

THE WEEE MANAGEMENT AND ITS INFLUENCE ON ENVIRONMENT AND HUMAN HEALTH. CASE STUDY: MARAMUREȘ COUNTY, ROMANIA

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Abstract: *This paper addresses a number of issues regarding the management of waste electrical and electronic equipment (WEEE) and its influence on environmental and human health factors. The study was conducted for Maramures County to highlight the WEEE management and its threats to the environment and human health. Worldwide research results show that improper WEEE treatment and recycling is a factor of environmental pollution and the generation of various diseases, especially where rudimentary techniques are used and there is no means of protecting workers. By dismantling mechanical and pyrometallurgical processing of WEEE components result in a series of contaminants that can pollute the soil, surface water, groundwater, the atmosphere and finally can cause a lot of human diseases. Following the investigations, it is found that the management of WEEE in Maramureș County poses a low risk of contamination given the fact that in this county only WEEE collection is made not also their treatment or recycling. Moreover, all collection activities of WEEE are made safe and are authorized by the environmental protection point of view.*

1. INTRODUCTION

Studies made on the WEEE treatment in some developing countries showed that the rudimentary treatment technologies pose a risk on the environment and human health by

releasing some toxic pollutants like lead (Pb), polybrominated diphenylethers (PBDEs), polychlorinated dioxins and furans as well as polybrominated dioxins and furans (PCDD/Fs and PBDD/Fs). In China and India high concentrations of these pollutants were found in air, bottom ash, dust, soil, water and sediments especially in WEEE recycling area [1-3].

The most observed health problems related to e-waste processing include diseases, problems of skin, stomach, respiratory tract, tuberculosis, blood diseases, malfunctioning of the kidneys, lung cancer, or congenital ones like birth defects, underdevelopment of the brain of children, damage of nervous and blood systems [4-6].

From places where this waste is dismantled and burned in order to recover useful materials, pollutants and especially fine particle with heavy metals are transported by air currents over large areas. This leads to air pollution and soil and surface water contamination. Soil pollutants can easily pass into plants and from there into the food chain causing a number of diseases [4, 7].

In line with European waste management policy (Directive 2008/98/EC), the legislative provisions on WEEE focus on preventing the occurrence of WEEE and minimizing the toxic substances and elements contained in it, on the recovery and reuse of components, recycling and the energy recovery of non-recoverable components and, last but not least, the disposal of WEEE in conditions that do not create pollution or damage to the environment [8]. Also, in Romania the content of toxic substances in EEE is regulated, being allowed only those EEE that comply with the maximum permitted limits to be placed on the market [9]. Therefore, there are not allowed EEE which contain substances in concentrations exceeding the maximum allowed limits set out in Annex 2 to GD no. 322/2013 [10]. To this end, EEE producers apply the product conformity assessment procedure by carrying out internal control and issuing the declaration of conformity and affixing the CE marking to the finished product, respectively. The purpose of these regulations is to reduce the hazardous properties of the future WEEE [9,10].

The objective of this study is to highlight the WEEE management activity in Maramureş County and the possible risks for the environment and human health.

2. MATERIALS AND METHOD

In order to carry out this study, data published in specialized scientific papers were used, respectively statistical data held by environmental protection authorities at European, national and county level.

In order to obtain the statistical evidence regarding the quantities of WEEE collected at the level of Maramureş County, reporting data provided by National Environment Protection Agency (NEPA) for the period 2015-2018 were used. In order to highlight the evolution of WEEE management in the Maramureş county, statistical interpretations and graphical

representations were made for each category of WEEE, in accordance with the provisions of GEO no. 5/2015 [11].

3. RESULTS AND DISCUSSIONS

At European level, the statistics of the quantities of WEEE collected from the population, indicate the lowest collection rate for Romania in the period 2012-2016 [12]. Moreover, for the years 2017 and 2018 there are no data reported by Romania for this waste. It can be seen in the graph in *fig. 1* that there is a big discrepancy even compared to Bulgaria, the country that joined at the same stage with Romania to the European Union. Compared to developed European countries such as Denmark or Belgium, the differences are even more obvious.

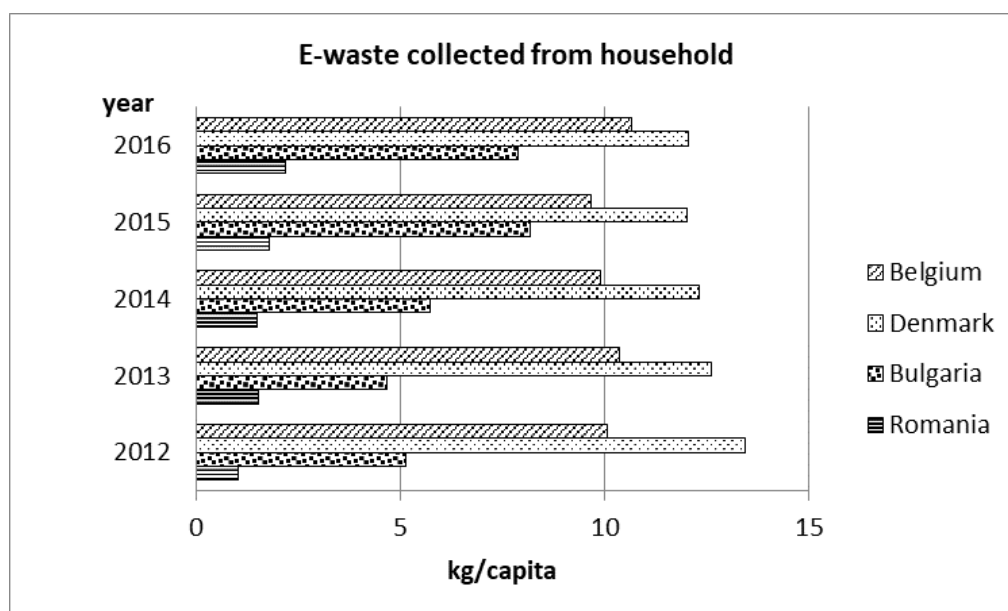


Fig. 1. Amount of WEEE/capita collected in several European countries in the period 2012-2016 [12]

The placing on the market of EEE is allowed only by producers who are registered in the “Register of Producers and Importers of EEE” [13, 14]. At national level, at the end of 2019, there were 3431 registered producers of electrical and electronic equipment (EEE) [14] and at the level of Maramureş County, 30 operators [15].

According to Environment Protection Agency of Maramures County (EPA MM)[15], at present, in Maramureş County there are 21 WEEE collection points by economic operators authorized for this type of activity.

The environmental report for 2019 (table 1), prepared by NEPA, shows that Romania has failed to achieve its collection targets set by European and national legislation [8, 11], thus:

- ✓ 4 kg of waste/inhabitant/year in the period 2008 - 2015;

- ✓ at least 40% of the average quantities of EEE placed on the market in the previous 3 years, for 2016 ,;
- ✓ 45% of the average quantities of EEE placed on the market in the previous 3 years, for the period 2017 – 2020

Table 1. Quantities of EEE placed on the market and WEEE collected in 2015-2018 period in Romania [14]

Crt. no.	EEE/WEEE category	Quantities of EEE placed on the market and WEEE collected (tonnes)							
		2015		2016		2017		2018	
		EEE	WEEE	EEE	WEEE	EEE	WEEE	EEE	WEEE
1	Large household appliances	103475.36	24122.22	129548.53	29592.17	140581.09	31175.22	146784.12	35755.95
2	Small household appliances	14667.61	1218.31	16224.62	1320.07	18467.35	1303.18	22675.82	1633.02
3	IT and telecommunications equipment	13469.45	6837.44	13231.54	5645.37	15230.91	6571.14	16042.00	9362.28
4	Consumer equipment and photovoltaic panels	15236.29	5385.17	17594.37	7063.19	27702.55	6545.39	26189.23	9699.59
5	Lighting equipment	6010.49	1781.32	7042.15	1292.77	9084.30	2002.53	13666.18	3171.92
6	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	9654.61	796.00	11108.44	891.33	18030.34	903.08	23932.63	1206.34
7	Toys, leisure and sports equipment	1616.51	107.26	2150.54	115.51	3489.87	83.39	4718.89	91.31
8	Medical devices (with the exception of all implanted and infected products)	673.90	48.43	564.86	83.24	889.33	67.33	1430.59	114.16
9	Monitoring and control instruments	2566.35	383.15	2126.21	411.01	3343.29	700.15	4538.30	2065.84
10	Automatic dispensers	808.83	94.84	1093.56	239.79	1225.34	337.79	1169.18	678.47
11	Total	168179.40	40774.14	200684.82	46654.45	238044.36	49689.20	261146.92	63778.88

In Maramureş County, in the period 2013-2018 there is an increasing trend of the quantities of WEEE collected by authorized economic operators, the highest amount being registered in 2018. Unfortunately, the activity of the associations taking over the responsibility of producers is not fully reflected in centralized and reported data at environmental authority level (Table 2) [15].

Table 2. WEEE collected in Maramures County during 2013-2018 (tonnes) [15]

Collector name	amount/year (tonnes)					
	2013	2014	2015	2016	2017	2018
Economic operators authorized for collection	29.84	41.86	59.79	176.46	119.69	846.36
Ecotic			152.55	259.82		
Asociația Română pentru Reciclare – RoRec				232.35		
The Green Project (RoRec partner)					111.229	

The management of WEEE in Maramureș County encounters some difficulties regarding the complete realization of the database because some economic operators that were authorized to collect WEEE stored the waste without sending it for treatment or others went into insolvency and the associations taking responsibility for the producer did not reported to the county environmental protection authority the quantities of WEEE collected from citizens during the collection campaigns.

4. WEEE STATISTICS FOR MARAMURES COUNTY

At the level of Maramureș county, the total quantities of WEEE collected are reported differently on the categories of equipment according to the provisions of GEO no. 5/2015 [11]. As can be seen in the graphs below (*fig. 2-10*), except for waste from category 7 (Toys, leisure and sports equipment (*fig. 8*)), there was an increase in the quantities collected. This increase is more accentuated, in the case of the first 5 categories of equipment waste as they are presented in the annex to GEO no. 5/2015 [11].

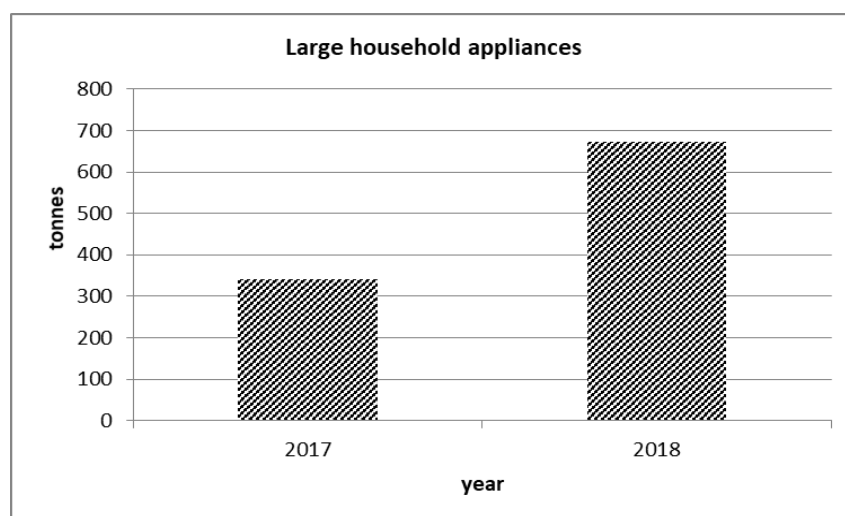


Fig. 2. Large household appliances collected during 2017-2018 in Maramures County [16]

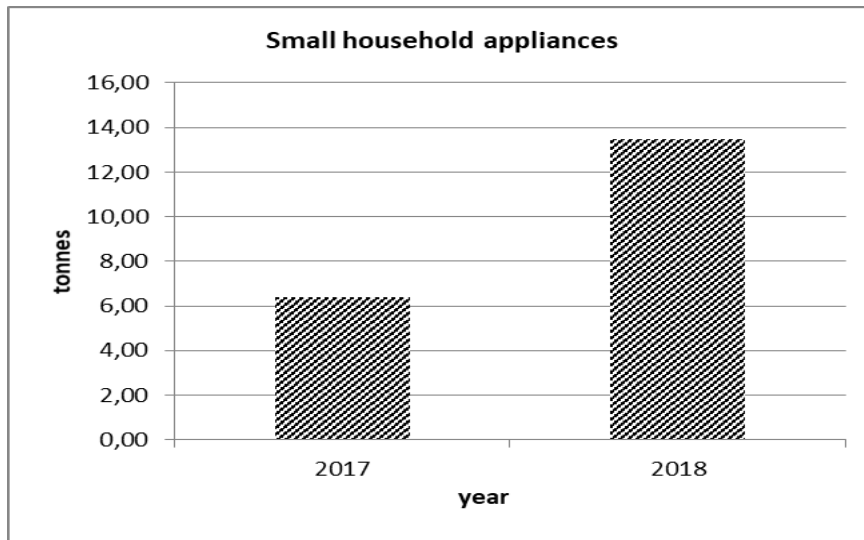


Fig. 3. Small household appliances collected during 2017-2018 in Maramures County [16]

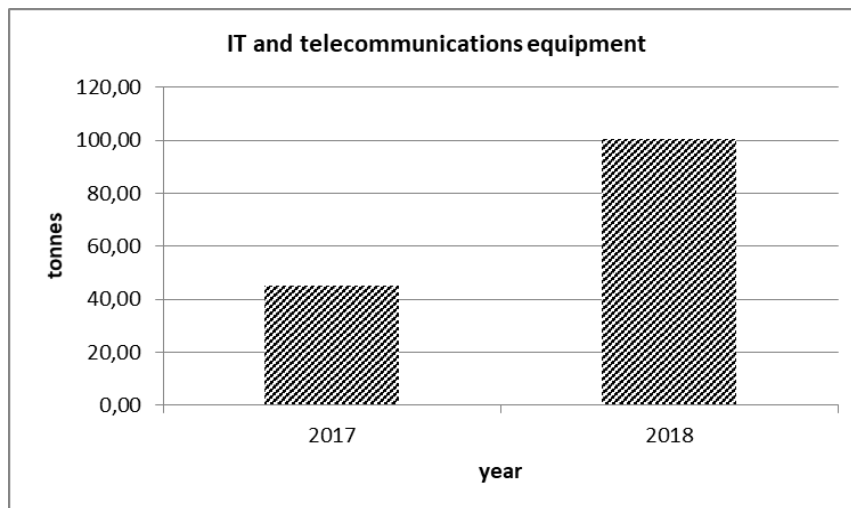


Fig. 4. IT and telecommunications equipment collected during 2017-2018 in Maramures County [16]

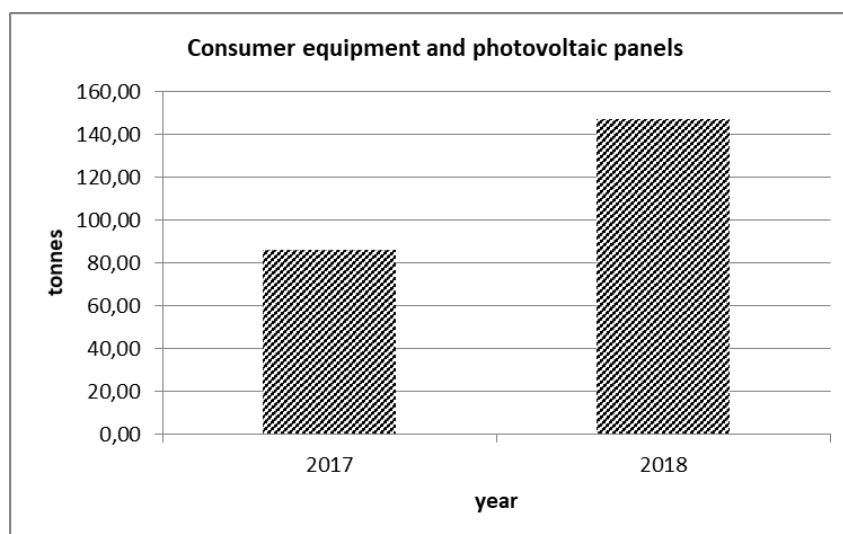


Fig. 5. Consumer equipment and photovoltaic panels collected during 2017-2018 in Maramures County [16]

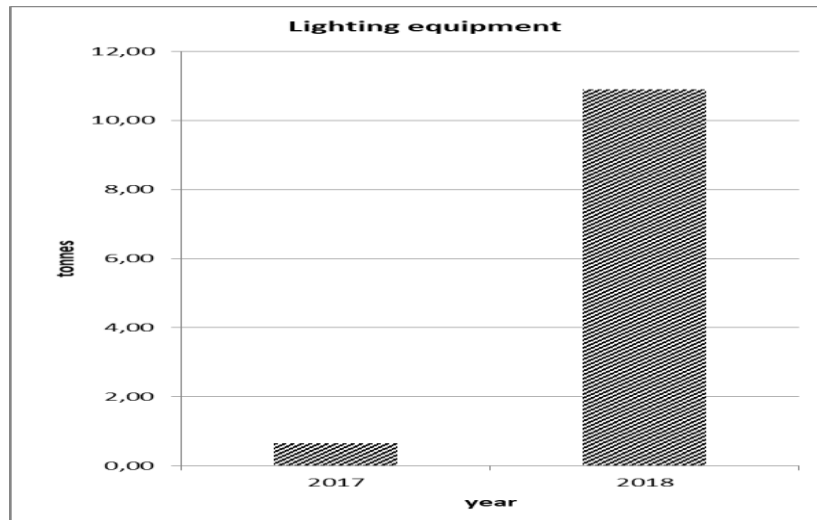


Fig. 6. Lighting equipment collected during 2017-2018 in Maramures County [16]

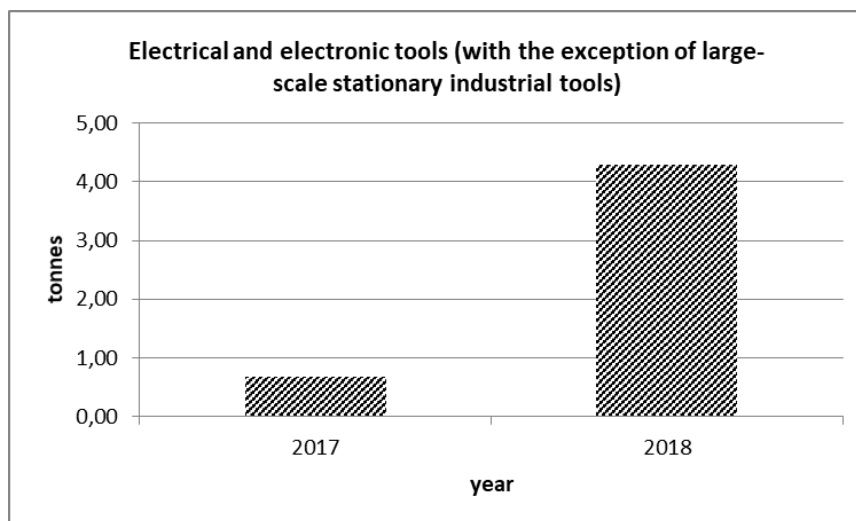


Fig. 7. Electrical and electronic tools (with the exception of large-scale stationary industrial tools) collected during 2017-2018 in Maramures County [16]

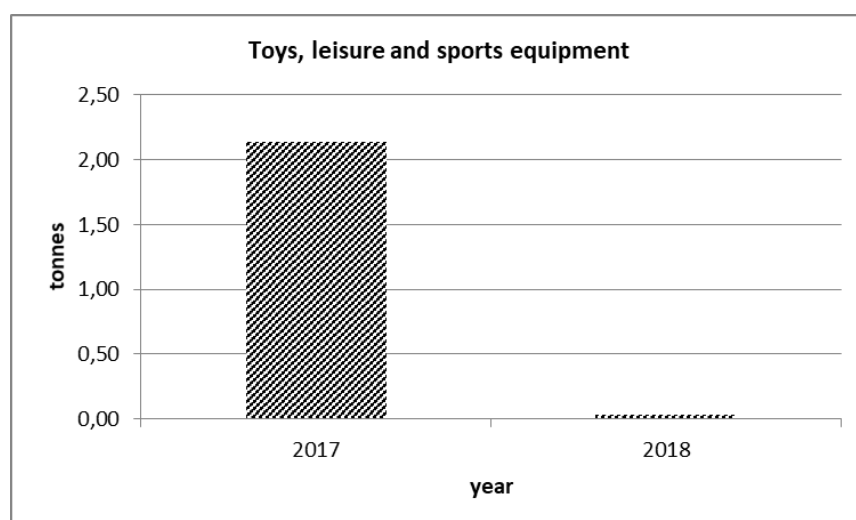


Fig. 8. Toys, leisure and sports equipment collected during 2017-2018 in Maramures County [16]

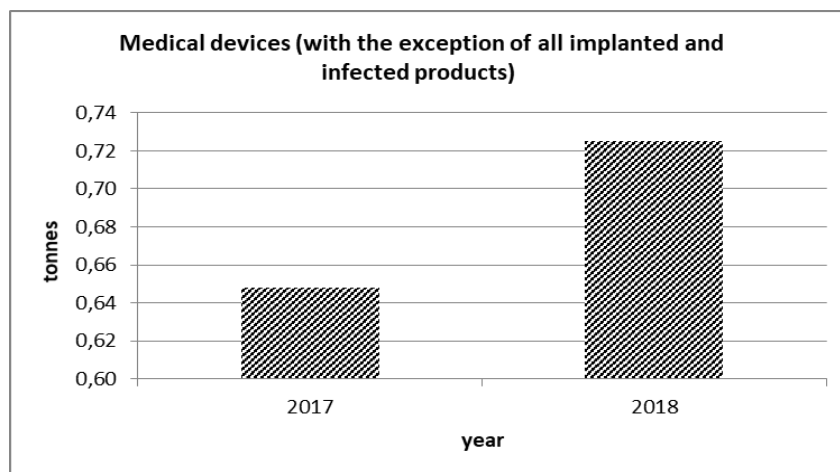


Fig. 9. Medical devices (with the exception of all implanted and infected products) collected during 2017-2018 in Maramures County [16]

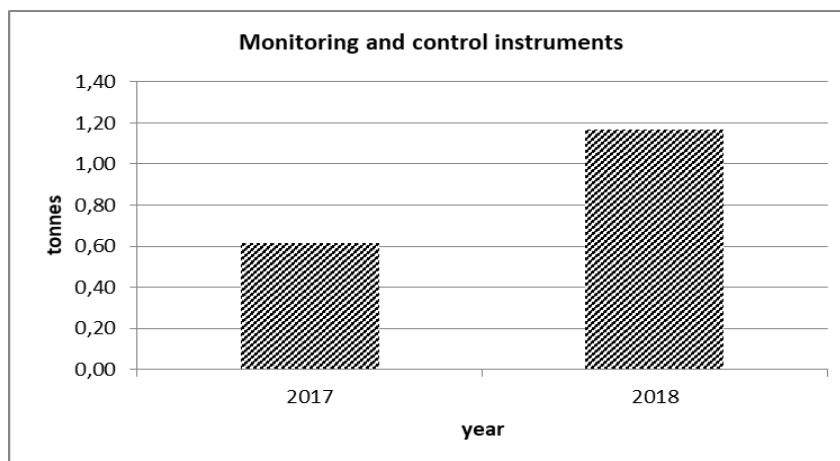


Fig. 10. Monitoring and control instruments collected during 2017-2018 in Maramures County [16]

The statistical data presented in the graphs above reveal an increase of about 17 times of the amount collected of Lighting equipment waste in 2018 compared to 2017. A high increase of approx. 6 times are also registered in the case of Electrical and electronic tools (with the exception of large-scale stationary industrial tools) waste and at the opposite side there is a reduction of about 65 times the amount of Toys, leisure and sports equipment waste in 2018 compared to 2017 .

5. SWOT ANALYSIS OF WEEE MANAGEMENT IN MARAMUREȘ COUNTY

This method allows the analysis of the global situation, the establishment of key strategic points, as well as the identification of strategic alternatives, helping to make the right decisions, but also to plan strategies. The SWOT analysis of WEEE management in Maramureș County is presented in table 3.

Table 3 The SWOT analysis of WEEE management in Maramureş County

<p style="text-align: center;">Strengths</p> <ul style="list-style-type: none"> • Legislation in the field harmonized with European Union legislation. • The existence of associations that have the role of implementing collection campaigns. • Involvement of producers of electrical and electronic equipment by offering advantages to the purchase of new products provided the delivery of old products such as electrical and electronic equipment. • Introduction of the national program for appliances waste: "Programul Rabla pentru Electrocasnice" 	<p style="text-align: center;">Weaknesses</p> <ul style="list-style-type: none"> • Lack of waste treatment plants for electrical and electronic equipment (which results in additional costs for transporting waste to treatment plants in neighboring counties). • Reduced number of WEEE collection points. • Lack of state involvement in developing strategies to support the efforts of local authorities. • Lack of legislation to involve more the public authorities in the collection of WEEE. They have direct links with citizens which are the main generators of WEEE
<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> • Potential for developing partnerships with various communities in the European Union. • Increasing investments and increasing associations involved in waste management of electrical and electronic equipment. 	<p style="text-align: center;">Threats</p> <ul style="list-style-type: none"> • The disinterest of the population for respecting and protecting the environment. • Disinterest of both the population and economic agents related to the selective collection of waste electrical and electronic equipment

6. RISKS ON ENVIRONMENT AND HUMAN HEALTH RELATED TO DEEE HAZARDOUS CONTENT.

Over 1000 of the chemicals were identified in e-waste and there is not an exhaustive knowledge about their toxicity and environmental impact [4]. In table 4 some hazardous contents are related to some components of WEEE.

Table 4 Hazardous elements in WEEE [17, 18, 4, 19].

Hazardous element	WEEE component
Mercury	Relays, switches, gas discharge lamps, batteries, Liquid Crystal Display (LCD)
Cadmium	Batteries, Printed circuit boards, Chip resistors and semiconductors
Lead	Batteries, printed circuit boards, fibre optics, panels and gaskets in computer monitors; as PbO in the Cathode Ray Tubes (CRTs)

Lithium	Batteries, LCD
Beryllium	Printed circuit boards, motherboards of computers
Antimony	Printed circuit boards, flame retardant, Cathode Ray Tubes (CRTs)
Polybrominated diphenyl ethers (PBDEs) used in brominated flame retardants (BFRs)	Plastics, Plastic housing of electronic equipments and circuit boards to reduce flammability
Polychlorinated biphenyls	Capacitors
Dioxins and furans	PVC in wire insulation when burning
Lead	CRTs, Solder of printed circuit boards, glass panels and gaskets in computer monitors
Gallium	Silicon chips and LCD, monitors, Integrated circuits, optical electronics,
Indium	Silicon chips and LCD, monitors
Zinc	LCD, Plating material
Fluorine	Fibre optics
Yttrium	Fibre optics
Zirconium	Fibre optics
Arsenic	Transistors
Barium	Front panel of Cathode Ray Tubes (CRTs)
Chlorofluorocarbons (CFCs); hydrochlorofluorocarbons (HCFCs); hydrofluorocarbons (HFCs) and hydrocarbons (HCs)	In old coolers, refrigerators, air conditioners
Cobalt	Rechargeable batteries and coatings for hard disk drives
Copper	Used as a conductor
Hexavalent chromium	Used as corrosion protection of untreated and galvanized steel plates and a decorator or hardener for steel housings
Asbestos	Used in older appliances such as electric coffee pots, toasters, irons and electric heaters
Radioactive substances	Found typically in some medical equipment, certain test instruments, and commonly in smoke detectors

According to Sepúlveda et al., 2010; Zhao et al., 2010; Wang et al., 2011 [1, 2, 3] the biggest risks for the environment and health are presented by the activities of dismantling and burning WEEE by using rudimentary uncontrolled methods.

The threatness for environment and human health is represented by the presence of various hazardous substances in WEEE like: heavy metals (mercury, cadmium, lead, arsenic, zinc, copper, antimony etc), flame retardants (pentabromophenol, polybrominated diphenyl ethers (PBDEs), tetrabromobisphenol-A (TBBPA) etc) [18].

According to Tsydenova&Bengtsson, 2009 [18] even for industrialized/developed countries, there is a concern related to occupational risks of the electronics dismantling workers. They are exposed to contamination via ingestion, inhalation or dermal contact.

Generally, the most risk is associated with treatment operation of WEEE because there are involved several processes like: shredding for components size reduction, grinding, separation by different methods, pyrometallurgical operation etc. From all these result dust composed of plastic, metals, ceramic, glass and silicon, brominated flame retardants (BFRs) and from smelting result fumes of heavy metals, mixed halogenated dioxins and furans etc. The risks associated with landfilling of WEEE is related to leaching and evaporation of hazardous substances [18].

Because of exposure to the WEEE hazardous substances, which might be by ingestion, inhalation, dermal contact, people could get sick of a lot of diseases such as problems of skin, stomach, respiratory tract, tuberculosis, blood diseases, malfunctioning of the kidneys, lung cancer, or congenital ones like birth defects, underdevelopment of the brain of children, damage of nervous and blood systems [4, 5, 6, 17, 20, 21].

In Maramureş County there are no dismantling and recovery centers of some WEEE elements, but only collection [15]. Dismantling and recycling operations are carried out outside the county in authorized installations from the point of view of environmental protection. Therefore, in the absence of facilities and operations for treatment and recycling of WEEE on the territory of our county, the risks of contamination of the environment and the population with hazardous substances contained in WEEE, are relatively low.

7. CONCLUSIONS

WEEE management is an activity that can have unpleasant consequences for the environment and human health. The entire flow of WEEE treatment involves a certain risk for environmental factors and the safety of the people involved in the process. Thus, where WEEE is processed with rudimentary techniques and without environmental and munitions protection equipment, there is the possibility of contamination and the generation of diseases associated with different types of hazardous substances.

The present study was carried out for waste management in Maramureş County and it was found that this activity involves only the collection of WEEE, not their treatment, respectively recycling. The treatment and recovery operations, respectively the elimination, as the case may be, are carried out in compliant installations outside the county. Moreover, the activities of economic operators that carry out WEEE collection in Maramureş County are authorized from the point of view of environmental protection. Thus, the risks of environmental contamination and disease of the population associated with WEEE management are relatively low.

To optimize WEEE management it is necessary to improve environmental performance at all levels and apply an environmental management correlated with the principles of circular economy and sustainable development.

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