

Local population, tourism, hotel and restaurant enterprises as the main producers of municipal solid waste

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Abstract. The study analyzed the state of municipal solid waste management in Ukraine and found that the coverage of separate waste collection is low. There is an insufficient supply of different types of containers for separate waste collection. Less than 20% of the population is covered by separate collection and most settlements have containers for separate collection of PET bottles only. Only 31% of the population expressed their intention to participate in sorting. The reasons for the low level of sorting are not surprising, as in addition to the low level of environmental awareness among Ukrainians, municipalities, with the exception of large regional centres, have not yet created the right conditions for sorting. A sociological survey was carried out and the results analysed using Spearman's rank correlation in order to identify the most effective measures for influencing the population's environmental behaviour.

1 Introduction

Sustainable development entails the achievement of equilibrium between people, society, and nature, resolving conflicts between society and nature, ecology and economy, developed and developing nations, and meeting people's needs while satisfying reasonable requirements. The year 2022 was designated as the International Year of Rethink Tourism by the United Nations (UN) and the theme of World Tourism Day was 'Tourism and Green Investment'. As early as 1987, the UN General Assembly [1] coined the concept of sustainable development as the rational use of natural resources to preserve the earth for future generations. It has not lost its relevance since then - the concept of sustainable development is now actively discussed by world leaders. Modern scientists [2-6] define sustainable development as the balance and interdependence of economic, social, ecological, institutional, and innovative-technological components aimed at maximizing human well-being without compromising the ability of future generations to meet their needs.

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Ukraine is facing a critical situation with waste generation, accumulation, storage, processing, recycling and disposal, which is characterised by further development of environmental threats. Despite the declaration of the waste problem as a priority, the development of an appropriate regulatory framework and the implementation of various targeted programmes at both state and local levels, the process of waste accumulation has not been stopped.

In Ukraine, 4-7% of the territory is polluted by waste, with around 6,000 legal and 30,000 illegal landfills. The official landfills occupy 9,000 hectares and every Ukrainian discards at least 1,4 kg of waste each day. Environmental elements have a significant impact on tourism, influencing its advancement, durability, and environmental well-being. One of the fundamental ecological elements that affect tourism is climate change [7].

Furthermore, environmental contamination is an environmental factor that impacts tourism. Poor management of waste in tourist destinations can have an adverse impact on the health and comfort of tourists, as well as on the local population and ecosystems.

1.1 The relevance and the problem of the research

Russia's large-scale armed aggression against Ukraine has resulted in a sharp increase in the volume of specific waste, including damaged and abandoned vehicles and equipment, shell fragments, demolition waste, household and medical waste. Some of the waste is quite hazardous, in particular shrapnel, medical waste and demolition waste containing asbestos and heavy metals.

Thus, according to the report 'Ukraine: Rapid Assessment of Damage and Recovery Needs'[8], 5% of waste collection vehicles, 17% of biogas plants, and 9% of sorting lines were destroyed or damaged in the country. Direct losses in the waste management sector amounted to USD 95.36 million. The estimated cost of removing waste from the destruction of buildings and structures and rubble is USD 320.7 million, and the loss of profits of enterprises is USD 1.5 billion. The loss of profits of waste processing companies is estimated at USD 11.9 million. These estimates were made only for certain regions of Ukraine, including Donetsk, Luhansk, Kharkiv, Kyiv and Chernihiv oblasts, but they allow us to assess the overall scale of potential losses throughout Ukraine. Preparation and implementation of comprehensive environmental clean-up measures, especially those related to the collection, safe disposal and management of huge amounts of waste, including war waste, will help reduce immediate risks to the environment and human health.

Current waste management practices in Ukraine are considered inefficient and lead to negative environmental impacts. According to national statistics, in 2020, Ukraine generated over 462.4 million tonnes of waste, including 85% of extractive industry waste, 11% of processing industry waste, and 1.3% of municipal solid waste, with the rest coming from other sources. Hazardous waste amounted to 532.0 thousand tonnes. Waste imports totalled 2.7 thousand tonnes, including 1.5 thousand tonnes of hazardous waste. In particular, permits were issued for the cross-border transport of waste that does not contain components with hazardous properties, such as agricultural waste, waste paper, cotton, textiles and wood. Waste exports totalled 257.8 thousand tonnes, including 0.1 thousand tonnes of hazardous waste. Ukraine mainly exports non-ferrous metal waste and waste batteries.

In 2021, Ukraine generated more than 51 million m³ of municipal solid waste, or more than 10 million tonnes, and recycled and disposed of about 7.64% of municipal solid waste, of which 1.14% was incinerated, and 6.5% of municipal solid waste was sent to recycling centres and waste processing lines. According to the data provided by the regional military administrations, excluding information on the temporarily occupied territories, in 2022,

almost 39 million m³ of municipal solid waste, or more than 7 million tonnes, was generated in Ukrainian settlements, which is disposed of at 5.7 thousand landfills and landfills with a total area of almost 8 thousand hectares. In 2022, about 9.9% of municipal solid waste was recycled and disposed of, of which: 1.66% was incinerated, and 8.24% of municipal solid waste was sent to recycling centres and waste processing lines. The link between effective waste management and sustainable economic development is one of the top priorities of many countries around the world, including Ukraine.

In this context, the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand, is ratified with the Declaration by Law 1678-II of 16.09.2014. Section U: Economic and Sectoral Cooperation, Chapter 6: Environment, Annex XXX, Ukraine has to implement: the provisions of Directive 2008/98/EC on waste, including the preparation of waste management plans based on the five-step waste hierarchy and waste prevention programmes the provisions of Directive 1999/31/EC on waste, as amended by Regulation (EC) No 1882/2003, in particular the preparation of a national strategy to reduce the amount of municipal solid waste that is biodegradable by micro-organisms (biodegradable waste) going to landfills.

1.2 Literature Review

There are different approaches to the implementation of the waste management concept in different countries, Dikole, R. and Letshwenyo, M [9] examined the generation, composition and characteristics of municipal solid waste from households with different income levels on weekdays and weekends in Palapye village, Botswana. Paulina Bohdanowicz [10] notes that environmental management in hotels in Sweden and Poland has been affected by the economic situation and government initiatives on environmental practices. Hotel operators recognise the importance of environmental protection, but need customer demand for sustainable practices. The article [11] notes that waste generated by the hospitality industry is a challenge for tourist destinations. Eugenio Diaz-Farina, Juan J. Díaz-Hernandez, Noemi Padron-Fumero provide recommendations for reducing household waste and working with hotel and restaurant owners and managers.

Starting from 1 October 2019, local residents, tourism, hotel and restaurant businesses are required to provide separate waste sorting systems in residential and public premises. However, it is not being implemented for a number of reasons, including a lack of connections with recycling carriers, a misconception that it is a priority to build a recycling plant (in the pre-war period, most recycling plants in Ukraine were underutilised), low motivation and lack of punishment. In terms of solid waste management, Ukraine faces such problems as an outdated regulatory framework, low tariffs for waste disposal and management, and a lack of incentives to recycle solid waste. The main obstacle is the lack of focus on preventing waste generation, instead focusing on what to do with waste once it is generated.

2 Results

In 2021, Ukraine enacted its inaugural special law with the objective of limiting the production and consumption of plastic bags within the country. This legislation was the Law of Ukraine No. 1489-IX, dated 1 June 2021, entitled 'On Restricting the Circulation of Plastic Bags in Ukraine'. This introduced certain provisions of the amendments introduced by EU Directive 2015/720 to the basic EU Directive 94/62 on packaging and packaging waste in Ukraine. The Ukrainian Retailers Association has provided information indicating that, following the government's decision to set minimum retail prices for plastic bags, the

use of these bags was reduced by 40-90% and the consumption of biodegradable bags was increased by more than twofold. However, the distribution of other single-use plastic products at retail outlets remains unregulated.

According to expert data, approximately 30% of municipal solid waste in Ukraine is packaging waste, while only 12-14% of this packaging waste is recycled. A study commissioned by the American Chamber of Commerce has revealed that approximately 2 million tonnes of the 2.4 million tonnes of packaging placed into circulation each year are lost, including 33% of glass, 30% of paper, 21% of polymers, 10% of wood, 4% of metals and 2% of other waste.

Ukraine consumes approximately 1.5 million tonnes of cardboard and paper products per year. Of the total volume of products consumed by the domestic market, the industry returns approximately 800,000 tonnes as secondary raw materials, while the demand for existing production capacity is approximately 1.2 million tonnes. Concurrently, a considerable proportion of the secondary raw materials is procured from abroad (Romania, Moldova, etc.), amounting to approximately 350 thousand tonnes of waste paper, with a total annual processing of approximately 1.3 million tonnes. This equates to approximately 27% of the production needs being met by imported raw materials.

There are 17 operational glassworks in Ukraine. The majority of glass containers are reused by beverage and canning manufacturers after undergoing sterilisation and reuse in an undamaged state. In the manufacture of glass products, the glass furnaces are fed with a mixture of cullet and fresh additives, such as sand, soda, limestone, and so forth. The proportion of used glass in relation to fresh additives at Ukrainian glassworks is lower than at similar European enterprises, indicating an opportunity and a need to increase the use of secondary resources. Manufacturers are interested in this because recycled materials are cheaper than fresh materials and an increase in the share of used glass in the mix will reduce natural gas consumption in glassmaking. In total, Ukrainian plants are capable of processing 800 thousand tonnes of cullet. Despite the fact that only 5-8% of glass scrap remains in landfills after recycling, the needs of glassmaking companies cannot be met – only 300,000 tonnes are processed annually.

Today, the capacity of Ukrainian enterprises to recycle all types of plastics is more than 300,000 tonnes per year, while only 180,000 tonnes of polymer waste is processed. In total, approximately 20 companies in Ukraine are engaged in the recycling of PET containers into secondary materials. However, the production capacities for PET packaging recycling are only 50-70% loaded with raw materials. Consequently, while the recycling rate for polymers in general is 14%, it reaches 55% for bottle PET. This is due to the fact that plastic bottles are a convenient and easy object for pre-sorting and organising an individual processing chain.

Currently, there are 91 waste recycling companies operating in Ukraine. These include 17 waste paper recycling companies, 39 polymer recycling companies, 19 plastic bottle recycling companies, and 16 glass recycling companies. However, their capacities are only 50-70% utilised due to a shortage of recyclable materials in the domestic market, which is covered by purchases from abroad. The quality of recyclables received by the industry from domestic sources is suboptimal due to the prevalence of irresponsible waste management practices, particularly in the context of packaging.

Home composting can only be carried out by residents of rural areas and suburban areas of cities and towns in the framework of pilot projects accompanied by an intensive information and education campaign in each case. The successful implementation of a home composting scheme requires significant efforts on the part of local governments to disseminate information and raise awareness, as well as to supervise and monitor the use and effectiveness of the scheme.

Given that 30.4% of Ukraine's population lives in rural areas and 24.6% in small towns, with a high level of utilisation, the coverage of home composting schemes will result in a 2.5% reduction in total municipal waste generation by 2035, requiring 2.6 million composters at a total cost of around EUR 105.0 million. Composters should not be provided free of charge, but only at a reduced or discounted price, or purchased by local governments.

Composting operations can be used by waste collection centres to treat separately collected green waste (garden waste from households, parks and gardens). Composting of green waste can be carried out in the open air, as the smell of biological treatment of this material is minimal.

The average annual volume of biodegradable waste is 47% (about 5.2 million tonnes) of the total amount of municipal waste generated in Ukraine, which varies significantly by region and type of settlement. The maximum amount is generated in rural areas and sparsely urbanised areas. This is due to the level of income, consumption patterns and demographic characteristics of the regions (Table 1).

Table 1. Forecast of municipal solid waste generation (2023-2035, million tonnes per year).

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
population	11,83	13,23	13,26	13,29	13,32	13,34	13,37	13,4	13,43	13,46	13,48
institutions	1,61	1,8	1,81	1,81	1,82	1,82	1,82	1,83	1,83	1,83	1,84
bulky and repair	1,35	1,34	1,33	1,32	1,32	1,31	1,3	1,29	1,29	1,28	1,27
Waste electrical and electronic equipment	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21
Per capita:											
Solid waste generated, kg	423,6	429,4	435,3	441,3	447,4	453,6	459,9	466,2	472,6	479,2	485,8
Dynamics, in % by 2022, including:	133,2	135,0	136,9	138,8	140,7	142,6	144,6	146,6	148,6	150,7	152,8
population	334	377,9	383,1	388,4	393,7	399,2	404,7	410,3	415,9	421,7	427,5
institutions	45,6	51,5	52,2	53	53,7	54,4	55,2	55,9	56,7	57,5	58,3
bulky and repair waste	38	38,2	38,5	38,7	38,9	39,2	39,4	39,6	39,9	40,1	40,3
Waste electrical and electronic equipment	6	6,1	6,1	6,2	6,2	6,3	6,4	6,4	6,5	6,6	6,6

It would appear that the average Ukrainian generates 1.04 kg of municipal solid waste per day, which includes the amount of snowmelt and waste from the green space in the adjacent territory. This equates to an average of 379.6 kg of municipal solid waste per year, which is significantly less than the European average, and 38 kg of bulky, repair and construction waste per year. These volumes are taken as a baseline for the forecast of waste generation, with the understanding that the average annual growth rate of waste generation, according to the forecasts of the Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine, is 1.38%.

It is estimated that in 2025, 13.51 million tonnes of municipal solid waste will be generated, and in 2030, 13.65 million tonnes of municipal solid waste from households and other sources that generate similar waste.

According to the State Statistics Service of Ukraine, as of 1 January 2021, the permanent population of Ukraine was 41,588.4 thousand people. Of these, 28,959.5 thousand people (69.6%) were urban residents and 12,628.8 thousand people (30.4%) were rural residents. As of 1 January 2022, the population of Ukraine decreased by 421.1 thousand people, resulting in a total of 41,167.3 thousand people. Of these, 69.8% were urban residents and 30.2% were rural residents. It is notable that the percentage of population decline in Ukraine is quite significant and significantly exceeds the expected population decline for this period in all other EU countries. With regard to the distribution of the population by place of residence, it is anticipated that there may be a slight increase in the percentage of urban population as a result of internal migration processes.

It would be remiss of us not to consider the dynamics of municipal solid waste generation in other groups of administrative districts, which also show a negative trend, with the exception of the group of 75-100 thousand tonnes and the city of Kyiv.

These trends should be taken into account when drawing up regional and local waste management plans and planning the location of waste management facilities, primarily landfills and thermal, mechanical and biological treatment, composting and recycling facilities, as well as the location of waste transfer stations and sorting lines.

A further analysis of the population and the amount of municipal solid waste generated by territorial communities reveals even more significant differences between them, primarily in terms of region. This is due to the dispersion of population settlement, with a large number of rural settlements, especially in the central, northern and southern regions, which are part of territorial communities with a population of less than 100-250 people. This will undoubtedly have a significant impact on the organisation of the waste management system and the quality of services provided to residents of these villages.

Due to natural growth and internal and external migration, the number of territorial communities with a population of 5, 10, 25 thousand people will increase significantly. This will require additional funding for waste management, as the costs of logistics and organising separate waste collection and treatment will increase significantly.

One challenge that territorial communities face is the presence of spontaneous and unauthorised landfills in virtually every rural settlement. Given that a territorial community includes from 5 to 50 rural settlements, it may not be feasible to finance their elimination from local budgets. It would be beneficial to explore other financial mechanisms to address these issues.

One potential solution to these waste management challenges in territorial communities could be to explore the possibility of introducing a regional division into clusters and cooperation of territorial communities. Additionally, it might be beneficial to consider ways to attract international technical and financial assistance to achieve the goals of sustainable development of territories.

It is estimated that total capital expenditures (construction and reclamation of existing landfills and dumpsites, construction of thermal and mechanical-biological treatment and

composting facilities with construction waste recovery and disposal sites, waste recycling and recovery, sorting and reloading stations for municipal solid waste, centres for separate collection of household and bulky waste, including hazardous waste containing hazardous waste contained in municipal solid waste, purchase of containers and vehicles, etc.) will amount to approximately EUR 4.6 billion.

It is estimated that operating costs, namely collection, sorting, and operation of facilities, will amount to approximately EUR 6.6 billion over the planning period up to 2035.

It is our hope that the projected capital and operating costs of approximately EUR 11.2 billion will be fully recovered. We believe that the cost should be recovered on a polluter pays basis, i.e. by waste generators – households, public sector and commercial/industrial enterprises. It would be beneficial to improve the current system and consider increasing the fees for waste management services provided to households, public sector and commercial/industrial enterprises in the planning period. This could help ensure full cost coverage. It might also be worth exploring the possibility of introducing an extended producer responsibility scheme for packaging waste, which could potentially cover the costs of separate collection and sorting.

In Ukraine, the current average tariff for households, public sector and commercial/industrial enterprises for municipal solid waste management services is based on the cost of waste collection and removal and its final disposal at a landfill or dump (incineration in Kyiv). On average, the cost of the services provided is €7-15 per year per resident. This represents 0.32 to 0.73% of the average annual disposable income per person. A preliminary assessment of the realisation of investment costs has indicated that total costs may increase to an average of 1.7% of the average annual income per household in Ukraine (ranging from 1.34% to 1.92%). This would mean that tariffs for consumers may have to increase significantly, while still remaining within acceptable affordability limits. As of 2022, almost 80% of Ukraine's population is covered by municipal solid waste collection services.

In Ukraine, separate municipal solid waste collection is being implemented in 1440 settlements (excluding the temporarily occupied territories, as well as the eastern and southern regions of Ukraine, which were unable to provide complete information due to military aggression by the Russian Federation), covering 72% of residents. Overall, approximately 30% of the country's population is covered by separate waste collection. It would be beneficial to provide municipal solid waste management services in accordance with the scheme of sanitary cleaning of settlements with separate collection of municipal solid waste. The methodology of separate collection of municipal solid waste provides for technological schemes with the use of 2 to 5 containers. It is a common practice to use 1 container to collect only PET bottles or plastic. In cities, a two-container scheme is used to collect the 'dry fraction' of resource-value components and mixed waste, or a three-container scheme with different variations of collection of plastic, paper, glass and metal waste.

Currently, municipal waste management in Ukraine is mainly based on low-level technologies aimed at predominantly landfilling.

There are approximately 5,700 landfills and dumpsites with a total area of almost 8,000 hectares. It is estimated that 40% of these require reclamation. It is encouraging to note that approximately 120 landfills comply with the DBN standards. At 55 landfills, there is a leachate collection system, including a leachate disinfection system at 50 landfills, and storage tanks at the rest, from where leachate is periodically transported to treatment facilities. Biogas extraction systems are in place at 18 landfills and cogeneration units are in operation.

The first area of recycling collection is largely driven by households, which do not dispose of part of their waste in garbage containers but rather hand it over to collection points. The second area of separate collection is ensured through contracts with enterprises that generate large flows of packaging waste in their production cycle.

The existing system of Ukrvtorma's recycling organisations and enterprises, as well as local networks, includes 1,500 enterprises that play an important role in the market, with waste recycling facilities.

3 Discussion

The primary tenets of the state policy in the field of waste prevention and management are the principles of prevention, ‘polluter pays’, territorial proximity, and the formation of a competitive environment in the field of management. Strategic planning efforts will focus on preventing waste generation by introducing requirements for product design, life cycle extension, and repair capabilities.

Waste management will be carried out in accordance with the adopted waste management hierarchy, which provides for the following in order of priority:

1. Prevention of waste generation;
2. Preparation of waste for reuse;
3. Recycling;
4. Waste recovery (including energy production);
5. Waste disposal.

Thus, in order to reduce the accumulation of solid waste, it is advisable to introduce the practice of waste sorting by its producers.

In addition, the state should facilitate the formation of an ecological culture among the population through various means, including the media, economic incentives, and the establishment of a fundamental legislative framework with financial responsibility. Once these measures have been implemented, the population will be able to provide enterprises with sorted waste, which will in turn result in cheaper electricity and a social benefit in the form of reduced landfills. The primary factor that will ensure the success of this scheme is the provision of sorted waste to enterprises, as significant funding is required for the installation of sorting lines. In order to identify the most effective measures that can form an environmental culture among the population, a sociological survey was conducted and its results analysed using Spearman's rank correlation. A total of 148 respondents from different administrative-territorial units of Ukraine were interviewed using a Google form, with parity maintained between women and men, as well as urban and rural populations. Some of the emirate data confirm the national statistics.

In response to the question, "Are you satisfied with the existing waste collection system?," 74% of respondents indicated a negative response, as shown in Fig 1.

Table 2. Respondents' attitudes to waste sorting.

Answer options	Number of respondents
I do not sort waste and will not sort waste	16
I do not sort waste but will sort it	46
I sort all waste	33
I sort some waste (only certain fractions: PET, paper)	28
I only sort organic waste	25

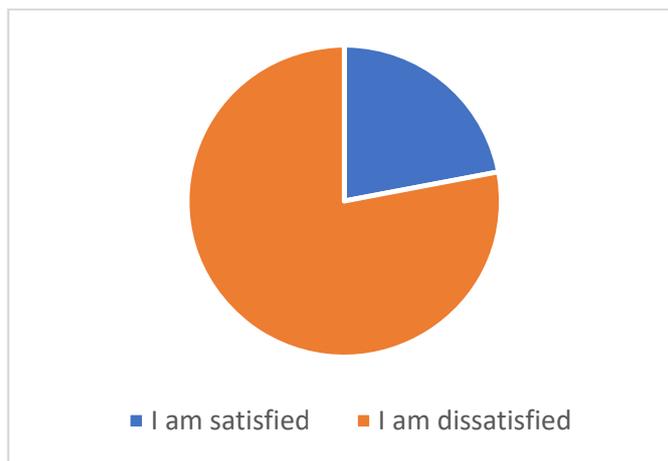


Fig. 1. Are you satisfied with the existing waste collection system?

This answer demonstrates that respondents understand the existence of a waste problem in Ukraine. The next question was about sorting and attitudes towards sorting. The answers are shown in the Fig 2 and table 2.

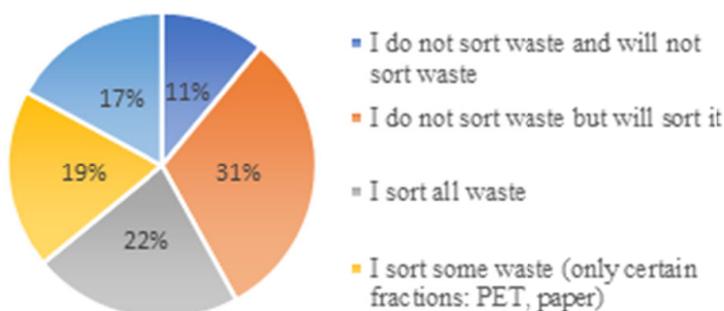


Fig. 2. Respondents' attitudes to waste sorting.

Thus, 22% of respondents sort all waste fractions, which is slightly lower than the official statistics. Thirty-one per cent have expressed their intention to start sorting. The reasons for the low level of waste sorting are not surprising, as, in addition to the low level of environmental awareness among Ukrainians, with the rare exception of large regional centres, communities have not yet created the right conditions for sorting. For example, residents of the Kharkiv region do not want to take sorted waste to Kharkiv Zero Waste on their own, as it causes a number of inconveniences, including time and money spent on transporting waste, etc. Therefore, many of them do not see the point in this process. In addition, some citizens express doubts about the further 'fate' of sorted waste, believing that all waste (sorted or unsorted) will eventually end up at a landfill. This confirms the need for public education. The next point was about the morphological structure of the waste generated. In Ukraine, there are no systematic studies with official data on the morphological composition of municipal solid waste, and spot studies are often contradictory in nature. Based on the available measurements of waste composition in different cities of Ukraine, the average morphological composition of waste was adopted (organic waste - 20.3%, paper and cardboard - 6.4%, plastic - 11.5%, glass - 19.3%, metal - 1.9%, textiles - 3.8%, wood - 1.4%, hazardous waste - 0.7%, bones, leather, rubber - 3.6% and mineral and other - 31.3%), as shown in Fig. 3.

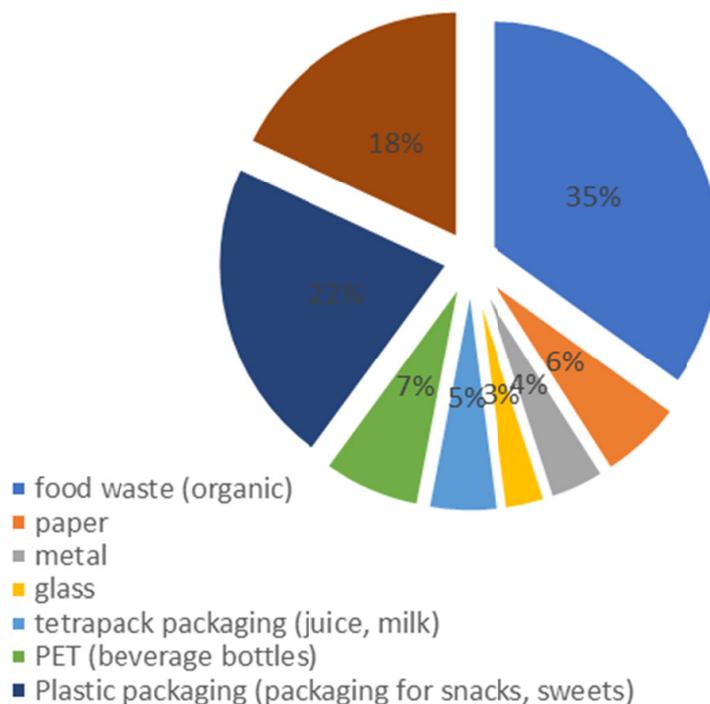


Fig. 3. Official data on the morphological composition of solid waste [7].

Additionally, the respondents' attitudes towards the problem under study were evaluated using an ordinal rating scale, in accordance with the Likert scale (Fig. 4).

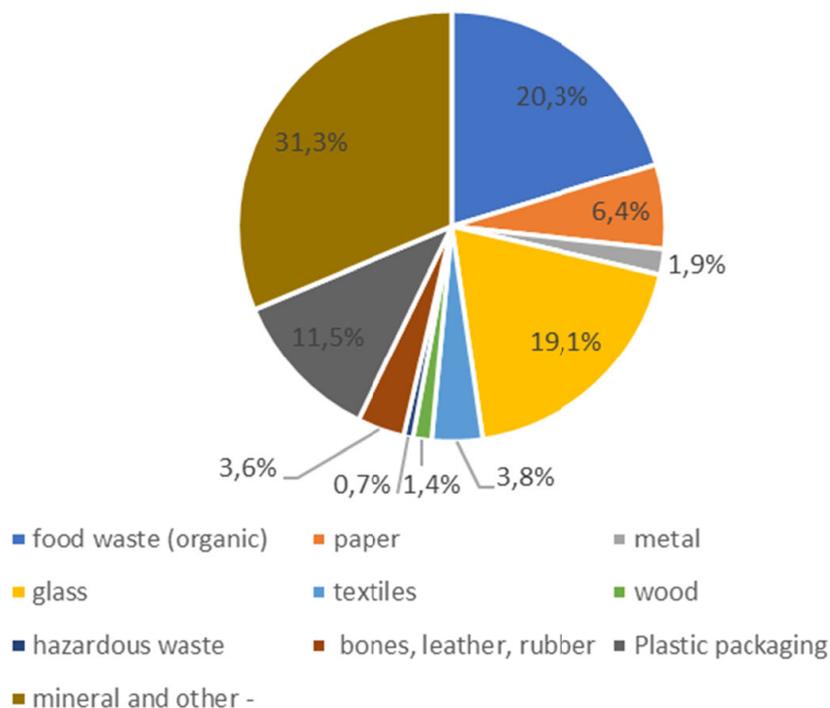


Fig. 4. Respondents' answers.

The utilisation of this method enables the acquisition of quantitative assessments of respondents' attitudes, which are suitable for the analysis of the degree of interest in the studied aspect, as measured on a rank scale [12].

In practice, the ordinal rating scale is employed to ascertain whether respondents concur or diverge with the proposed statements that typify the object of research, upon which the analysis is predicated.

The data collected and processed for the purposes of the study, as well as the calculations made for the study of certain aspects and the overall results of the study, were presented by the authors in the form of a table, clearly showing the assessment of the agreement or disagreement of individual respondents with the statements selected by the authors that characterise the behaviour of solid waste producers.

The measurement scale can be modified in various ways, with the number of assessment items ranging from two to seven. In this study, we employed the classical scale, which consists of five assessment items: Strongly disagree (1 point), Disagree (2 points), Neutral (3 points), Agree (4 points), Strongly agree (5 points),

The format of the questionnaire, which contains the statements posed to the respondents, is in the Fig 5.

Please indicate how strongly you agree or disagree with the following statements *

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I understand the responsibility for my waste, even if it ends up in a landfill.	<input type="radio"/>				
I am willing to sort if the state/local government creates appropriate conditions and consequences	<input type="radio"/>				
I can influence the solution of the problem	<input type="radio"/>				
I understand the size of existing landfills and their negative impact on the environment	<input type="radio"/>				
I agree to pay more for waste management	<input type="radio"/>				

Fig 5. The proposed form for assessing statements on the Likert scale.

The research results were processed in the following sequence: The initial stage of the research process involved the administration of the survey and the subsequent compilation of a summary table containing the survey results. Table 3 presents the findings of the survey. Given the limitations of space, we have chosen to present only a portion of the data in this article.

It should be noted that the scores obtained are summed for all the statements. The total score makes it possible to characterize the respondent's position on the problem under study.

Table 3. Results of the questionnaire processing.

respondent	I agree to pay more for waste management	I understand the responsibility for my waste, even if it ends up in a landfill	I am willing to sort if the state/local government creates appropriate conditions and consequences	I can influence the solution of the problem	I understand the size of existing landfills and their negative impact on the environment	total score
1	5	5	5	2	5	22
2	1	4	5	1	2	13
3	1	2	2	1	3	9
...
144	1	1	1	1	2	6
145	1	2	2	1	3	9
146	1	1	1	1	2	6
147	2	4	4	1	4	15
148	1	1	2	1	3	8

Stage 2 - Statistical processing of the results.

This stage involves the construction of a correlation table, on the basis of which the correlation coefficient for each statement is calculated. Table 2 shows the results of the calculation for statements 1 - "I am willing to pay more for waste management". Similarly, the indicators of the conjugate tables for statements 2-5 are calculated.

Step 3 is the calculation of Spearman's coefficients for each statement and the drawing of conclusions. The calculation is based on Spearman's rank correlation formula:

$$r_s = \frac{6 \sum d^2}{n(n^2 - 1)}$$

r_s is Spearman's rank correlation coefficient; d is the difference between the rank pairs for the i -th statement; n is the number of rank pairs (number of respondents).

The results of the calculation of the coefficients are presented in Table 4.

Table 4. Conjugate table for statement 1.

respondent	total score, S_0	statement score S_b	$S_0 - S_b$	S_b rank	$S_0 - S_b$ rank	difference ranks, d	d^2
1	22	5	17	15	22	-7	49
2	13	1	12	117,5	66	51,5	2652,25
...
143	9	1	8	117,5	88,5	29	841
144	6	1	5	117,5	133,5	-16	256
147	15	2	13	72	51	21	441
148	8	1	7	117,5	111	6,5	42,25
							339376,5

Table 5. Results of Spearman's coefficient calculation.

Answers	r_s
I agree to pay more for waste management	0,37
I understand the responsibility for my waste, even if it ends up in a landfill.	0,47
I am willing to sort if the state/local government creates appropriate conditions and consequences	0,66
I can influence the solution of the problem	0,19
I understand the size of existing landfills and their negative impact on the environment	0,76

The calculations show the difference in the coefficients obtained according to the proposed statement.

In order to interpret the results obtained, it is necessary to determine the limits of the calculated indicators, which make it possible to assess the closeness of the relationships between the attributes. Conventionally, the limits are estimated as follows: strong relationship - the value of the r_s coefficient is 0.7 or more; moderate relationship - from 0.4 to 0.699; weak correlation - from 0 to 0.399.

Thus, the results of the study indicate a strong relationship for statement 5 - 'I understand the size of existing landfills and their negative impact on the environment' (r_s value = 0.76). A fairly close relationship between the behavioral factors identified by the authors and the willingness of MSW producers to sort was also shown for statement 3 - 'I am willing to sort if the state/local government creates appropriate conditions and consequences' (r_s value = 0.66). Statement 1 - 'I am willing to pay more for waste management' (r_s value = 0.37) shows that MSW producers are not willing to pay more for measures to improve the existing MSW collection system, so the government's intention to introduce a 'user pays' payment system may face obstacles. An interesting result was obtained for the statement 'I can influence the solution of the problem' (r_s coefficient value = 0.19), i.e. respondents believe that they cannot influence the solution of the problem. Of course, this is a false opinion, because every citizen of Ukraine can influence this problem by reducing the production of solid waste and implementing the principles of environmentally friendly behaviour in their lives [13].

Today in Ukraine, in addition to households, tourism enterprises and the hotel and restaurant business are also producers of solid waste. Official statistics only count the amount of waste generated by households. Between 10 and 30% of municipal solid waste generated by organisations, institutions and enterprises of all forms of ownership is not accounted for in the statistics, although it is subsequently transferred to recovery and disposal facilities. State accounting and statistics of municipal solid waste in Ukraine have significant shortcomings due to the fact that only legal entities whose activities are related to the generation and management of waste of I-IV hazard classes submit reporting data in the form № 1-waste, so official statistics do not cover the full list of solid waste producers.

According to the Cambridge Institute for Sustainability Leadership, tourism contributes around 5% of global greenhouse gas emissions and this is expected to increase by 130% by 2035. In addition, the hotel industry is responsible for around 1% of global emissions. According to a 2017 report by the Sustainable Hospitality Alliance, the hotel industry needs to reduce greenhouse gas emissions per room by 66% annually by 2030 compared to 2010 levels, and by 90% by 2050. However, to achieve full decarbonisation by 2050, the industry needs to grow, attract more guests and build more properties. On average around the world, each guest generates around 14 kg of CO₂ per night through energy consumption, excluding food and beverage. However, actual emissions can vary significantly depending on the type of accommodation, from 1kg to 260kg of CO₂ per guest [15].

According to the State Statistics Service of Ukraine, in 2019 there were 5,335 accommodation facilities in Ukraine (including 3,165 hotels) with a total of 370,500 beds, 6.96 million visitors and 18.5 million overnight stays. And this is without taking into account the potential of sanatoriums, children's health camps and apartments rented by private individuals. As for the catering industry, by 2021 there will be 14.7 thousand units with the value of services provided at UAH 14.1 billion. This means that there will be more than 20,000 catering establishments, generating 3.6-6.3% of Ukraine's GDP.

According to expert estimates, Ukraine's HoReCa generates 97.1 thousand tonnes of solid waste (1% of the total amount of municipal solid waste in Ukraine, excluding data from sanatoriums, children's health camps and apartments rented by private individuals).

The municipal solid waste generated by hotels is multi-component and includes paper, food, various metals, plastics, aluminium and glass. Implementing a municipal solid waste reduction programme in a hotel can significantly reduce waste disposal costs while making the hotel more environmentally friendly [16-17]. This is especially true as municipal solid waste becomes an increasingly serious environmental issue and landfill fees rise. Hotels are reluctant to implement solid waste management programmes because of the need for co-ordination and co-operation between managers, staff and guests. However, it is important to note that municipal waste is often very visible, creating a 'broken windows' effect [18-19].

4 Recommendations

Implementation of educational campaigns. These campaigns should be targeted at individuals, businesses and other organizations to raise awareness of the negative effects of littering and the importance of proper waste management. The aim of the communication strategy should be to help society to stop tolerating cases of littering and burning of green waste and to perceive it as a violation of the rules and the personal right to a clean environment. At the same time, the capacity of the regulatory authorities to enforce the rules prohibiting such behaviour must be strengthened.

Public clean-up campaigns. Authorities and waste management service providers should promote initiatives that involve residents in cleaning activities, such as volunteer environmental clean-ups or community clean-ups.

Strengthen enforcement and monitoring. Law enforcement agencies could be given more resources to enforce waste management and landscaping regulations, and fines for littering should be increased to a level that deters people from such behaviour. Environmental inspectors should take action to close and remove unauthorized dumps - where a permitted alternative exists - and inform local authorities of the need to take such action.

Improve waste collection and treatment infrastructure. This includes investment in waste collection and treatment infrastructure, such as measures to achieve full coverage of the population with waste management services and to improve waste collection systems.

To ensure that a comprehensive waste management infrastructure is in place, it is important to raise awareness of the negative impacts. It is also important to explain that the costs of providing integrated waste management services should be recovered from waste producers through tariffs, supplemented where necessary by grants or subsidies. In addition, information on the realistic costs of waste management services should be made available to decision-makers, planners, the media and civil society.

There is a widespread misconception in civil society that material recovery and recycling generates revenues that exceed costs. However, analysis shows that this is actually a net cost of operation. This message needs to be made clear to all stakeholders. Such misconceptions can prevent effective waste management decisions.

Waste prevention policy. A national waste prevention programme will include measures to reduce the amount of waste generated, such as a ban on single-use plastics, as well as incentives for businesses to reduce waste.

Spatial planning measures. Public spaces should be designed to be litter-free, for example with sufficient bins and signs encouraging proper waste management. The colour and bright lettering of the bins should attract people's attention and encourage them to dispose of their waste properly. In public places where smoking is allowed, ashtrays can prevent littering with cigarette butts. Investment can be made in innovative technologies, such as smart bins, which detect when they are full and need to be emptied. Physical barriers such as fences, hedges and low walls prevent litter from being blown off the site. By incorporating these features into the design of public spaces, littering can be discouraged and the public can be encouraged to dispose of waste properly.

5 Conclusions

The source of environmental pollution is inadequate waste management, including the dumping and disposal of waste in places not intended for it. According to the Ministry of Infrastructure, in 2022 year 20% of the population was not covered by waste management services. Every year in Ukraine, about 20,000 unauthorized landfills of 0.4-0.6 thousand hectares are created in settlements, mostly in the private sector, due to inadequate municipal solid waste management. Improper waste management on land results in waste entering rivers and being transported into the marine environment. The Ukrainian Scientific Centre for Marine Ecology, together with the EMBLAS project, has found that the amount of litter and plastic in the Black Sea has increased over the past 30 years to 90 units per 1 km² - twice as much as in the Mediterranean. This has a negative impact on the marine ecosystem, as 6 to 50 pieces of litter are carried into the Black Sea by large rivers every hour. In the Black Sea garbage patches, 68% of the pollution is plastic.

The study analyzed the state of municipal solid waste management in Ukraine and found that the coverage of separate waste collection is low. There is an insufficient supply of different types of containers for separate waste collection. Less than 20% of the population is covered by separate collection and most settlements have containers for separate collection of PET bottles only. Only 31% of the population expressed their intention to participate in sorting. The reasons for the low level of sorting are not surprising, as in addition to the low level of environmental awareness among Ukrainians, municipalities, with the exception of large regional centres, have not yet created the right conditions for sorting. There is a lack of specialised vehicles for separate collection with appropriate labelling of the type of waste collected in the fleet of market operators. The lack of visual distinction between vehicles reinforces the public perception that all waste (mixed and sorted) is collected by one truck, which reduces the desire to sort waste at home. In addition, 74% of respondents are dissatisfied with the current waste collection system, believing that they have no influence and are waiting for the local administration to create the conditions for sorting.

In addition to the population, tourism enterprises and the hotel and restaurant business are also producers of municipal solid waste. By at least partially adhering to the principles of zero waste (prevention, reuse, sorting, composting), establishments can reduce the amount of waste generated many times over. This is also facilitated by the PAYT incentive tariff.

A city cannot develop successfully without a diverse range of large, medium and small businesses, and the more establishments of different formats implement waste-free and environmentally friendly practices, the more attractive the city becomes to tourists.

Businesses that have embarked on the path to zero waste are more likely to foster local connections and support local producers, as well as producers of environmentally friendly or reusable products. The community gets greener facilities, and the amount of mixed waste and emissions into the city air is reduced. The number of sorting sites is increasing with the assistance and at the request of businesses: they are quicker than municipalities to introduce separate collection.

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