E-WASTE: GENERATION, COLLECTION, AWARENESS

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Abstract

European Union has underwritten to reduce the generation and to increase the amount of recycled WEEE. This work analyses the generation and processing tendencies of WEEE in Baltic countries, to evaluate the attitudes and habits of students and pupils regarding WEEE in Lithuania. Analysis showed that WEEE has decreased in 2008 in Baltic countries due to global economic crisis. But new EEE released to the internal market, e-waste collection, sorting and recycling has been on increase since 2009. Most of collected WEEE is large home appliances, IT and telecommunication equipment, monitoring and control devices. Estonia successfully implemented the EU Directive 2002/96/EC and has collected 4.2 kg/capita of WEEE already in 2010, in Lithuania only in 2012 4.48 kg/capita of WEEE was collected. The survey showed that 74.7% respondents need information about EEE, as respondents do not know exactly what is classified as EEE. Even 67% of pupils and 69% of students attributed batteries and accumulators to EEE. 55% of pupils and 48% of the students indicated that the toys with batteries are also attributed to EEE (though they are not). 21% of respondents stated discarding small WEEE together with municipal waste. 69.7% of the respondents indicated that more collection points are needed. Respondents, living in flats (χ^2=0.98, $p<0.05$) and women (χ^2=7.79, $p<0.1$) more often said, that there is not enough infrastructure to sort and give out WEEE.

Keywords: E-waste; waste generation, waste collection, public awareness

1. Introduction

Waste of electrical and electronic equipment (WEEE) is assigned to hazardous waste and needs special attention as it imposes a great danger to human health (Song, Li, 2015) and the environment (Song, Li, 2014; Hong *et al*, 2015). The production of electrical and electronic equipment requires a number of raw materials: various metals, plastics, rubber, glass, semiconductor, oil, gas and so on. Many of these materials can be recycled and reused (Dalrymple *et al*., 2007). Landfilled or improperly dismantled electronic devices leach extremely hazardous substances: heavy metals, plastics (antistatics, polyvinyl chloride, phthalates, antipyrens, etc.), ozone-depleting gases (freons), nervous system damaging lead, brain infringing cadmium (Dimitrakakis *et al*., 2009). WEEE (Oguchi, Sakanakura and Terazono, 2013) as well as Waste of small electrical and electronic equipment (s-WEEE), is a source for selected metals (Cu, Sb, Hg etc.) and non-metals (Cl, Br, P) and PCBs, indicating the growing importance of s-WEEE regarding secondary resource metals and potential toxic substances (Morf *et al*., 2007). Growing numbers of people and increased consumption of products means that the amount of waste increases too. Total amount of WEEE per year reaches 8.39 million tons in Europe. It is estimated that by 2020, electric and electronic waste will reach as much as 12.3 million tons per year (EC, 2008). Hence, the proper waste handling is a top priority in sustainable development strategies and in the plans of municipalities. As the further growth in WEEE is projected (Vasilenko *et al*., 2009), European Union (EU) community and the other countries are underwritten to reduce the generation of electrical and electronic equipment waste every year and to increase the amount of sorted and recycled waste of electrical and electronic equipment. The aim for 2016 was to reach the minimum collection rate of 45% calculated on the basis of the total weight of WEEE collected and for the 2019 the minimum collection rate to be achieved annually shall be 65% of the average weight of EEE placed on the market or 85% of WEEE generated (2012/19/EU). According this directive Lithuania, as some other transition countries in Central and Eastern Europe (CEE) has some exceptions and can reach lower collection rate than 45% but higher than 40% from 2016, and postpone the implementation of the second target up to 2021. The purpose of this work is to analyse the generation of waste of electrical and electronic equipment, processing tendencies in Baltic countries, also to evaluate the opinion of students and pupils, their habits in sorting the waste of electrical and electronic equipment.

2. Methods

Electrical and electronic waste sorting and recycling analysis of Lithuania and the Baltic countries carried out based on the Eurostat database and Lithuanian Environmental Protection Agency's waste accounting data. The study period was from 2006 to 2012. Indicators like actual domestic volume supplied (tons), household or non-household WEEE generated quantities (tons), collected handled WEEE quantities (in tons and kg/cap.), WEEE quantities of the different categories (tons and kg/cap.) collected and managed WEEE quantities (percentage) and treated and exported WEEE quantities (tons) were analysed. To reveal knowledge and sorting behaviour pupils and students were surveyed. The questionnaire was posted on the website www.apklausa.lt. The study was

conducted in 2014 in November - December. The study covers 300 completed questionnaires (150 – pupils of 11th and 12th grades and 150 students) in Lithuania. The profile of the respondents is provided in the table 1. The data collected were processed with SPSS 17 program. For the analysis of survey data collected chi-square test and significance level of $p < 0.05$ was used. Results

3.1. Trends in WEEE in the Baltic States

According to the data, Estonia successfully implemented the EU Directive 2002/96 / EC aim, which provides that, within one year at least 4 kg per capita of WEEE must be collected from the private household sector, in 2010. Estonia has collected 4.2 kg/capita. Lithuania and Latvia failed to reach this number in 2010. However, more recent data of Environmental Protection Agency in Lithuania shows that in 2011 Lithuania has collected 3.78 kg/capita and in 2012 - 4.48 kg/capita of WEEE (Fig. 1). Other developed countries, such as Germany in 2010 have collected 8.8 kg/capita per year, Austria - 8.7 kg/capita per year, while Sweden even 15.9 kg/capita per year. In general, analysis showed that WEEE has decreased in 2009 in Baltic countries and in the whole European Union due to global economic crisis. The actual waste quantities of EEE were reduced within a half; volumes of collected and recycled waste were reduced, too. But since 2010 new EE equipment released to the internal market, EEE waste collection, sorting and recycling, has been on increase every year. Most of collected waste of electrical and electronic equipment is large home appliances, IT and telecommunication equipment, monitoring and control devices. In 2012 Lithuania compared with the Baltic countries, collected most of IT and telecommunications equipment waste - 1844 tons. In total it was collected 14260 tonnes of WEEE in Lithuania in 2012.

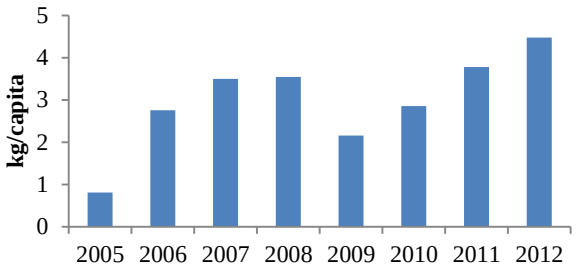

Figure 1. Collected WEEE in Lithuania 2005 – 2012
(Lithuanian Environmental protection agency data)

In Lithuania during 2008 - 2012 about 28.9 thousand tons of new EEE were released into the domestic market on average each year. However, only 10.8 thousand tons (38%) of no longer used EEE were collected annually. There is processed about 9 thousand tons (84%) of the total volume of WEEE collected each year.

3.2. Knowledge and behaviour regarding WEEE

The survey results showed that youth know about WEEE causing danger and importance of sorting and recycling. It was found that 81.3% of respondents knew what EEE is. Survey data showed that pupils (χ^2=4.303, $p<0.05$) more often knew what is EEE (Table 1.). However, 74.7% respondents need more information about EEE. The survey results indicated that the respondents do not know exactly what is classified as EEE. Even 67% of pupils and 69% of students attributed batteries and accumulators to EEE. 55% of pupils and 48% of the students indicated that the toys with batteries (operating on batteries) are also attributed to EEE, but these devices are not classified as electrical and electronic equipment (Fig. 2).

Table 1. Profile of the respondents

Pupils	**Students**
Gender	
Male 28% Female 72%	Male 33% Female 67%
Age groups	
16 - 17 yr. 61%, 18 - 19 yr. 39%	18 - 19 yr. 14% 22 - 23 yr. 45% 20 - 21 yr. 34% >24 yr. 7%
Grade	**Study year, graduate level**
11th grade 53% 12th grade 47%	1 year 14 % Bachelor studies 95% 2 year 17 % Master studies 5% 3 year 15 % 4 year 54 %
Incomes	
<= 400 Lt (115.9EUR) - 13.4% 401 - 800 Lt (116.1-231.7 EUR) - 26% 801 - 1200 Lt (231.9-347.5 EUR) - 28% 1201 - 1600 Lt (347.8-463.4 EUR) - 16% 1601 - 2000 Lt (363.7-579.2 EUR) - 6% >=2001 Lt (579.5EUR) - 10.6%	<= 400 Lt (115.9EUR) - 10% 401 - 800 Lt (116.1-231.7 EUR) - 29% 801 - 1200 Lt (231.9-347.5 EUR) - 24.5% 1201 - 1600 Lt (347.8-463.4 EUR) - 16.7% 1601 - 2000 Lt (363.7-579.2 EUR) - 10% >=2001 Lt (579.5EUR) - 9.8%

Table 1. Factors for the awareness on EEE *(survey results)*

	χ^2	p
Gender	0.410	0.522
Age	1.740	0.419
Housing type	0.323	0.570
Incomes	3.214	0.201
Students/Pupils	**4.303**	**0.038**

Handling the small WEEE 49.8% of the respondents indicated that they store this type of WEEE at home and later on take it to the collection points. However, 21% of respondents stated discarding EEE waste together with municipal waste. Large WEEE is immediately transported to the collection points as noted by 47.3% of the respondents. 8.7% mentioned addressing the businesses that collect large WEEE directly from the home. In addition, 69.7% of the respondents indicated that more collection points/containers are needed. Respondents, living in flats (χ^2=0.989, p<0.05) and women (χ^2=7.790, p<0.1) more often said, that there is not enough infrastructure to sort and give out waste of EEE in the city (Table 2). To the question, what circumstances should change (improve) in order respondents would start properly sort waste of electrical and electronic, between answers additional information on WEEE handling, material refunding (payment) for recycling and fines for improper handling dominated (Fig. 3). Information provision could be a reasonable approach for improving WEEE management. 74.7% of respondents said there is no sufficient information on how correctly to sort generated WEEE.

Table 2. Factors regarding WEEE infrastructure *(survey results)*

	χ^2	p
Gender	**7,790**	**0.051***
Age	5,113	0.276
Housing type	**0,989**	**0,032**
Incomes	2,230	0,328
Students/Pupils	0,200	0,650

*p<0.1

When asked what kind of information is missing in order to sort of electrical and electronic waste, 21% of respondents indicated that they lack information about what exactly consists of electrical and electronic equipment waste. 32% lack of information where they can give away WEEE. 21% noted a lack of information about EEE sorting benefits and importance as such. The lack of information about companies that may come and take electrical and electronic waste was identified by 25% of those surveyed. According to the respondents it is economically and ecologically useful to sort, process and recycle WEEE. This was acknowledged by almost 97% of pupils and 99% of students. When asked what benefits the waste sorting and recycling does, 31% of pupils and 27% of students indicated that this contributes to decreasing environmental pollution. Saving of natural resources was acknowledged by 24% of pupils and 27% of students.

3. Conclusions

Together with increasing consumption, WEEE is becoming an urgent problem, especially taking into account negative environmental and health outcomes.

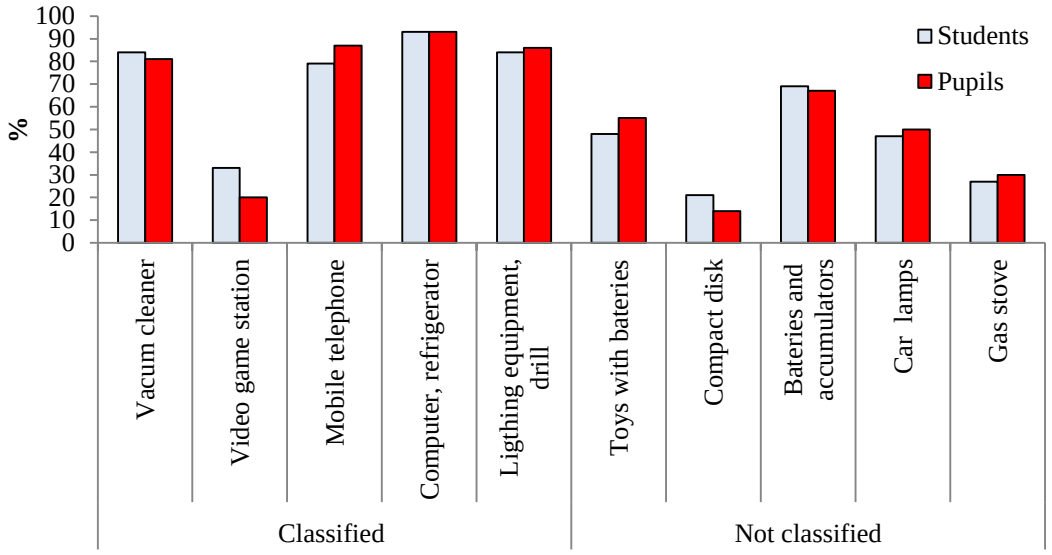

Figure 2. Allocation of separate waste to the WEEE category *(survey results)*

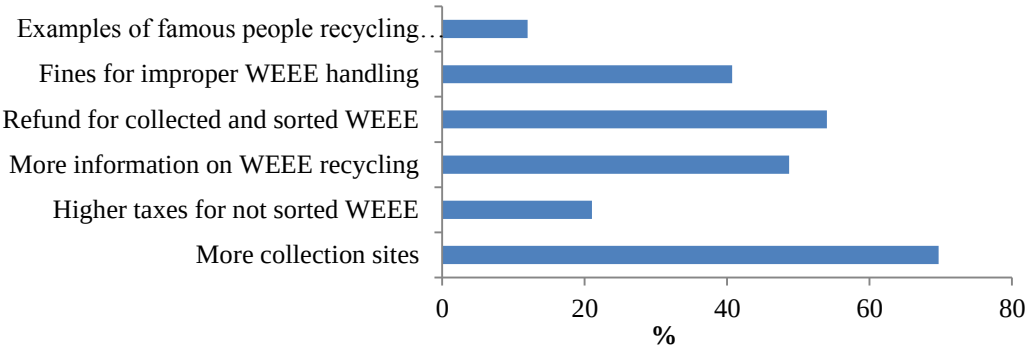

Figure 3. Changes needed to improve WEEE recycling *(survey results)*

Consumption level in the Baltic States is still lower to compare to the old EU member states, however increasing trends pose threats related to electric and electronic equipment and WEEE handling. Still emerging WEEE management system and low public awareness might pose additional challenges to reach environmentally desirable state. Therefore, information provision for young people, future main consumers, on WEEE, their handling possibilities and benefits, environmental impacts together with proper infrastructure provisioning remain the main tools. Of course lower consumption levels thru sufficiency approach, repairing, and producer's responsibility should be addressed, too.

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