

## DIAGNOSIS OF TOXIC WASTE IN THE REPUBLIC OF MOLDOVA - SWITCHING CIRCULAR MODELS

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**Abstract:** Hazardous waste management is a complex subject consisting of several components. There is no perfect model that can be applied in any situation, but the EU has firm principles on which to base its approach to waste management that can be applied in the Republic of Moldova. The most important challenge facing the authorities is to minimize the impact of hazardous waste on the population and the environment. Thus, risk minimization is possible only through an efficient and correct management of waste of any kind. In the study, the author aimed to analyse and evaluate the management of hazardous waste, to identify the most important problems and risks to the health of the population. This study was developed within the State Program 20.80009.0807.22 Development of the mechanism for the formation of the circular economy in the Republic of Moldova.

**Keywords:** circular economy, toxic, hazardous waste, recycling, waste hierarchy.

**JEL Classification:** Q54, Q57, Q58.

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### 1. Introduction

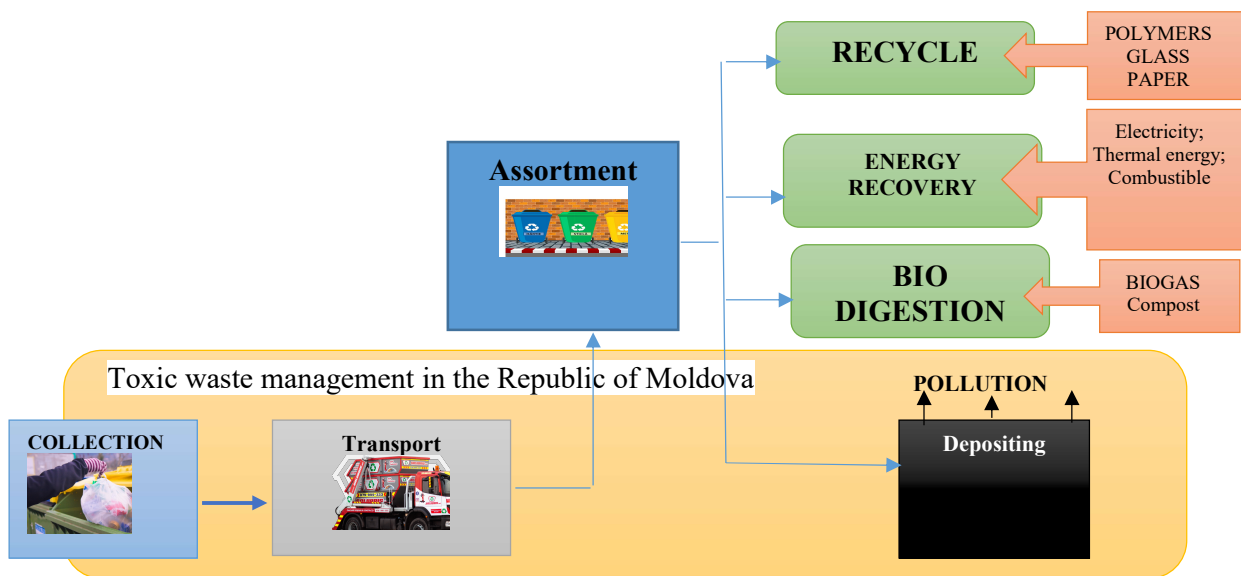
In the Republic of Moldova, the problem of toxic waste management is very acute, given the socio-economic aspects related to the transition to a market economy. During the last two decades, important transformations have taken place in the national economy in the Republic of Moldova: privatization and / or bankruptcy of large industrial enterprises, changing the spectrum of economic units, with the prevalence of small and medium enterprises, implementation of high and cost effective technologies, application of new chemicals. and so on Thus, waste is one of the main sources of environmental pollution, as well as contributing to the phenomenon of climate change, which affects the health and quality of life of the population. Insufficient development of a functional waste management system is also an impediment to the economic development of localities.

Therefore, in our view, several social issues are addressed in the discussion on toxic waste. In countries with pollution regulations, it is imperative that polluters do not have incentives to limit the elimination of toxins in the air, water or landfills, so the costs are imposed to pay the population. Such a cost approach raises fundamental equity issues. In countries with stricter pollution regulations, toxic waste can be dumped illegally, and some polluters may try to cover up this activity. Another approach taken to treat toxic waste is to direct it elsewhere; Many e-waste products in the US are shipped to developing countries, risking leaks and the health of local people, who often lack the expertise and technology to deal with toxic waste safely.

In the context of these realities, a major risk problem for the health of the environment and that of the population of the Republic of Moldova is generated by toxic waste, which is mixed with household waste and then dumped in landfills. Unfortunately, in the Republic of Moldova waste management is based on the linear model (collection-transportation-storage) but not the circular one. In the linear model - landfills are:

- Long-term sources of water and soil pollution;
- Contributes to climate change;
- Missed opportunities to reuse resources and create jobs;
- Irrational land use.

In this study we come up with a comprehensive analysis of the reality of toxic waste management in the Republic of Moldova and propose the transition from a linear model to a circular model, as provided by the EU (Japan International Cooperation Agency, 2022b).



**Figure 1. Linear model of waste management in the Republic of Moldova**

*Source: prepared by the authors.*

**2. Characteristics of hazardous waste.** Properties. Hazardous waste is harmful to human health and the environment. Industrial activities use artificially processed chemicals as well as various heavy metals extracted from the ground that did not exist or did not have an appreciable amount in the natural biosphere, where living organisms were conceived or evolved. Thus, waste with a chemical content and /or an excessive content of heavy metals can be hazardous to life. The industrial activity that has made our lives more comfortable and better produces hazardous waste that poses a degree of risk to both our lives and the environment (ODIMM, 2022b).

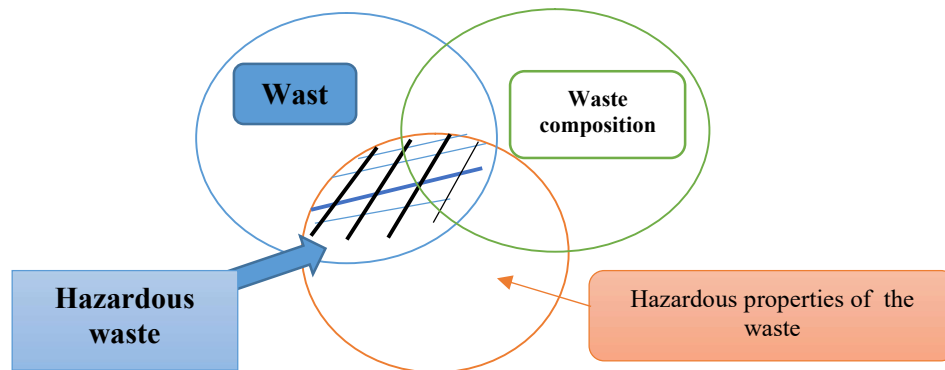
**Examples of hazardous waste:** hospital waste, pharmaceutical, medicinal and veterinary components, biocides, solvents, halogenated organic substances used as solvents, cyanides, hydrocarbon/water emulsions, substances containing PCBs or PCTs, polychlorinated dibenzofurans, dibenzofurans polychlorinated para-dioxins, tars, paints, resins, plasticizers, adhesives, unidentified chemicals and whose effects on humans or the

environment are not known (eg laboratory residues), explosives, etc. All of these are listed in specific lists. The handling and treatment of this type of waste is done only by economic agents that meet the necessary conditions and keep strict records, based on an authorization.

From a technical point of view, **hazardous waste can be defined in three ways:**

1. The type of waste that has one of the hazardous properties in certain processes OR the waste that contains one of the listed constituents that has hazardous properties;
2. Components of different types of waste that make it possible for waste to be hazardous when it has a certain degree of hazard;
3. Properties that can make waste hazardous (Japan International Cooperation Agency, 2022b).

In the Figure below we present the basic concept for hazardous waste from the European Waste Catalog (EWC) which includes the three points of view.



**Figure 2. The concept of hazardous (toxic) waste**

Source: Japan International Cooperation Agency, 2022b. *Study on the General Plan for Hazardous Waste Management in Romania*. Final Report. Volume 1. Main Report: Strategy and Action Plan, Chapter 3, Waste Prevention and Recycling. [pdf] Available at: <[https://openjicareport.jica.go.jp/pdf/11737715\\_05.pdf](https://openjicareport.jica.go.jp/pdf/11737715_05.pdf)> [Accessed 13 January 2022].

The risk of hazardous waste to human health and the environment cannot be assessed solely on the basis of the hazardous nature of the waste. The risk can be characterized and assessed by the following three components:

1. Degree of hazardousness of the waste (including: volume, concentration, extent, etc.);
2. The route of exposure by which the dangerous substance passes from source to receiver (including geographical and hydrogeological location, etc.);
3. Receiver status. Thus, it is important to know this data and information to assess the risk posed by the production, storage and storage of hazardous waste.

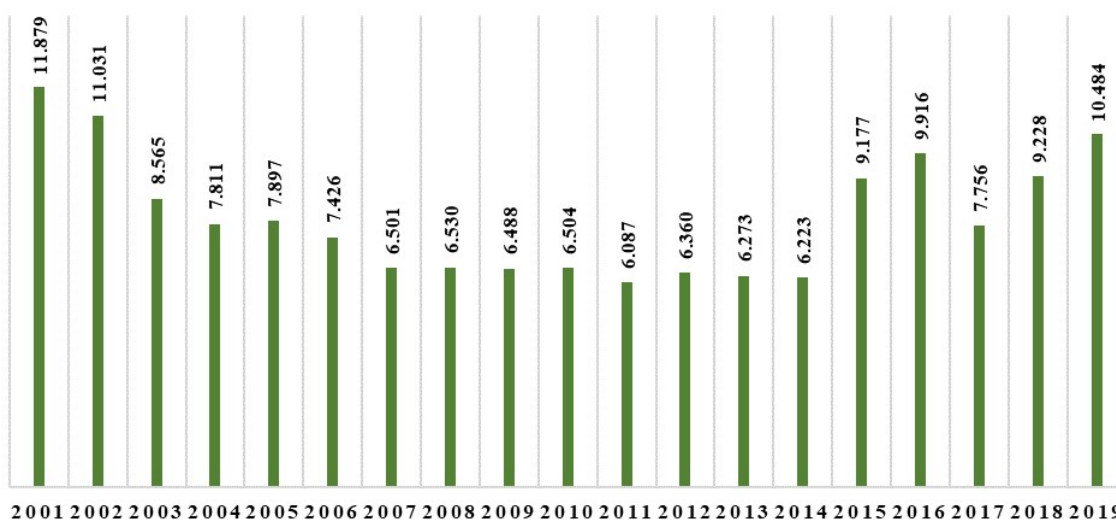
According to Law no. 209 of 29.07.2016 on waste, hazardous waste are any waste that has one or more of the hazardous properties specified in Annex no. 3 of the law. Therefore, *According to art.7 of Law no. 209 of 29.07.2016 on waste, the list of waste, including hazardous waste, is prepared and updated periodically by the Ministry of Agriculture, Regional Development and Environment and is approved by the Government. Thus, in the*

case of a type of waste which, according to the List of Waste, falls under two different codes, depending on the possible presence of hazardous characteristics (codes marked with an asterisk), the classification as non-hazardous waste is carried out by producers and owners of waste only on the basis of an analysis of origin, tests, analysis reports and other relevant documents (Law No. 209 of 29-07-2016 on waste).

If the Ministry of Agriculture, Regional Development and Environment finds, based on laboratory analyzes or feasibility studies, that a waste that is classified as a hazardous waste does not have any of the properties specified in Annex no. 3 of the waste law, it is considered to be non-hazardous. At the same time, it is prohibited to reclassify hazardous waste as non-hazardous waste by diluting or mixing it in order to reduce the initial concentrations of hazardous substances to a level lower than the level required for a waste to be defined as hazardous (Ministry of Agriculture, Regional Development and Environment, Environment Agency, 2022).

### 3. The amount of hazardous / toxic waste in the Republic of Moldova

Hazardous / toxic waste management is one of the difficult issues that need to be solved in the Republic of Moldova. According to the latest statistical data provided by the NBS, in 2019, the total amount of hazardous / toxic waste generated was 10484 tons, up 1.7 times compared to 2014 (6223 tons), and compared to 2001 this trend is in decrease by 12% (11879 tons). However, the tendency to aggravate the problem of waste in the Republic of Moldova, especially hazardous waste, is generated by the faulty way in which various stages of waste processing are currently solved.



**Figure 3. Toxic / hazardous waste at the end of the year in the Republic of Moldova, in the period 2001-2019, tons**

Source: National Bureau of Statistics, 2010. *Formulare statistice*. [pdf] Available at: <[https://statistica.gov.md/public/files/Formulare\\_statistice\\_2010/Mediul\\_inconjurator/Instructiuni\\_1\\_deseuri\\_toxice.pdf](https://statistica.gov.md/public/files/Formulare_statistice_2010/Mediul_inconjurator/Instructiuni_1_deseuri_toxice.pdf)> [Accessed 13 January 2022].

Hazardous waste stock is the amount of hazardous waste to be treated or disposed of. Hazardous waste is normally stored before treatment or disposal. Some hazardous waste cannot be treated, disposed of or exported during the year in which it is generated. At the end of the year, this amount of hazardous waste that will contribute to the stock of hazardous waste to be treated or exported for disposal in the coming years. In principle, the sum of the quantities of hazardous waste to be: (Recycling + Incineration + Landfill + Other Disposal) should be equal to the amount of "Hazardous waste treated or disposed of during the year". However, as there may be double counting due to secondary quantities of waste (for example, incineration residues that are deposited in the landfill), the amount may be higher than the quantities to be managed.

**Table 1. Toxic / hazardous waste management in the Republic of Moldova, tons**

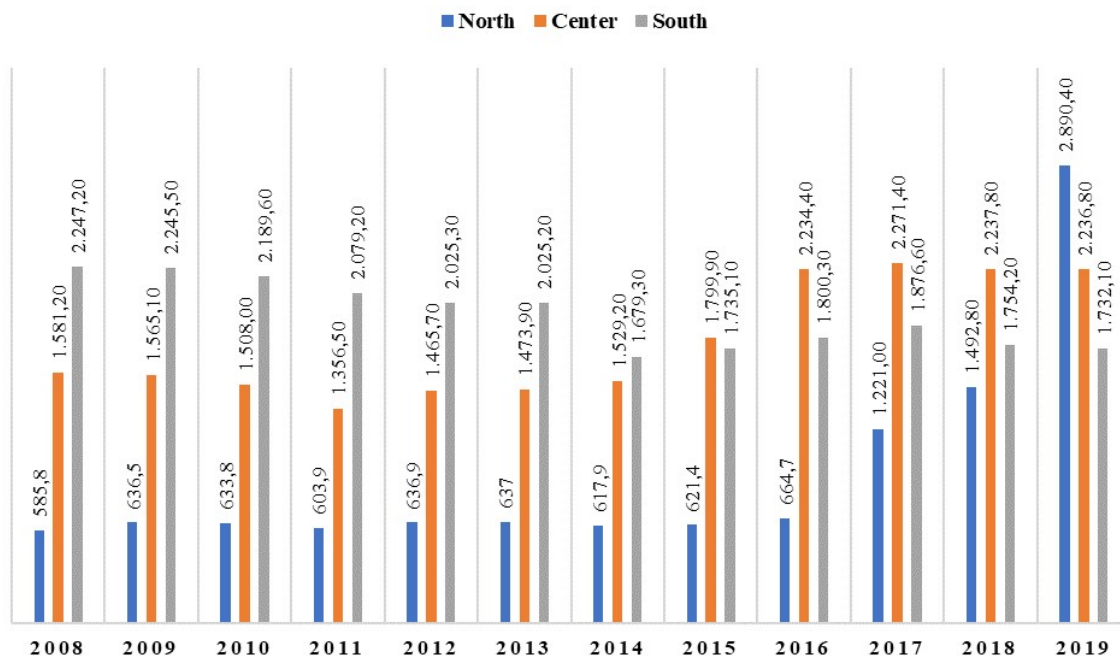
	2011	2012	2013	2014	2015	2016	2017	2018
<i>Formed</i>	528	418	727	682	3722	2114	1511	4254
Class I		2	10	267	309	452	-	4
Class II		249	298	258	447	1092	497	3679
Class III		82	265	99	160	308	188	47
Class IV		84	155	58	2806	263	826	524
<i>Recycle</i>	874	571	834	854	935	2277	6168	4582
Class I		-	0	-	-	-	2	2
Class II		119	177	119	50	1023	737	1199
Class III		8	9	20	79	43	158	63
Class IV		445	649	715	806	1211	5271	3318
<i>Neutralize</i>	112	51	133	96	13	15	10	37
Class I		1	5	55	3	-	-	-
Class II		42	124	38	5	4	3	1
Class III		2	2	1	2	0	0	2
Class IV		6	3	2	3	11	7	34
<i>Shipped to surface deposits</i>	3	91	3	19	8	9	58	95
Class I		8	-	-	-	-	-	-
Class II		80	3	13	-	7	3	1
Class III		-	-	4	7	0	5	60
Class IV		3	-	2	1	2	51	34
<i>Shipped to landfills for household waste</i>	17	21	27	19	17	98	621	33
Class I		-	-	-	-	-	-	-
Class II		-	2	1	-	-	-	-
Class III		-	6			98	39	33
Class IV		21	18	18	17	-	582	0
<i>Waste stock at the end of the year</i>	6087,0	6360	6273	6223	9177	9916	7756	9228
Class I		3793	3806	4066	4356	4808	4804	4808
Class II		1109	1115	1067	1351	1378	1072	2326
Class III		575	519	337	344	366	384	296
Class IV		883	833	753	3126	3365	1496	1799

Source: Ministry of Agriculture, Regional Development and Environment, Environment Agency, 2022. *Hazardous Waste Management*. [online] Available at: <<http://www.mediu.gov.md/ro/content/i2-gestionarea-de%C8%99eurilor-periculoase>> [Accessed 13 January 2022].

According to the data presented by the NBS, it is observed that until 2009, most of the toxic waste was transported to the landfills or was liquidated. Since 2010 the situation is improving, most of the toxic waste has been recycled 90%. Thus, in 2019, 4570 tons of waste were recycled, and 8 tons of toxic waste were disposed of.

Most of the toxic waste existing on the territory of the Republic of Moldova was attributed in 2008 to 2014, to the southern region of the republic, after which from 2015-2018 it belongs to the central region. At the regional level, in 2019 the stock of toxic waste

will return to the northern region of the Republic of Moldova, with 2890.40 tons, followed by the Center with 2236.80 tons and the southern region with 1732.10 tons.



**Figure 4. Existence of hazardous waste by regions at sf. year, in the period 2008-2019, tons**

Source: National Bureau of Statistics, 2010. *Formulare statistice*. [pdf] Available at: <[https://statistica.gov.md/public/files/Formulare\\_statistice\\_2010/Mediul\\_inconjurator/Instructiuni\\_1\\_desuri\\_toxice.pdf](https://statistica.gov.md/public/files/Formulare_statistice_2010/Mediul_inconjurator/Instructiuni_1_desuri_toxice.pdf)> [Accessed 13 January 2022].

Analyzing the series of statistical data on sanitation of localities, there is a slow increase, on average about 3.6% of waste volumes in the period 2017-2019, in the case of rural localities the generation trends are increasing on average by 30%, and in the case of urban growth is more modest than 1.3%. In total, in 2020, 187 specialized services in waste collection and disposal are organized and operate (53 services in the urban sector and 134 services in the rural sector), respectively 296 rural localities benefit from municipal waste collection services. Most of the toxic waste accumulated at the district level is reflected in the table below.

**Table 2. Top 15 Districts with the most toxic waste in the Republic of Moldova, tons**

To p	District	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Ialoveni	651.2	655.6	573.5	459.6	454.1	462.1	768.4	1 040.00	1 473.60	1 473.60	1 473.40	1 472.00
2	Căușeni	1 195.80	1 196.20	1 196.40	1 196.20	1 093.40	1 093.40	1 053.20	1 053.20	1 053.20	1 053.20	1 053.20	1 053.20
3	Orhei	383.4	360.3	384.6	363.4	363.5	363.6	362.5	362.9	363.2	363.6	363.9	364.2
4	Cahul	218.2	217.8	217.8	217.8	217.8	217.8	219.1	219.5	226.5	229.1	234.9	243
5	Taraclia	475	475	434.5	362	351.2	351.2	166.4	163.1	190	187.1	170.5	172
6	Leova	234.7	235.2	235	235	247.1	247	173.6	199.4	199.4	199.5	199.5	161.7
7	Hâncești	105.2	105.3	107.9	108.2	108.9	108.9	107.5	105.2	105.9	139.8	106.8	103.7
8	Telenești	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2
9	Călărași	199.3	199.3	199.3	199.3	199.3	199.3	67	67	67	67	67	67
10	Cimișlia	97.4	98.3	98.7	60.4	60.7	60.7	61.1	62	61.8	61.9	61.4	63.9
11	Nisporeni	50	51.2	51.2	61	176	176	61.1	61.1	61.1	61.1	61.1	61.2
12	Anenii Noi	80.7	80.7	80.7	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
13	Basarabesca	26.1	23	7.2	7.8	55.1	55.1	5.9	37.9	69.4	145.8	34.7	38.3
14	Dondușeni	15.7	14.2	17.8	4.1	9.9	9.9	10	9.5	16	9.6	10	9.9
15	Strașeni	8.7	9.3	8.6	9	7.6	7.6	7.7	7.9	7.9	7.9	7.9	7.6

Source: National Bureau of Statistics, 2010. *Formulare statistice*. [pdf] Available at: <[https://statistica.gov.md/public/files/Formulare\\_statistice\\_2010/Mediul\\_inconjurator/Instructiuni\\_1\\_deseuri\\_toxice.pdf](https://statistica.gov.md/public/files/Formulare_statistice_2010/Mediul_inconjurator/Instructiuni_1_deseuri_toxice.pdf)> [Accessed 13 January 2022].

The issue of hazardous waste management is a priority in state policy, as this area has a particularly high impact on the environment and public health. In order to reduce the impact on this sector, it is necessary to take concrete waste management measures at national level and to develop solutions for some categories of hazardous waste to be treated / disposed of abroad in environmentally friendly technologies.

According to the Concept of creating the Hazardous Waste Management Center, it is foreseen that this object will generate revenues from the provision of the following services:

- from pick-up / packing services, transportation, temporary storage at the Center of hazardous waste from the population through mobile points - the services being paid by the DMS collection operators;
- from services for taking over / packing, transporting, temporary storage at the Center of hazardous waste from economic agents on a contract basis;
- from the sale of recyclable hazardous waste fractions;
- from the provision of services for the elaboration of technical solutions for decontamination of contaminated lands and laboratory analyzes;
- from technical assistance activities regarding the waste management of generators and / or economic agents.

The results of the analysis of the current situation of the hazardous waste sector in the Republic of Moldova show the following: Annual total revenues are planned starting with 17,000,000 lei in the first years of activity, so the investment is recovered after 12 activities of the Center. According to the economic-financial calculations, the investment is feasible to be made only with non-reimbursable financing in proportion of at least 90% of the total



value of the investment, according to which  $RIR F(c) = 9\%$ ,  $NPV = € 1,494,178.12$  the discount rate being 6% (Ministry of Agriculture, Regional Development and Environment, Environment Agency, 2022; Popa and Popa, 2021).

The creation of a Public Hazardous Waste Management Joint Stock Company is crucial in solving the problem of hazardous waste. The Joint Stock Company must have the necessary means to function properly in order to carry out its activity on the basis of the state property transferred to the management, and the allocation of land for the location of this object is a first step in developing the national hazardous waste management system. with European requirements.

The purpose of the Joint Stock Company "Hazardous Waste Management Center" will be to improve the management of hazardous waste in the Republic of Moldova and reduce its negative impact on the environment and human health. The Joint Stock Company "Hazardous Waste Management Center" will carry out the following activities:

- identification of solutions for recycling / disposal of historically accumulated hazardous waste directly from the place of storage;
- the collection and temporary storage of current hazardous waste streams to be transported to operators authorized for recycling / treatment of hazardous waste, including the solidification of certain categories of waste for landfill disposal;
- recycling of fluorescent lamps and other mercury-containing wastes (Hg-containing measuring devices) in safe environmental conditions;
- the provision, at the request of the beneficiary, of services for the disposal of hazardous waste in the applicant's territory (asbestos waste, contaminated land etc.).

#### **4. Conclusions and recommendations**

Large volumes of hazardous substances, which are not identified as hazardous substances, are discharged along with wastewater and blast furnace gases (hazardous waste omitted). Thus, it is necessary for the legal framework to be well strengthened, which will ensure the endowment with pollution control equipment and the omitted waste mentioned above will be collected and identified as hazardous waste. At present in the Republic of Moldova, there are no standards for the collection, transport, recycling, treatment and disposal of hazardous waste. The lack of facilities is also evident, and in these conditions, the awareness of the proper management of hazardous waste is not well perceived by the hazardous waste plants / factories. It is also important for the consumer:

- To limit the use of dangerous products through rational and responsible consumption;
- Try environmentally friendly alternatives to regular detergents;
- Products in good condition, but which they no longer use, must be reused (sale, donation);
- Defective products can be repaired and then reused;
- Waste is thrown in specially arranged places;
- We sort the waste and send it for recycling;
- Replace regular batteries with rechargeable batteries;
- To return expired or no longer needed medicines to the pharmacy;
- Use water-based paint, not solvents,



- Waste management services are paid in the same way as any other service (Popa and Popa, 2021).

All these activities lead to a change in consumer behavior and a more efficient management of hazardous waste. Therefore, local public authorities must also participate in the decision-making process by:

- Working groups;
- Public consultation meetings;
- Endorsement of draft decisions,
  - ✓ To provide expertise and consultancy, through:
- Elaboration of project proposals;
- Participating in the process of conceptualizing the model of hazardous waste management as well as municipal waste;
- Organizing study visits and exchanging experiences.
  - ✓ And to provide communication and information services with citizens.

Thus, for the efficient management of toxic / hazardous waste, we come up with the following recommendations:

- Harmonization of the normative and legislative framework related to the Waste Law according to the European legislation;
- Population: rational consumption, collected and separated waste, paid services;
- LPA: integration in the regional waste management system, sorting / incineration stations, regional landfills;
- CSOs: pro-activism in decision-making and policy monitoring (Japan International Cooperation Agency, 2022a).

Hazardous waste management is a complex multi-part subject. There is no perfect model that can be applied in any situation, but the EU has strong principles on which to base its approach to waste management that can be applied in the Republic of Moldova.

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