-waste and 19% compost it. Among the inhabitants of Zagreb (Croatia), only 23.6% of respondents segregate organic waste, and the main reasons

why respondents do not segregate this fraction are a lack of space for another bin and odors coming from separate waste collection [43]. Research conducted in Germany showed that the major disposal routes of food waste by residents were throwing it into organic waste bins (34%) and mixed waste bins (33%). Moreover, 14% of respondents indicated that they throw food waste into the sewage system and 9% compost it [51].

In the case of expired/unused pharmaceuticals, 83% of respondents declared that they returned them to a pharmacy or an appropriate collection point, and this value is higher than the values presented by Rogowska et al. [58] for Poland (about 30%). In accordance with the provisions of the 2012 Act on expired/unused waste, pharmaceuticals are treated as hazardous waste. As mentioned earlier, the commune is obliged to collect municipal waste, including expired/unused medicine. However, Poland lacks regulations including the collection of expired/unused pharmaceuticals from residents into the system, even though research both in Poland and worldwide indicates that pharmacies should dispose of expired/unused pharmaceuticals [58]. Pharmacies participate in this system on a voluntary basis, and the local government does not have any legal tools to obligatorily include them in this system [59].

In other surveys conducted by Lorek and Lorek [60] in Poland, respondents indicated that over half of them (53%) take broken electrical and electronic equipment to be repaired (or repair it themselves) and reused. Approximately 43% of respondents indicated that they donate unused household appliances to a specialized collection point, while 29% of respondents sell them and 25% give them to others for free. The contribution of used electronics was also one of the most common methods of e-waste disposal by respondents (40.8%) in the study conducted by Arain et al. [61] at one of the US universities.

4.2. Sources of Information on Waste Sorting Preferred by the Respondents

The respondents indicated that their main source of information on waste sorting is the Internet, primarily social media. Also, in the case of research conducted by Pucherová et al. [49] among the residents of the city of Nitra (Slovak Republic), they indicated that among the information campaigns on proper sorting and prevention of waste initiated by the city, respondents responded best to online campaigns (81.2%). Awareness campaigns were also one of the main motivations for recycling by Spanish respondents. Stakeholders also indicated that actions aimed at improving the level of recycling should include, in addition to increasing the number of street containers and placing them all together, increasing the number of campaigns raising awareness of the need to separate waste and encouraging recycling [22]. However, the case study in Brazil conducted by Conke [62] showed that one of the main barriers to recycling is a lack of knowledge about waste recycling programs. In Poland, as in other EU countries, social campaigns are carried out aimed at the general population regarding waste sorting. They are implemented both by authorities at the national and regional levels and by environmental organizations. At the national level, the information and educational campaign 'Five for sorting' has been implemented since 2019 by the Ministry of Climate and Environment on the proper method of segregating waste. The campaign, which started in 2019, is addressed to both local governments and all citizens. The campaign is also supported by an educational program for children [63]. The 'Our Garbage' and 'Don't litter your conscience' campaigns were implemented early on. Municipal authorities carry out information campaigns primarily due to the obligation arising by law.

In the years 2017–2019, the Supreme Audit Office (NIK), which is the supreme state audit body, audited the effectiveness of actions taken by the government and local government bodies to reduce the generation and management of plastic waste and implement the circular economy in this area. Moreover, as part of the inspection, the educational activities of the inspected entities were analyzed. NIK positively assessed the educational and information activities carried out by the audited entities regarding proper waste management. It was estimated that in 11 out of 15 inspected communes (73.3%), positive effects of educational activities were found. On the other hand, it was identified that 7 out of

15 communes did not incur any costs of educational and information activities focusing on waste management issues, which clearly indicated that educational activities had to take place, for example, during school classes or in the form of volunteering. However, it was emphasized that most of these activities were aimed at segregating waste, not preventing its formation [64]. At the same time, in research on the awareness and ecological behavior of Polish residents (conducted as part of a multi-year research program of the Ministry of Climate and Environment), the respondents indicated that 15% of them assessed the activities of the ministry, which are aimed at improving waste management in Poland, as definitely negative (15%), and over a third (34%) rated them rather negatively. Residents indicate that the three basic actions that the ministry should take to improve the effectiveness of waste management are educational activities and the promotion of proper waste management (15%), control of the waste management system (14%), and reducing the costs of waste management and introducing subsidies (8%) [65].

Moreover, it should be noted that education alone without the use of additional tools may not achieve the intended goal. Research conducted by Saladié and Santos-Lacueva [66] indicates that awareness campaigns will never be sufficient to accomplish the goals set in municipal waste management programs, and only the use of educational activities in combination with other tools will have an impact on improving the rates of separate waste collection.

5. Conclusions

The main condition to make the process effective in the aspect of the transition from a linear economy to a CE is the participation of consumers in this process. As Purvis et al. [60] point out, one of the most important elements of the process of moving towards the CE is the knowledge and self-agency of interested parties, including consumers, in this regard. Survey research aimed at examining the motivation, knowledge, and behavior of Polish respondents regarding the segregation of municipal waste and related problems shows that although almost 90% of residents declare that they segregate waste, some of them do not segregate waste into all fractions. In the case of some waste, the respondents had problems with assigning it to the appropriate fractions, which indicates the need for education in this area. An interesting conclusion is the respondents' motivation to segregate waste. Although some authors have indicated that the most important motivators for separating waste are economic factors, the respondents indicated that the most important factors are the fear of the environmental threat posed by waste (34%) and the desire to contribute to the recycling of waste generated (34%). However, it should be noted that respondents could indicate appropriate behaviors about which they had knowledge and which they did not necessarily use in everyday life. At the same time, 98% of respondents indicated that waste segregation is important. This means that 8% of respondents, although indicating that waste segregation is important, do not participate in the segregation process. When the respondents were asked to explain the reasons for such an attitude, some of them, who declared that they did not sort waste, indicated the lack of publicly available containers for selective waste collection or their too-small volume (which often causes them to overflow), as well as a lack of conditions for sorting waste at home. The respondents indicated that the main source of information on waste sorting is social media sites.

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