

SEPARATE WASTE COLLECTION – AN INDISPENSABLE FACTOR IN IMPLEMENTING THE CIRCULAR ECONOMY MODEL

COLECTAREA SEPARATĂ A DEȘEURILOR – FACTOR INDISPENSABIL ÎN IMPLEMENTAREA MODELULUI ECONOMIEI CIRCULARE

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Abstract:

Waste management is one of the important problems that the Republic of Moldova is facing in environmental protection activities. At present, the problem of waste is manifesting more acutely, due to the increase of its quantity and diversity, as well as of its more pronounced negative impact on the environment. The urban and industrial development of the localities, as well as the general increase of the living standard of the population, entails the production of huge quantities of waste. In order to implement a sustainable Municipal Solid Waste Management System, it is necessary, first of all, to create premises for the separate collection of waste. This article analyses the theoretical and practical aspects of organizing the separate collection of waste in rural and urban areas. At the same time, the authors aim to cross the path of waste circularity from collection to recycling, but also to identify good practices regarding the organization of the integrated waste management system. The research was conducted within the State Program 20.80009.0807.22 Developing the circular economy mechanism for the Republic of Moldova.

Keywords: waste management, separate waste collection, circular economy, recycling, integrated waste management system, municipal waste.

JEL: Q53, Q54

1. Introduction

The separate collection of waste represents one of the important problems faced by the Republic of Moldova within the environmental protection activities. Currently, the waste problem is becoming increasingly acute, due to the augmentation of its quantity and diversity, as well as its increasingly pronounced negative impact on the environment. The urban and industrial development of localities, as well as the general increase in the population standard of living, leads to the production of large amounts of waste.

The basic objectives of the current policy of the European Union regarding waste, to which the Republic of Moldova is going to align, consist in the prevention of waste generation and in the promotion of circular economy principles to ensure environmental protection. Waste is increasingly perceived as a source of valuable raw material for the industrial sector, with approaches such as reuse, recycling and energy recovery, with the implementation of regulation of packaging waste, end-of-life vehicles, equipment waste, electrical and electronic, biodegradable waste and tires.

In rural areas, the problem of waste management is even more acute. This phenomenon is caused by the small number of villages connected to sanitation services, where there are no waste management companies, and the transportation of waste to storage places is mostly done individually by waste generators. Therefore, the separate collection of solid/household waste is not carried out in many rural localities and is transported to the locality landfills without any separation. According to the available data, currently in the Republic of Moldova there are 1136 landfills with an area of 1220.55 ha, which were organized by the local public authorities in the respective localities and are operated according to the decision of the local councils. To these waste landfills, in 2021, 3,555.0 m.c of various municipal waste streams were transported, of

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which the greater part was collected by the municipality of Chisinau, but also by the North and Center regions.

If for less developed states waste generation is a problem due to the lack of infrastructure, and good practices at community level are still isolated cases, then for the EU member countries good practices are implemented at country or regional level, allowing the multiplication of positive experience.

For the implementation of a sustainable municipal solid waste management system, it is necessary, first of all, to create premises for the separate collection of waste. This option involves the separate collection of 4 types of municipal solid waste at the source (in households) or at collection points/platforms. At the same time, the encouragement of composting and reuse of manure is necessary, both at the individual household level and at the local public service level. Thus, an infrastructure that aspires to EU standards for the disposal of municipal solid waste would be developed and a reduction of the costs necessary for the final disposal of waste with low environmental impact would be achieved. Last but not least, the separate collection of waste would promote the establishment of economically viable sanitation services.

2. Research methodology

The purpose of this article is to summarize the approaches regarding the organization of separate waste collection, methods and solutions to make the collection process more efficient. Waste selection models and thematic research results are examined in a comparative approach. The following research methods and tools were applied: comparative analysis of models, analytical, descriptive and interpretation of the results described in the specialized literature. The research approach is of a theorized type, as it is based on the aspect of the analysis of selective waste collection, the process and methods of waste valorisation and it was structured as follows: the delimitation of the research problem, the analysis of the state of knowledge relevant to the research problem and the establishment of the hypothesis. In this context, the authors apply a set of already validated knowledge to study the model of the circular economy – the separate collection of waste considered by the authors to be essential components of the theory of contemporary economic growth.

3. Research results

The results of the study confirm our hypothesis that one of the modern approaches to the waste selective collection is waste separation at its source of generation, which means that the waste generators themselves carry out the sorting of waste depending on its type, as well as its subsequent disposal. Thus, the separate collection of waste is one of the essential stages of a modern waste management, in order to transform it into useful products. Almost all the materials that make up the waste, such as paper, cardboard, glass, plastic packaging or metal boxes, can be the object of the process of selective collection and then their recovery.

Thus, the separate collection of municipal waste (also called selective collection or collection with sorting/separation at the source) involves depositing, by the waste generator (for example, the tenant of an apartment or the worker in an office of a public institution), the waste separately on categories, in different containers and the subsequent, separate collection/transportation of these categories of waste.

The separate collection of waste is the solution that must be practiced by everyone and requires minimal effort on behalf of population in depositing recyclable waste in specially designed and easily accessible places for citizens, usually in bins/containers of different colours. Separating recyclable waste from the rest of the waste means that only a relatively small fraction of the total waste ends up in landfills, and the recovery (reuse, recycling) and subsequent treatment of recyclable waste becomes much easier, as this waste has a higher quality.

In the European Union (EU) the mostly practiced waste collection system is the primary waste collection system, which is used by the majority of the country's inhabitants. Thus, the

primary waste collection systems used by the majority of the population are differentiated into the following categories:

- "Door-to-door" collection system - the system that uses bags, sacks, dumpsters (bins), containers - waste being collected separately directly from the household with a predetermined fixed frequency;
- Mixed collection ("gate to gate") - similar to the previous system, only some fractions, for example plastic and metal, are collected in the same bin;
- Collection points – containers in public places for different fractions;
- Public collection facilities – usually closed/fenced and often manned collection facilities where recyclable fractions, residual waste, hazardous waste, bulky waste, E-waste etc. can be brought from households by citizens;
- Refund system (deposit and return) – system used, as a rule, for beverage bottles (cans) made of glass, plastic, metal [6].
- Selective collection is determined by two approaches:
 - easier recovery of reusable materials, this recovery can be done either before urban waste collection, or after collection, in treatment stations;
 - facilitating the subsequent use of waste, in the case of industrial treatment by fermentation (composting), separating non-fermentable or harmful elements [5].

Waste subject to selective collection and recycling are:

1. Non-hazardous packaging waste (paper-cardboard, plastic, glass, metal) obtained from storage, handling, tertiary repackaging and shipping of primary pre-packaged products, as well as from current office activity:

- Paper waste (paper and cardboard packaging waste): cardboard boxes from various materials and products (from furniture, supplies, food products, etc.), wrapping paper, scrap paper waste: documents, newspapers, magazines.
- Plastic waste: packaging waste from various products, consumables, foil, PET, other plastic containers.
- Metal waste: beverage and food packaging waste.
- Glass waste: packaging waste from food containers.

2. Hazardous waste and their packaging (mineral oils, car consumables, detergents, batteries and accumulators; fluorescent bulbs and tubes; printer cartridges and toners, etc.).

3. Waste from electrical and electronic equipment, resulting from the failure of office equipment in the process of current activity or products of this type, damaged during storage or handling, as well as from electrical and electronic products returned by customers.

4. Household and similar waste, originating from current office, cleaning and maintenance activities.

Waste that cannot be recycled is also called "household waste". Even normally recyclable waste can become non-recyclable if it is stored with organic waste. For example, a paper cup that has not been emptied of juice before being deposited in the paper container will destroy all the paper it spills over, making it non-recyclable. Other non-recyclable waste is used napkins, waxed paper, cleaning paper, cigarettes, etc. To preserve the recyclable character, but also for reasons of hygiene, it is advisable that the recyclable waste be cleaned as best as possible of organic residues before being deposited in the separate collection container [7].

In foreign countries, the door-to-door separate waste collection system is widely used, especially in small towns and rural areas with households. Thus, The "door-to-door" separate collection system involves the use of bags, sacks, dumpsters (bins), containers, so that waste is collected separately directly from the household by the local sanitation service with a predetermined fixed collection schedule.

Door-to-door waste collection involves placing collection containers at the source of generation, such as houses and apartment blocks, economic agents, institutions, etc. According to

the type of collection containers, the waste is evacuated by the sanitation service in plastic bags or collection containers - bins or containers.

In order to comply with the principles of the circular economy, the selective collection of waste by means of bags can be successfully implemented by means of different bags by category. Another option is to equip households with at least 4 garbage bags (preferably reusable) of 100-120 l., to separately collect recyclable waste (plastic, glass, paper/cardboard) and residual waste directly at source. This method involves the collection of waste from each household by the sanitation operator.

As a rule, *in the case of door-to-door collection of selectively collected waste, brochures with the daily collection schedule of various types of waste are distributed to the population.* In the case of this system, the effort made by the waste generator is minimal, he only has to take the container or containers corresponding to the type or types of waste that are to be collected that day to the street, in front of the house or institution/company.

The collection containers assume the use of bins for individual houses, and containers for housing blocks, or economic agents, etc. Bins can have capacities of 120 or 240 l and are usually made of plastic. The bins are distributed by the sanitation operator to each household. This method involves equipping each household with at least 4 bins to ensure the separate collection of different types of waste, namely: blue – paper and cardboard, yellow – plastic, polyethylene and PETs, green – for glass and black – for residual waste [6].

This system does not require large investments for the construction of collection platforms, but it involves collection costs of the sanitation operator, costs for procuring collection bags or containers, so that each household is equipped with at least 4 bins/garbage bags of different colours (blue – paper and cardboard, yellow – plastic, polyethylene and PETs, green – for glass and black – for residual waste). From the practice of other countries, bins are usually 120-240 liters and garbage bags 100-120 liters. Door-to-door collection in EU countries varies according to the number of bins used - from 1 bin - collecting residual waste and up to 6 bins/bags for bio-waste recyclable waste.

The door-to-door waste collection method involves ensuring the access of the sanitation operator to the garbage container. Thus, the tenants must ensure the sanitation operator access to the yard or remove the garbage containers behind the gate according to the established waste collection schedule.

In the Republic of Moldova there are 60 operators who hold environmental authorizations for waste management, of which 5 operators hold authorization for the collection and transport of household waste, 2 operators hold authorization for the collection and transportation of municipal waste and an operator that holds authorization for the collection, transportation, sorting, temporary storage and treatment (composting and baling) of municipal waste [7].

One of the largest operators serving the municipality of Chisinau is the municipal company „Auto Sanitation Directorate”. The activity of this operator is aimed at collecting and transporting household waste to the municipal landfill. About 5000 m³ of household waste are evacuated from the city every day. Waste transportation is also organized on days off, holidays, and the center of the city is permanently sanitized in two shifts. 92 transport units are involved in the sanitation activity. The car fleet is constantly renewed with new special trucks of higher capacity. More than 10,000 containers are installed in the city for the accumulation of waste.

The process of separate waste collection is the first step in the recycling process in every household, which involves:

- Identification of packaging waste from each household;
- Pressing plastic, paper or cardboard packaging waste before storage to save space; ∞
- Storage of packaging waste separately from household waste;
- Depositing separately collected waste in the bin/container – yellow (plastic), green (glass), blue (paper-cardboard) and black (waste that cannot be recycled).

A successful example of implementing the door-to-door separate collection is the case of Sălacea community from Romania, where households were provided with 120 liter bins for glass, small 10 liter bins for biodegradable waste collected at home, 40 liter bins for biodegradable waste stored outside, 40 liter bins for mixed waste and coloured bags for the rest of the waste. The mayor of Sălacea was responsible for the project together with a sanitation operator and the recycler ECO Bihor, under the direct supervision of the environmental protection NGO "Zero Waste Romania". Thus, since the project initiation, in a few months, the residents have halved the amount of waste stored at the landfill (from 27 tons to 12 tons), sorted 60% of what they threw away, and the sanitation operator handed over 40% of the amount of waste produced.

The investments of the authorities in the implementation of the Zero Waste system in the communities were approximately EUR 20,000, spent on the creation of a new waste collection infrastructure: 3,000 bins for 3,000 inhabitants/1,000 households, with a cost of EUR 4-5 per person.

Another successful example of foreign experience in implementing the door-to-door selective collection system is Ljubljana, that became the first European capital to adopt the Zero waste strategy and that accepted the challenge of putting zero waste principles into practice, taking on the strict principles of the Zero Waste Alliance International coalition: eliminating waste without setting up new landfills and without building new incinerators.

The authority responsible for implementing the waste management strategy was *VokaSnaga* - a public company that provides waste management in Ljubljana and ten suburban municipalities. Thus, *Snaga* has implemented 3 stages within the process of optimizing the door-to-door waste separate collection system:

1. Introduction of the door-to-door collection system, specifically focused on the collection of organic waste.
2. Reducing the frequency of residual waste collection, while maintaining the collection of recyclable materials and organic waste.
3. Promoting a strong communication strategy focused on prevention and reuse in order to increase the degree of involvement of citizens to solve environmental problems[4].

From 2013 a decision was taken to reduce the frequency of garbage collection by two times, while maintaining the collection of recyclable and compostable materials. For areas with low population density (predominantly single-family dwellings), at first a collection round was introduced every two weeks, but later it was changed to a collection round every three weeks. In densely populated areas (mainly multi-apartment buildings) waste was collected weekly, while compostable waste and recyclables were collected several times a week. This tactic fully meets the basic operational principles of selective kerbside collection - if recyclable and compostable materials are collected more often than other waste, citizens who do not want their waste to remain have an incentive to separate it at home more efficiently.

The results were impressive. If in 2008 the city recycled only 29% of its garbage and lagged behind the rest of Europe, today 68% is recycled and almost 80% less waste ends up in the landfill, which means that Ljubljana is now in the lead European capitals. Currently, the Slovenian capital produces only 155 kilograms of garbage per capita annually. In addition to door-to-door collection, Ljubljana also has two household waste recycling centers where citizens can go to dispose of their waste.

Separate collection by voluntary contribution, in street collection points is another type of waste collection system, which is spread in the Republic of Moldova but also in other European countries. In the Republic of Moldova, the given system is implemented mostly next to housing blocks in big cities or on certain streets in rural localities (for example, SărataVeche, SărataNouă and Hârtiestii villages in SărataVeche commune, Șoldănești district)[8].

The system of separate waste collection through collection points or collection platforms/container parks involves the collection of waste in containers, which are usually 1.1m³, being installed on collection platforms.

For example, in the city of Ștefan Vodă, with a population of over 7000 inhabitants, a new waste management system is applied. Thus, in four neighborhoods of Ștefan Vodă, a selective waste collection module is set up. These are closed platforms, i.e. the dumpsters are placed in modules to which neither dogs, cats nor gardeners have access.

At intervals determined by the contents of each container and its capacity, they are picked up by high-capacity machines and either emptied on the spot in the back of these machines, or transported to treatment/recovery centers, where they are emptied and then returned to the original place. Thus, in order for the waste to be recycled, it is necessary for it to be correctly identified, then sorted and deposited by the consumer in a separate container with the concrete specification of the waste. From the practice of other countries, bins are usually 120-240 liters and garbage bags 100-120 liters.

The collection system through collection platforms requires investments in the construction of collection platforms and their provision with containers. Other disadvantages of waste collection platforms are[1]:

- The long distance to the collection platform for some individual dwellings may be inconvenient;
- Complaints from the tenants of the households near which the collection platforms are built;
- Involvement of a larger number of personnel;
- Relatively longer collection duration;
- Difficulties in tracking the amount of waste disposed of by each household.

The choice of the types of containers for waste collection must be made in such a way as to avoid exceeding the optimal collection capacities, while respecting hygiene standards. In the case of the collection procedure in single-use bags, the collection process becomes easier, the waste being collected cleanly and hygienically in paper or plastic bags, they are manually loaded directly in collection vehicles.

Other advantages of using the bags are: shortening the collection time, no need to clean the bin, the involvement of a small number of personnel, low maintenance costs and low investment costs.

As disadvantages we will mention the risk of the bags breaking and the need to procure different types of bags and place them with regular frequency. The installation of the bags can be carried out by the sanitation authority itself or the recycling company, which will reflect in higher costs for the provision of services.

4. Conclusions

This paper is part of the flow of publications that emphasize, from a theoretical and empirical point of view, the problem of waste that is becoming more acute due to the increase in its quantity and diversity, as well as its increasingly pronounced negative impact on the environment. In the vast majority of rural and urban regions, the waste management service is limited only to the collection, transportation and storage of waste, without the separation or sorting procedure, which is against the specific principles of the Integrated Waste Management System. The successful organization and implementation of an integrated waste management system must be achieved by understanding institutional roles, applying effective techniques for monitoring the practical implementation of national legal requirements in the field of waste management, knowing the best practices in the field, including normative instruments necessary for the organization of the integrated management system. At the same time, the local public authorities must direct their efforts towards the development of the infrastructure in localities for the implementation of the principles of the integrated waste management system, the development of the management of the operation of the communal household public service for

the purpose of waste management by applying the principles of the circular economy, the development of practices and services regarding separate collection and waste recycling.

It is therefore necessary to develop an economic mechanism and a system of regulations to stimulate the reduction, separation and recycling of waste. Integrated waste management systems must be created at national, regional and local levels, combining organizational, economic and social approaches. In the event of pandemics, authorities should strengthen existing structures, develop risk-based approaches to waste management. Activities should also be implemented to rigorously monitor the waste sector and improve data quality, as well as to set targets and promote awareness campaigns. At the same time, to address the vulnerabilities and main challenges in the waste sector, authorities should reconsider the calculation of the total thermal capacity in future waste plans, as well as address the coordination and integration of public waste infrastructure.

For the successful implementation of waste management measures, an indispensable premise is collaboration with citizens. Thus, intensive communication is necessary between the local public authority, the sanitation operator, the companies processing recyclable materials with the citizens, the economic agents, which represent the source of waste generation. In order to support the realization of the specific principles of the integrated waste management system, measures of communication and involvement of the population are mandatory. The awareness and information campaigns of the population regarding the impact of waste on the environment and the quality of life, but also the possibilities of applying the principles of the circular economy in solving the problem of waste represent an important tool in local development activities, promoting the formation of the necessary skills to understand the importance of the problems environment and for the development of conscious and responsible activity on the part of citizens for the benefit of the community.

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