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BACHELOR THESIS

RECYCLING IN THE CZECH REPUBLIC WITH A FOCUS ON ELECTRONIC WASTE

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Recycling in the Czech Republic With a Focus on Electronic Waste

Objectives of thesis

The Thesis focuses on issue of recycling in Czech Republic. The main objective is to investigate relation and opinion about recycling of inhabitants. Subsequently the Thesis and investigation of the questionnaire are concentrated on electronic waste, its possibilities of recycling and citizen's familiarity with it.

Methodology

The Thesis will be ellaborated with use of descriptive and comparative methods.

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Shaw, L. G., 2005, Attitudes and Behaviour about Recycling, Conference Waste - The Social Context held on 11-14 May, 2005 in Edmonton, Alberta, Canada, pp. 695-701

Bhutta, M. K. S., Omar, A., Yang, X., 2011, Electronic Waste: A Growing Concern in Today's Environment, Economics Research International, Hindawi Publishing Corporation, vol. 2011, 474230, pp. 8

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STATUTORY DECLARATION

I, THE UNDERSIGNED, HEREBY DECLARE THAT THE THESIS „RECYCLING IN THE CZECH REPUBLIC WITH A FOCUS ON ELECTRONIC WASTE“ IS RESULT OF MY PERSONAL WORK AND ONLY SOURCES I USED ARE LISTED IN THE REFERENCES.

In Prague, March 13, 2014.

……

Edita Svitáková

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Recycling in the Czech Republic with a Focus on Electronic Waste

Recyklace v České republice se zaměřením na elektronický odpad

Summary:

The goal of this bachelor thesis is to introduce the current situation of recycling in the Czech Republic and the issue of electronic waste, as well as to summarize some basic facts about the methods of waste disposal. In order to investigate inhabitants' relation to and opinion on recycling and electronic waste in the Czech Republic quantitative research was conducted and acquired results were analysed.

The thesis is divided into two parts. Firstly the theoretical part introduces and defines basic terms about waste, recycling and electronic waste. The second, practical part, is based on results gained through a questionnaire. The aim of the questionnaire was to investigate people's opinion on recycling, to find out whether they sort their waste, and if so then what type of waste and why. With regard to electronic waste it is crucial to find out how people handle this waste.

Souhrn:

Cílem této bakalářské práce je představení současné situace recyklace v České republice, problematiky týkající se elektronického odpadu a shrnutí základních možných způsobů naložení s odpadem. Za účelem zjištění vztahu a názoru občanů České republiky na recyklaci a elektronický odpad byl proveden kvantitativní výzkum a získané výsledky byly následně analyzovány.

Bakalářská práce je rozdělena do dvou částí. První, teoretická část, představuje a definuje základní pojmy týkající se odpadu, recyklace a elektronického odpadu. Následná praktická část je založena na výsledcích získaných z dotazníků. Cílem dotazníků bylo zjistit názor občanů na recyklaci, jestli občané třídí odpad a pokud ano jaké druhy a proč. Co se týče elektronického odpadu, zásadní bylo zjistit, jak lidé s tímto odpadem nakládají.

Key words: recycling, Czech Republic, waste, electronic waste, household waste

Klíčová slova: recyklace, Česká republika, odpad, elektronický odpad, odpad z domácnosti

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List of Abbreviations

CR	Czech Republic
CZK	Czech Crown
e.g.	*exempli gratia*, for example
etc.	*et cetera*, and so one
EU	European Union
Kg	Kilogram
PVC	Polyvinyl chloride
RENE	The Recycling Network Europe
RoHS	Restriction of the use of certain Hazardous Substances in electrical and electronic equipment
UK	United Kingdom
WEEE	Waste Electrical and Electric Equipment

1. Introduction

This bachelor thesis topic comes out of the current issue which is the incessant increase in waste production. Over the course of the past few years people got used to buying huge amounts of things of all sorts, but only relatively recently they started to realize that it can be a serious problem. Nobody actually cared about what was happening with the waste or what its impact until it was obvious that almost all landfills were full. Until then the placement in a landfill was usually the only method of disposal of the waste. Now it is clear that it is necessary to look for other possible methods of disposal, to try make them as efficient as possible and to reduce the amount of waste we all produce as radically as possible. Currently the recycling, which is using waste and transforms it into a new useful product, seems to be the best solution and the government and many organizations in the Czech Republic try to improve the present state.

Another related issue on which this thesis focuses is electronic waste. In relation to the constant increase of inhabitants on Earth and continuing development of civilization, it is necessary to point out that the amount of so called e-waste is also still increasing. Worldwide the e-waste currently constitutes approximately 5% of household solid waste. Moreover it is much more dangerous than plastics for instance. People modernize their households, buy still more and more electronic appliances and change them quickly. According to statistics it is expected that up to 2017 the e-waste will increase over 33% (Solving the E-Waste Problem, 2013).

Nowadays the optimal solution for this e-waste problem has to be found. It is evident that it will not be easy and finding this solution will take more years. It would be optimal to be prepared for rise in amount of e-waste, ensure the monitored collection, utilization and removal.

2. Thesis Objectives and Methodology

2.1. Objectives

Because the thesis focuses on the issue of recycling in the Czech Republic its main objective is to investigate the inhabitants' relation to and opinions about recycling. This work attempts to discover what the reason is for people recycling, what they recycle in particular and how they do it. Subsequently, the thesis and the questionnaire are concentrated on electronic waste, on the possibilities of recycling it and citizens' familiarity with the collective systems.

2.2. Methodology

Firstly in the theoretical part all relevant data were gathered in order to clarify terms and definitions. Subsequently principle of recycling, methods of disposal, and the issue of electronic waste were explained and described.

The methodology of the practical part consists of quantitative research, which was performed through a questionnaire made for this purpose.

The questionnaire was randomly distributed to people with permanent residence in Středočeský region and the city of Prague, which was the only prerequisite to filling it in. The questionnaires were distributed online and also in print form in the period from January 1, 2014 to January 31, 2014.

In this period one hundred questionnaires were collected and subsequently evaluated using the comparative method. Graphs and figures based on particular questions were created and interpreted. Any significant difference or unexpected outcome in particular was pointed out. For this purpose was used SPSS program which enables to show causality between particular answers and socio-economic data.

3. Literature Review

3.1. Waste

3.1.1. Definition of Waste

Before the work can focus on the issue of recycling, its history, development and current problems, the term waste should be defined because it is basic and initial element of this work. The available definitions usually vary at some points but most of them correspond with the fact that waste is term for some unwanted material. However this could be subjective because waste to one person is not waste to another. According to Oxford Dictionaries "Waste is unwanted or unusable material, substances or by products: nuclear waste" (Oxford Dictionaries, 2014). Another definition by European Union says: "Waste is an object the holder discards, intends to discard or is required to discard" (UK Environmental Law Association, 2014).

Equally as we have a lot of definitions we have also many ways how distinguish between the categories of waste. Firstly we can divide them according to a phase of matter. This means solid waste or liquid waste. Secondly according to origin, this can be waste from mining, industry, agriculture or municipal waste. Others split the waste in following categories: municipal solid waste which includes for instance household waste, hazardous waste and medical waste. And finally division of waste according to legislation in relation to composition, hazardous waste and the other waste.

3.1.2. Methods of Disposal

In this part are summarized possible methods how to process accumulated waste in the Czech Republic. This means what happened after people, firms *etc.* collect the waste to dustbins or containers.

Landfills

The first option of waste disposal is placement in landfills. Landfill is permanent placement of waste on given spot and is the oldest method of waste disposal which was created by human activity. Landfill is the first form of organized waste management and the most used method all over the world. In the Czech Republic we know three main types of landfills, the first type is S-IO which is a landfill for inert waste (soil or stones), the second one is S-OO for municipal or industrial waste and the last one is S-NO storing hazardous waste. Problems have arised relatively recently when all the landfills became full and there was a need to use also other alternative methods. Moreover landfills have compared to other methods several disadvantages. During the storing and decomposing of organic substances occur many different and complicated chemical reactions. Hydrocarbon and greenhouse gas are escaping to atmosphere, this process causes the smell and also the change of shape and content of landfill and water can be contaminated. The number of waste taken into landfills is generally slowly decreasing but it is definitely a long distance run. According to (Calla - Sdružení pro záchranu prostředí, 2013) in the Czech Republic in 1992 ran 2044 landfills, in 1995 1278 landfills, in 1996 380 and nowadays only 237. Despite this important improvement as we can see on the Table 1, the Czech Republic put to landfills 65% of waste, which shows us that landfill is still the most used solution. This happens despite the fact that the European Union and even the Czech Republic came up to resolution that landfills are the least acceptable method of disposal because of its impact on the environment. It is also not economically suitable as we are losing material and energetic sources contained in the waste. If we compare it with Germany, which is according to the Table the most developed country in recycling, there is a significant difference because Germany puts into landfills only 1% of produced municipal waste. In consideration of the fact that in the Czech Republic are relatively low charges for placing waste in landfill, it is still more profitable option than other methods of waste disposal.

On the other hand movement from landfills to incineration is not desirable. It is necessary to support recycling and composting and first of all crucial is waste prevention which is the most important and stands on the top of waste hierarchy. The European Union strategy sets regarding to dispose of waste following hierarchy (sort from 1 as the most desirable to 4 as the least one):

1. Prevention
2. Material utilization
3. Energy utilization
4. Safe liquidation of waste

Table 1: Generated municipal waste and its disposal (2011)

	municipal waste generated, kg per person, per year (2011)	**Municipal waste treated, %**			
		Landfilled	**Incinerated**	**Recycled**	**Composted**
Belgium	465	37	23	25	15
Czech Republic	**320**	**65**	**18**	**15**	**2**
Germany	**597**	**1**	**37**	**45**	**17**
Greece	496	82	0	15	3
France	526	28	35	19	18
Poland	315	71	1	11	17
United Kingdom	518	49	12	25	14

Source: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-04032013-BP/EN/8-04032013-BP-EN.PDF

The Table above shows the data available at Eurostat. Firstly the total amount of municipal waste generated in kg per person per year (2011) and secondly percentage of particular methods of waste disposal. It is possible to compare the Czech Republic with several European countries and see the differences. Interesting is for instance Germany and its numbers. It can be seen that the amount of municipal waste generated per person is compared to other countries the highest however they can afford it because of the very good developed level of recycling. Almost half of all waste is recycled in Germany and only 1% of waste is landfilled.

Incineration

The second possible method how to handle the waste is incineration. “Incineration is waste treatment process that involves the combustion of organic substances contained in waste material” (Knox, 2005). This method firstly seems to be a simple solution how to get rid of the waste. In contrast to landfills where is waste stored for many years and do not bring us anything useful, incinerators can remove huge amount of waste in minimum time and are more effective because of energy utilization. However incineration compared to other methods is still not optimal and it is rather a controversial topic. Nowadays are three municipal waste incinerators in the Czech Republic, there are in Prague, Liberec and Brno. The oldest one in Brno was established in 1905. According to the Table 1 we know that in the Czech Republic about 18% of waste was incinerated in 2011 (Holík, 2014).

Most of the environment friendly organizations such as Arnika in the Czech Republic or Greenpeace worldwide point out several disadvantages. They claim that waste is not disappearing during the incineration, it only changes chemical composition and the toxicity of incinerated substances. New, usually more dangerous, waste comes into existence, which is spread to water and air. They argue that the energy which we gain from incineration is only a fragment of original energy which was invested in the incineration. If people will recycle more, they can gain more energy.

On the other hand, there are also others who believe that incineration is not such a bad solution. For instance the European Union: “The new EU waste legislation, created on the 17th of June 2008, has deemed that incineration of waste should be classified as a 'recovery' operation rather than 'disposal', providing the incineration meets certain energy efficiency standards” (Waste Management World, 2013). It is unquestionable that waste is also a significant resource of energy. It is possible to partly replace the incineration of fossil fuels (such as coal or crude oil) with incineration of waste and gain electricity and heat.

Even though the incinerators in the Czech Republic are generally in a good condition and meet all regulations, each incinerator is and probably will always be producing harmful emissions. This is the reason why incineration stands despite the useful energy utilization relatively low on the waste hierarchy.

3.2. Recycling

3.2.1. Definition of Recycling

After the term waste and two basic methods of disposal have been defined and explained, the work can focus on recycling which is another method of waste disposal. Recycling is a process or practice when a material (waste) is transformed and repeatedly used or changed into a new useful product. "It is production of new products or materials from used materials or scrap. Recycling is a key strategy in the reduction of solid waste, and the third plank of the waste hierarchy of reduce, reuse and recycle" (LeBlanc, 2014). It is valuable mainly because of resources saving and reducing the consumption of raw materials.

3.2.2. History of Recycling

Recycling is generally perceived as a recent activity which is environmentally beneficial. However in reality the history of recycling basically began at the same time while history of humans, of course in different form than as we know it nowadays. "During periods where resources were scarce, archaeological studies of ancient waste dumps show less household waste (such as ash broken tools and pottery) - implying more waste being recycled in the absence of new material" (Siegle, 2006). An example from the history can be also metal which was for thousand years recycled by melting and manufacturing into new items as weapons *etc.*

As long as inhabitants lived a nomadic way of life, there was no need to recycle arisen waste. When the group of people decided to move to another place, they simply left everything where it was. Additionally most of the material they used was organic. This changed when people started to build their own habitations and consequently started united into villages and cities. Basically right after that inhabitants constructed sewerage systems and gathered waste to given places. This is known from ancient Rome and Greece where they already realized importance of maintenance hygiene. The situation obviously got worse with increase in number of inhabitants in the city which resulted in more waste, more polluted water and optimal conditions for spreading diseases. According to given evidence, in times of ancient Rome was the situation generally good because

administration of the city paid attention to state of waste and organized for instance regular street cleaning. Nevertheless this disappeared with the downfall of the Roman Empire.

The development continued and the next crucial point was the Industrial Revolution which began in the 18th century. As the website Environmental Industry Associations (2013) points out "The availability of raw materials, increased trade and growing populations stimulated new inventions and the development of machinery. Growing populations and increased production let to greater amounts of waste. Government officials and the public increasingly became concerned about waste, to avoid the potential problems associated with unmanaged waste in urban environments, the Age of Sanitations began" (EIA, 2013). In Great Britain, where Industrial Revolution came into existence, was in 1848 issued The Public Health Act which can be regarded as the first modern law that deal with waste collection and regulation of dustbins.

Reversal came in the 19th century when the situation in the cities was unbearable primarily due to epidemics which spread really fast. Efficient system of handling the waste has arised. Solid waste was taken into landfills however they found out soon that the capacity of dumps is insufficient. Solution to this problem was establishment of waste incinerators which were built in the end of 19th century. In the Czech Republic the first incinerator came into existence in 1905 in Brno.

During the 20th century most of the countries adapted measures to regulation of waste. The first waste laws were established and world started to distinguish the hazardous waste. After the World Wars also some international organizations started to occupy with the waste issue and generally the interest in environment was increasing.

Composting

Composting is a form of recycling because during this process the waste is used or in other words we take advantage of waste. It is natural, organic-chemical transformation during the stable organic product - fertilizer is created. The fertilizer results from organic matters, with air access and with the living organism's influence. Final product of this process is the compost. We can also say that "Composting is a biological process that affects and is affected by physical and chemical forces" (Epstein, 1996). Epstein also claims that composting is the highest form of recycling because of the reuse of resources.

According to the Table 1, it can be seen that in the Czech Republic only 2% of municipal waste was composted in 2011 (which is compared to other countries generally the lowest percentage) while in Germany it was 17%. Moreover statistics state that about more than one third of waste in each Czech household is so-called green waste. Usually this green waste ends in dust bin and then in landfill while it could be valuable resource for us (Greenpeace, 2012).

3.2.3. Recycling in the Czech Republic

Currently in the Czech Republic is possible to recycle following materials: plastic, paper, glass, metals, organic waste, textile, batteries, electronic waste, liquid packaging boards, pneumatic tyres and oils.

In 2012 about 21% of municipal waste was recycled in the Czech Republic (ČSÚ, 2013). That is not a failure, the number is increasing every year (in 2011 it was 15%) but there are still other European countries which are significantly better developed in this branch. "Evidently there is plenty scope for further innovation in recycling. New ideas and approaches will be needed, since many communities and organisations have set high targets for recycling. The European Parliament voted to increase recycling rates by 2020 to 50% of municipal waste and 70% of industrial waste" (The Economist, 2007).

As the Ministry of the Environment of the Czech Republic published in a press release in the end of 2013, major future priorities regarding development of waste management include come up to hierarchy of waste treatment, which means the best is prevention, if some waste is created then recycling should be preferred, after that energy utilization and the last option should be the landfill. The Czech Republic would like to focus on landfills restrictions, increase in fee paid for each ton of waste and ban on placement unprocessed municipal solid waste in landfill. This prohibition is planned to be realized between years 2023 to 2025 (Ministry of the Environment of the Czech Republic, 2013).

3.3. Electronic Waste

3.3.1. Definition of E-Waste

Electronic waste also known as an e-waste or Waste Electrical and Electric Equipment (WEEE) is especially nowadays everyday part of our life. Production of electronic products is annually rapidly increasing while the lifespan of these products has become increasingly shorter. Most of the people could not imagine life without these appliances of all sorts. According to available statistics, in 2012 Europe generated about 10 933 millions of tons of e-waste and it is estimated that up to 2017 the amount of e-waste will increase over 33%. "E-waste is term used to cover almost all types of electrical and electronic equipment that has or could enter the waste stream." The term is very general and can cover almost any household or business item with circuitry or electrical components with power or battery supply (Solving the E-Waste Problem, 2013).

"E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The hazardous content of these materials pose a threat to human health and environment. Many of these products can be reused, refurbished, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem" (Vaishnav & Diwan, 2013).

It is not a surprise that the biggest problems with e-waste have countries which are also the main producers and in which is concentrated the most of the factories. This is definitely China which has produced 11 million tons in 2012 (Solving the E-Waste Problem, 2013).

E-waste which is produced nowadays is compounded from hundreds types of material. As Greenpeace points out most of these materials content some of the toxic heavy metals, as for instance lead or mercury, and hazardous chemicals. These substances may cause serious pollution and are dangerous in terms of health (Greenpeace, 2012). "The problem is that most of the people are unaware of the potential negative impact of the rapidly increasing use of computers, monitors and televisions. When these products are placed in landfills or incinerated, they pose health risks due to hazardous materials they contain. The improper disposal of electronic products leads to the possibility of damaging the environment. As more e-waste is placed in landfills, exposure to environmental toxins is

likely to increase, resulting in elevated risks of cancer and developmental and neurological disorders" (Omar, et al., 2011).

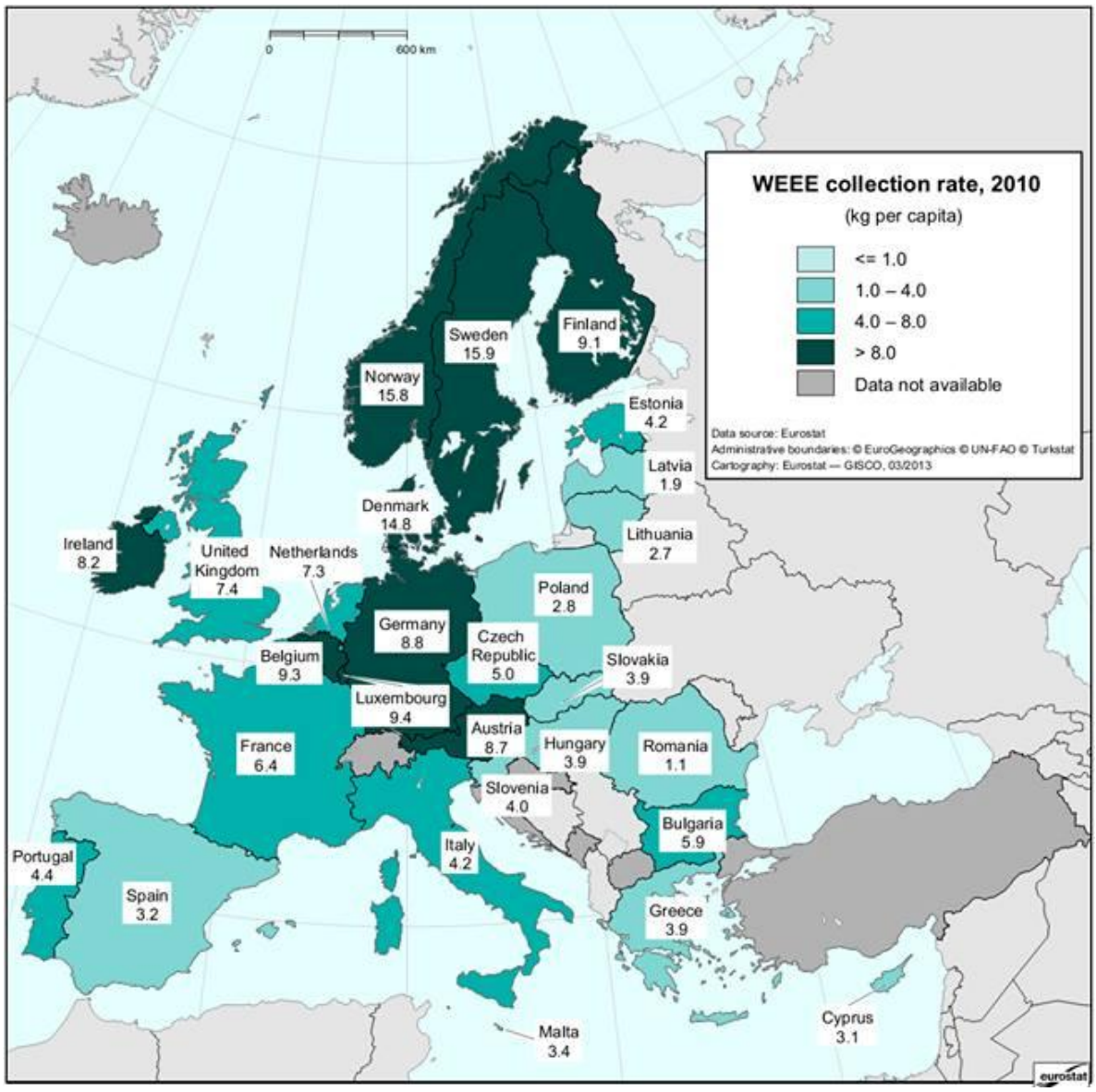
3.3.2. Legislative

Regarding the Ministry of the Environment of the Czech Republic basic terms are defined as follows: "Environmental issues regarding to WEEE (waste electrical and electronic equipment) laid down by the Directive 2002/96/EC of the European Parliament and of the Council on waste electrical and electronic equipment (WEEE) and the Directive 2002/95/EC of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) are provided by the Act. No.185/2001 Coll. on waste in sections 37f-37o and under implementing Decree No. 352/2005 Coll., on particulars of handling electrical and electronic equipment and waste electrical and electronic equipment and on the detailed conditions of financing their handling" (Ministry of the Environment of the Czech Republic, 2013). In other directives valid in the Czech Republic we can find for instance definition of producer and his or her responsibility.

The European Union's goal is to achieve improve in recycling of WEEE and responsibility of producers during the processing. Since 2005 is producer under an obligation to provide separate collection of electronic waste, reverse takeover, processing, utilization and disposal. This caused several complications for producers and it means that after selling their products, their obligations do not end.

The Recycling Network Europe (RENE) is a network connecting small and medium size companies. Its purpose is to gather experience in the area of recycling of electronic waste and also collection and logistics. The network has currently members from about 17 European Union countries and is one of the most successful companies providing these services (RENE AG, 2014).

Figure 1: WEEE collection rate



Source:
http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/key_waste_streams/waste_electrical_electronic_equipment_wee7

The figure above displays WEEE collection rates in kg per person for particular European countries in 2010. “The WEEE Directive currently sets a minimum collection target for European Union members of 4 kg per year per inhabitant for WEEE from households” (Eurostat, 2012). It can be seen that the Czech Republic with 5 kg in 2010 complied with required target. Interesting are collection rates of Norway, Sweden and Denmark because all these northern countries had very high collection rates (from about 9 to 15 kg)

compared to other countries. By contrast for instance Latvia, Poland or Spain fell behind the determined target.

3.3.3. Classification of E-Waste

According to European Union´s directive electronics can be divided into following ten categories (List of WEEE):

1. Large household appliances

2. Small household appliances

3. IT and telecommunication equipment

4. Consumer equipment

5. Lightning equipment

6. Electrical and electronic tools

7. Toys, leisure and sports equipment

8. Medical devices

9. Monitoring and control instruments

10. Automatic dispensers

3.3.4. Collective Systems

Because of the fact that producers are according to valid law responsible for securing reverse takeover of their electronic products, they decided to establish a collective systems. Significant issue which is related to collective systems is a recycling fee. "It is an expense of producers, shown separately at the time of sale of new products as of 1 September 2005, it is paid to collective system and used to meet the costs of take-back, reuse, treatment, recovery and competent disposal of scrapped electrical equipment marketed before 13 August 2005" (Elektrowin, a.s., 2011). The amount of recycling fee is calculated according

to mentioned categories. For instance the recycling fee for large appliance is about 60 CZK, for tools the recycling fee is 4 CZK.

In this part will be summarized basic information about main collective systems in the Czech Republic. Currently six collective systems are working here. These are Asekol, Ekolamp, Elektrowin, OFO recycling, Rema system and Retela. Each of this company has licence to handle different categories of waste. Interesting is that all of the categories mentioned in the classification of e-waste chapter are covered in the Czech Republic apart from category 10 which is automatic dispensers and there is no company having license to handle this waste category. Following part summarizes basic information about three main collective systems.

Elektrowin

The first mentioned collective system is called Elektrowin a.s. It is a non-profit organisation which was set up in 2005 as a collective system operator. The purpose of collective system is providing services as a return, separate collection, processing, utilization and removal of electronic equipment and electronic waste. Elektrowin provides these services for categories number 1., 2. and 6. (see Chapter 3.3.3. Classification of e-waste).

Table 2: Amount of recycled electrical waste in 2012

Amount of Recycled Electrical Waste in the Czech Republic in 2012			
		Material Recycling %	
Electrical Equipment Category	Material Recycling in tons	Achieved	Stipulated by s. 37m of Waste Act
1	17 894	86,7	75
2	2 019	92,3	50
6	207,4	91,4	50

Source: Elektrowin annual report 2012, available at: http://www.elektrowin.cz/cs/download/elektrowin-vz-2012-2-_fin.pdf

This Table displays amount of recycled electrical waste in the Czech Republic for chosen categories in tons, which are accepted by Elektrowin. All categories achieved required recycling percentage given by stipulated Waste Act without difficulty. Category 2 (small

household appliances) and 6 (electrical and electronic tools) were recycled nearly double in 2012 than required.

Asekol

Asekol is also a non-profit company founded in 2005 and is collective take-back scheme for WEEE. This company take back EEE in categories 3, 4 and 7. Among other things since 2007 Asekol ensures a project of so called "red containers". These containers having red colour are meant for small electronics such as frequent mobile phones or batteries. They were established mainly because small electronics ends in municipal solid waste containers much more often than the bigger types of electronic appliances. Currently are in the Czech Republic 1987 red containers and the company still places new ones (ASEKOL, 2014).

Ekolamp

This also non profit company called Ekolamp accepts category 5 which is lightning equipment. Every citizen, firm or municipality can bring old lightning equipment free of charge there. Ekolamp accepts all lightning regardless of brand or age and collecting is funded by recycling fees.

3.4. Possibilities of Electronic Waste Disposal

3.4.1. Landfills

First option is to place e-waste in a landfill. Landfills characteristic can be seen in Chapter 3.1.2. focused on methods of waste disposal and as it is obvious this method is probably the easiest however with respect to environment the least suitable because toxic matters which e-waste contains could pollute land and atmosphere. Therefore e-waste storing in landfill is banned in the Czech Republic.

3.4.2. Energy Utilization

Another possible method how to get rid of e-waste and simultaneously utilize this material is incineration. Opponents of e-waste incineration disagree mainly because of the fact that during the incineration heavy metals, such as lead or mercury, are escaping to atmosphere. As Greenpeace states, mercury in environment can accumulate in the food chain, namely for instance in fish, and can in this way subsequently contaminate public. Products containing PVC are also very dangerous if incinerated because toxic matters are also escaping. Because e-waste contains compared to other waste so many toxic matter, no natural, incineration is definitely not gentle to environment (Greenpeace, 2012).

3.4.3. Reverse Takeover

This possibility, to bring an old electrical appliance to a given collecting spot, ensures for instance above mentioned Elektrowin. Only a complete appliance is eligible to be taken back free of charge. Incomplete appliances are considered waste and the benefit of take-back system cannot be used. Its recycling and disposal costs must be covered by the local authorities.

In the Czech Republic are currently about 12 000 collecting spots including civic amenity sites that often cooperates with collective systems plus possibility to take small appliances to particular containers. Almost all traders also offer a possibility to take free of charge an old appliance when buying a new one. In 2012 inhabitants of the Czech Republic handed in about 45 000 tons of electronic waste and this number is constantly increasing.

Most of the electronic appliances contain components which can be used again. In case of mobile phone, these components create about 80%. Together with computers contain, apart from plastic, glass or iron, valuable metals such as silver and gold too. From one ton of mobile phones it is possible to obtain about 300 grams of gold. After people bring the appliance to collecting spot, old electronics are taken to processing facility where the devices are disassembled into pieces, from which components containing hazardous matter are removed. Such a hazardous component is for instance a battery. The other, non hazardous, components are consequently crushed and sorted according to types of material. Components or material which cannot be processed after that becomes a waste and is

incinerated. Available statistics present that incinerated part usually constitutes 15% to 25% of total disassembled electronic waste. Gained recyclable materials are used for new products manufacturing (Třídení odpadu, 2014).

It is obvious that this method is the most favourable in relation to environment, not only because of natural resources saving.

3.4.4. Export

It may be surprising but export is also a method of disposal not only of electronic waste. Many countries, mainly the well developed export their waste to less developed countries, to third world countries. "Major reasons for export are cheap labour and lack of environmental and occupational standards in Asia" (Vaishnav & Diwan, 2013). Generally the largest amount of waste is transported to China and India. "Problem is that much of the e-waste comes through illegal channels because under United Nations conventions, there is a specific ban on electronic waste being transferred from developed countries like the United States to countries like China and Vietnam" (Watson, 2013).

Example of how serious this problem became during only a few years is Chinese village Guiyu, sometimes called as electronic graveyard. It is the largest e-waste disposal all over the world. All the village is full of old electronics, local people take it to pieces but it is really dirty and dangerous work which is hugely devastating for the local environment and people's health.

It is obvious that this option is not sustainable, because the waste is not disappearing, it is only relocated. So it is provable a blind alley but to stop exporting waste is not really easy.

Regarding the Czech Republic, in 2012 was imported to the Czech Republic 0,8 million tonnes of waste and exported 2,8 million tonnes. This waste contains mainly iron metals from civil engineering, packing paper and cardboard. Both the import and export was transacted primarily within the European Union (about 97%) (ČSÚ, 2013).

4. Results

4.1. Questionnaire

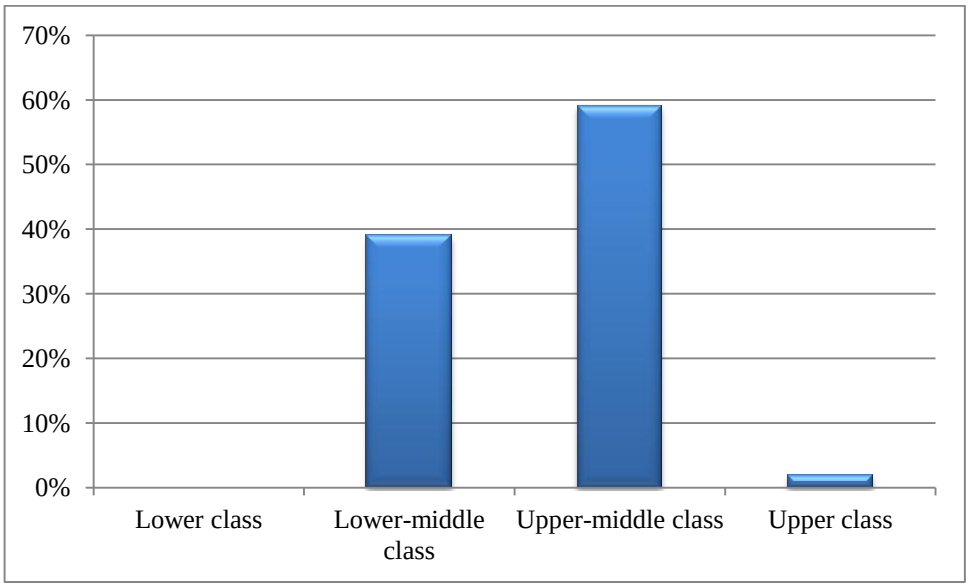
The research was based on a questionnaire containing 13 questions divided in two parts. First socio-economic part inquires basic information about respondents such as gender, age *etc.*, second part then focuses on recycling itself. Its purpose was to summarize and to find out what people in the Czech Republic think about recycling, why and what kinds of waste they sort, how they handle the electronic waste and their familiarity with collective systems. Crucial for this research was to put emphasis not only on findings but also on any unexpected or interesting relation between respondents' answers and socio-economic information.

The questionnaires were randomly distributed online and also in print form in period from January 1, 2014 to January 31, 2014. One hundred responses were collected and evaluated by using comparative method. The following chapter summarizes gained data and interprets it in figures.

4.2. Results of the Research

Regarding the results gained through this quantitative research, it is important to point out that this research is rather illustrative. Not only because of the respondents' area of residence, Prague or Středočeský region, but also because of the socio-economic data which each respondent stated in the beginning of the questionnaire. Aim of this part of the questionnaire was to gain data such as gender, age, achieved education or social class and some of these sections are not perfectly balanced. For instance according to age 78% of the respondents belong to the group of age between 15 to 25 years old, according to level of education 73% of respondents achieved secondary school with graduation and 23% finished the university.

Figure 2: Social class to which respondents think they belong to

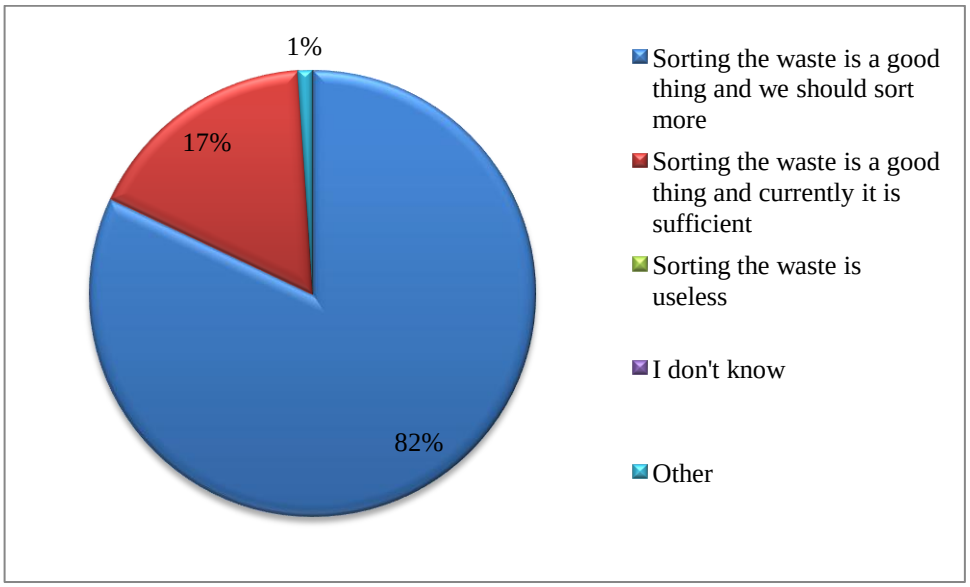


On the question about which social class people think they belong to 59% count themselves as upper-middle class, 39% as lower-middle class, only one respondent think that he belongs to upper class and nobody counts himself to lower class.

So it is obvious that these inequalities have also influenced the research and the following results.

On the other hand balanced socio-economic part is respondent's gender (58 women and 42 men) and number of people living in respondent's household (living alone, two, three, four or five and more people).

Figure 3: Respondents' attitude to waste separation



The first as well as one of the most important issues was to find out what people think about waste separation in the Czech Republic. It was discovered that 82% of respondents think that sorting the waste is a good thing and everyone should sort more. This is definitely positive finding. While the remaining 17% think that sorting the waste is good thing, they also believe that there is no need to sort more because the current state of affairs is sufficient. None of the respondents think that to sort the waste is useless. Regarding this question there were no significant differences in consideration of socio-economic factors except for social classes. After comparison was provable that generally people count themselves as lower-middle class sort the waste but usually think that it is sufficient. However upper-middle class tend to sort more and have generally higher ambitions.

Second goal was to find out how people evaluate the level of waste separation in the Czech Republic compared to other European countries. 2% stated that in their opinion the level of waste separation is excellent, 30% stated above average and most of the respondents which is 58% think that the level of waste separation is currently on average. This result could be also reckoned as positive because it is important that people are aware of need of improvement. 5% stated that the level is below average and 3%, only men and only people who belong to the age group between 15 to 25 years old, think that the level of waste separation is catastrophic.

Figure 4: Why do people sort the waste?

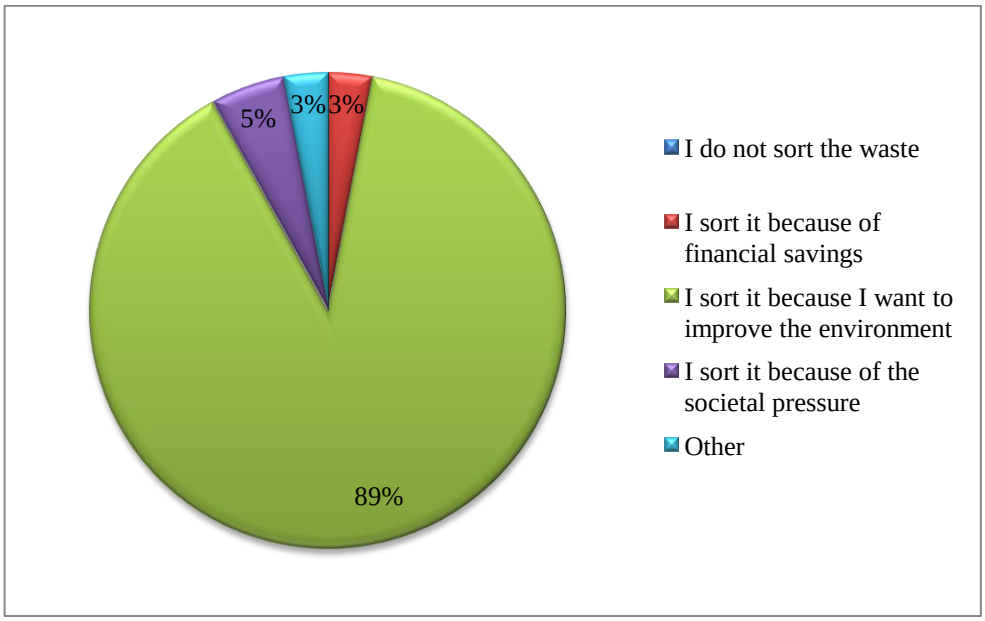
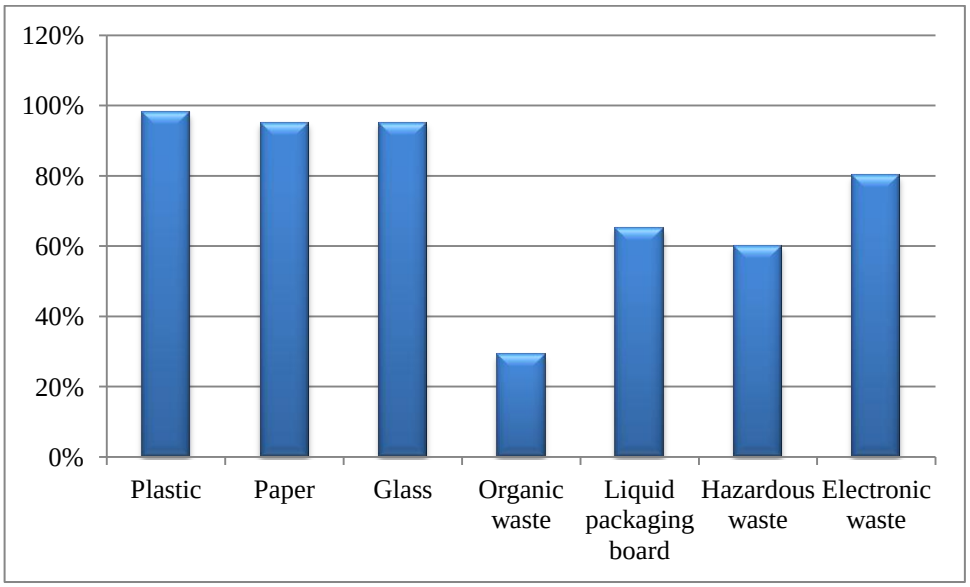


Figure 4 is based on the question which investigated why people sort the waste. It was found that the absolute majority of the people sort their waste because they want to improve the environment (89%). In this group there were mainly people who belong to the upper-middle to lower-middle class, which is interesting because some may expect that the lower-middle class, as opposed to the upper-middle class one, would prefer financial savings as their reason rather than the environmental one. Second most common reason is the societal pressure (5%) and the third reason for sorting the waste has to do with financial savings (3%). It is interesting that all those respondents who stated the societal pressure as their reason were men. Another reason marked as other was for instance effort to prevent the incineration of waste by sorting it.

Other few questions focused on types of waste which are possible to sort. The goal was to find out whether people sort following types of waste: plastic, paper, glass, organic waste, liquid packaging board, hazardous waste and electronic waste. If they do not sort the given material, aim was to discover what the reason is.

Figure 5: Percentage of sorting different types of waste



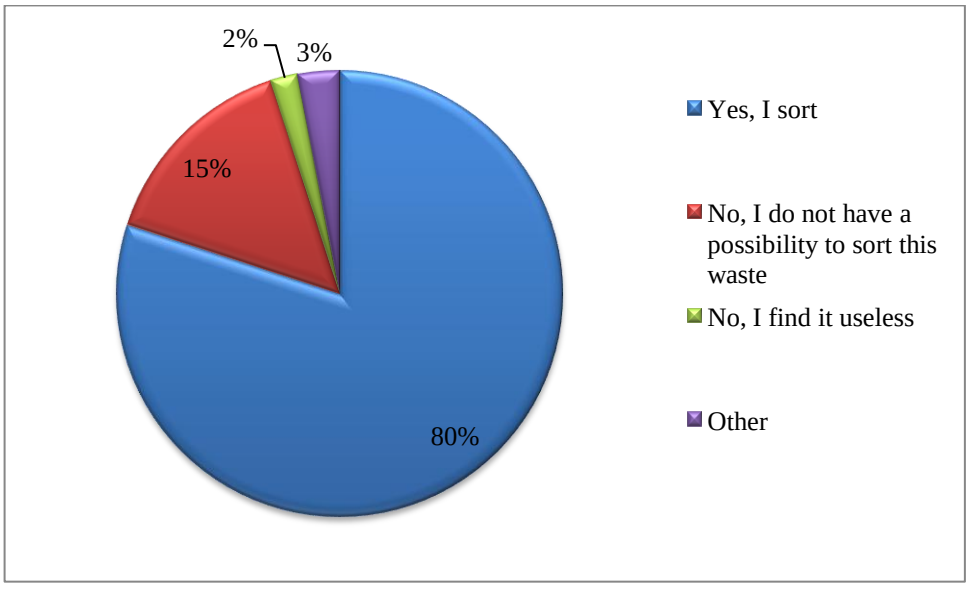
As it can be seen in Figure 5 it was discovered that respondents sort plastics the most (98%), then paper (95%) and then glass (95%). These are followed by electronic waste (80%), liquid packaging board (65%), hazardous waste (60%) and the last place is organic waste, which is only sorted by 29% of the respondents. Generally speaking, when people do not sort any given type of waste it is because of the fact that they do not have any possibility to do so, for instance due to the lack of containers *etc*. This was also the main reason regarding to organic waste stated by 53% of people. Another 8% think that organic waste separation is useless. Nonetheless, the most useless type of sorted waste, according to the respondents' opinions is the liquid packaging board (17%). It is obvious that people living for instance in the centre of Prague in flats do not have the possibility to have a compost however containers designated for liquid packaging board became rather frequent during past years and are nowadays usually at the same place as other containers designated for plastic or paper.

Interesting is the contrast in results between upper-middle and lower-middle classes regarding to organic waste separation, because compared to other questions there were usually no considerable differences between these two classes. The group which sort the organic waste is constituted primarily of upper-middle class respondents in contrast to lower-middle class whose absolute majority do not have a possibility to sort organic waste. This may be caused for example by the fact that people who belong to upper class are

richer and might have own family house with garden so they have the possibility of composting more likely than people living in flats. Or there can be definitely some other reasons. It would be interesting to find out or compare some other researches that occupy with composting and see the difference for instance between cities and villages, if people living outside the cities compost more.

This question also shows us quite alarming situation regarding hazardous waste. Even though this waste is extremely dangerous and should be theoretically, in ideal form, the most sorted one, in this research only 60% of respondents sort hazardous waste and moreover 5% think that it is useless. Less people sort only organic waste and this corresponds with the statistics mentioned in the literature review where was proven that composting is used as a method of disposal very rarely in the Czech Republic.

Figure 6: Do respondents sort the electronic waste?



Regarding electronic waste, on which is focused subsequent part of the questionnaire, 80% of people sort it, another 15% do not have the possibility to do it and 2% find sorting it useless as shown in the Figures. Others stated some other reasons, for instance that they have all their old electronic at home. It is interesting that there is such a big difference between sorting electronic waste and hazardous waste. It can be expected that both these types of waste can be for some people more difficult to sort because determined containers

or civic amenity sites are not as frequent as for example container for plastic. So theoretically we can suppose that if people sort electronic waste, they would sort the hazardous waste too because civic amenity sites accepts apart from old electronics hazardous waste too. And for instance any expired or left over medicine can be handed in to any pharmacy. Nevertheless regarding this research this is not valid.

Table 3: Mutual dependency of results

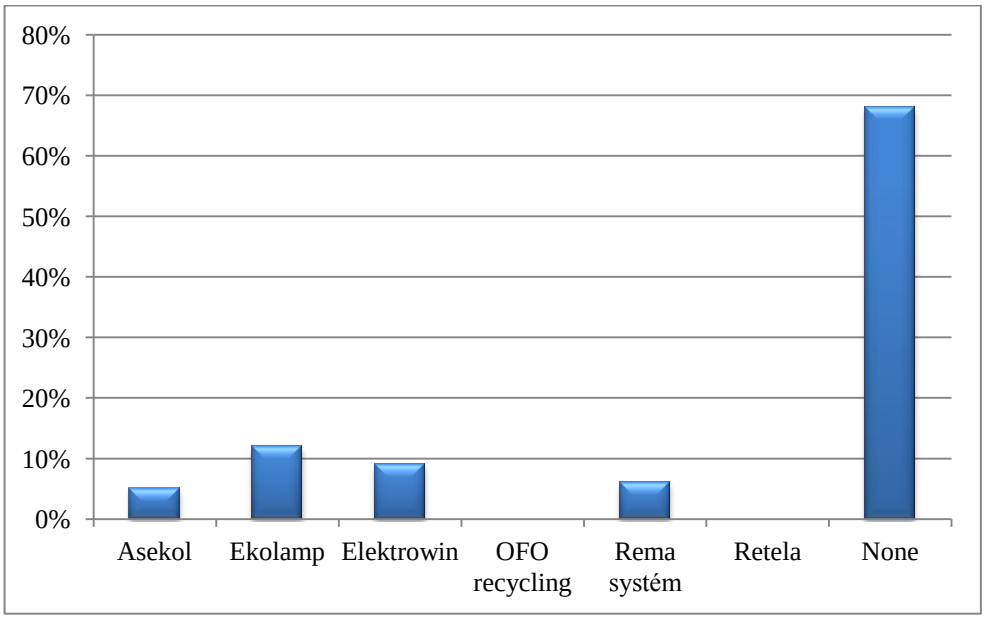
		What is in your opinion the level of electronic waste recycling?									
		I don't know		Catastrophic		Below average		Average		Above average	
Do you sort the electronic waste (old eletcronics, TV, PC etc.)?	**Yes, I sort**	50,0%		80,0%		86,4%		78,3%		100,0 %	
	No, I do not have a possibility to sort this waste	16,7%		20,0%		9,1%		21,7%		,0%	
	No, I find it useless	16,7%		,0%		,0%		,0%		,0%	
Which of the following collective systems do you know?	**Asekol, Ekolamp**	,0%	,0%	,0%	,0%	4,5%	50,0%	4,3%	50,0%	,0%	,0%
	Asekol, Rema system	,0%	,0%	,0%	,0%	4,5%	100,0 %	,0%	,0%	,0%	,0%
	Ekolamp	,0%	,0%	20,0%	25,0 %	9,1%	50,0%	4,3%	25,0%	,0%	,0%
	Ekolamp, Rema system	,0%	,0%	,0%	,0%	,0%	,0%	8,7%	100,0 %	,0%	,0%
	Elektrowin	16,7%	16,7 %	,0%	,0%	4,5%	16,7%	13,0%	50,0%	25,0%	16,7 %
	Rema system	,0%	,0%	,0%	,0%	,0%	,0%	4,3%	100,0 %	,0%	,0%
	I don't know any	83,3%	11,4 %	80,0%	9,1%	77,3%	38,6%	65,2%	34,1%	75,0%	6,8%
	Total	100,0 %	10,0 %	100,0 %	8,3%	100,0 %	36,7%	100,0 %	38,3%	100,0 %	6,7%

Table 3, generated in SPSS program, shows a mutual dependency of two questions and enables to compare how is one answer reflected in another. In this case can be seen answers how respondents evaluated the level of electronic waste recycling in connection whether they sort this type of waste. The results showed that there is no significant

difference in evaluation depending on sorting or not sorting the electronic waste. The highlighted percentage indicates that majority of all groups sort electronic waste.

Next follow-up question deals with electronic waste disposal, its aim was to discover how people handle old electronics. It was found out that most of the people which is 77% use possibility of collective spots – civic amenity sites hand in. Other 9% bring old electronics back to the producer or trader or use a repurchase. Only minority of respondents use the possibility of red containers or placement in landfills.

Figure 7: Respondents' familiarity with collective systems

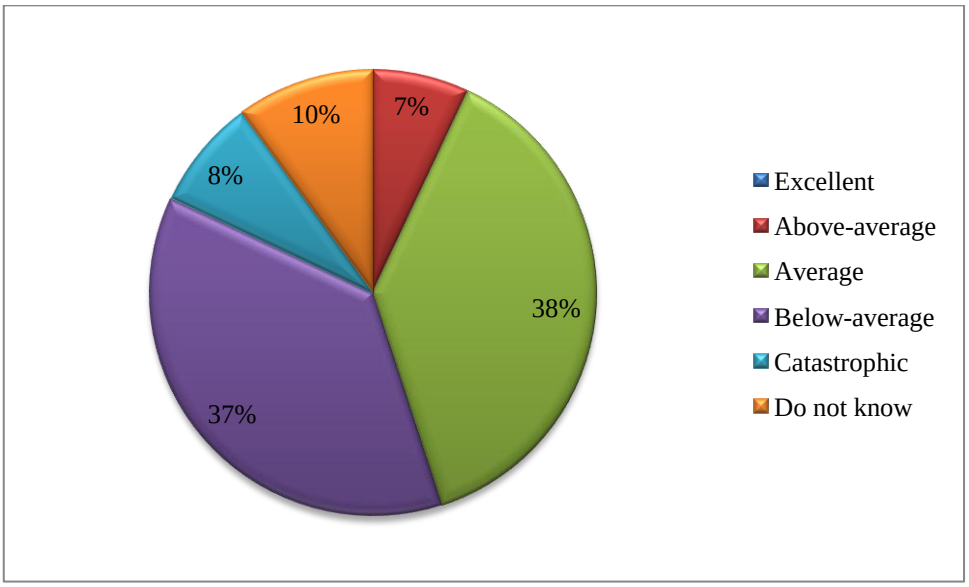


One of the crucial goals of this questionnaire was also to investigate the inhabitants' familiarity with collective systems. As it can be seen in Figure 7, most of the people (68%) do not know of any of the collective systems at work in the Czech Republic even though that most of the people bring the old electronics to civic amenity sites which often cooperates just with these collective systems. If we focus on the respondents who know at least some collective system and compare their answers, we can prove that all of them dispose of their old electronics by bringing it to one of the civic amenity sites. About 12% know Ekolamp collecting lightning equipment, then 9% recognize Elektrowin and 6%

Asekol and Rema system. None of the respondents know OFO recycling or Retela company. Regarding this question there were no significant answers differences according to socio-economic data (gender or age).

This research also proved that if people do not know any of the collective systems, it does not mean that they do not sort the electronic waste. Even the other way round, the research indicates that 75% of respondents who do not know any system sort the electronic waste.

Figure 8: Level of electronic waste recycling in respondents' opinion



Aim of the next question was to find out how respondents see the level of recycling of electronic waste in the Czech Republic and evaluate it. As it can be seen on Figure 8 it was discovered that nobody thinks that recycling of electronic waste is excellent, 7% think that the level is above average, the majority which is 38% see it as average and another 37% as below average. 8% (only people in the age group between 15 to 25 years old) think that electronic waste recycling is catastrophic and 10% were not able to answer this question. Generally it can be said that younger respondents were more critical, most of them stated catastrophic or below-average, than older people who see the level of e-waste recycling more optimistically.

Interesting is also the fact that people evaluate the level of electronic waste recycling worse and more sceptic than another question focused on evaluating the level of waste separation

in the Czech Republic where more people evaluate it as above-average. It is probably caused by the fact that waste separation itself is older in the Czech Republic than electronic waste separation and recycling which is issue that basically began roughly in 2007 and is developing slowly. This fact is also supported by another result of the questionnaire which is insufficient inhabitants' familiarity with collective systems. Therefore relatively poor evaluation can be basically caused by the lack of information.

Regarding both these levels, level of waste separation and level of electronic waste recycling, this topic would be a suitable opportunity for other research which can be focused on how inhabitants would improve it and what in their mind would be beneficial.

Last question of the questionnaire was focused on how or from which source people know about a possibility of electronic waste recycling. The research ascertains that most respondents know about electronic waste recycling from media (38%), then 29% from friends, 21% from promotional materials and 12% stated some other source such as family or school.

5. Conclusion

The market is offering more and more products including many electronic appliances which are very sophisticated, and their construction as well as their design are continuously modernized and changed. These appliances, e.g. mobile phones and TV sets, are constructed so that they cannot be easily repaired or their repairing would be too costly. Therefore many of these appliances become waste before their liveliness has ended. The manufacturers bring on the market new and new models and the customers are persuaded to buy the newest ones.

In this way a great amount of electronic waste originates and collecting of this waste, dismantling it and reusing most of its materials becomes very important. We can observe that people started to realize the importance of collecting this waste and enable separation of material that can be reused.

It cannot be expected that the producers of electronic appliances will change their politics of bringing new and new products on the market. Therefore crucial point is collecting of electronic waste and reusing the materials from it. This will save not only the materials but it will prevent the pollution of the environment.

Despite the fact that the research was rather illustrative, some of the results should not be ignored. For instance let us mention the fact that people do not sort hazardous waste very much, when compared with other types of waste. What is also important is the inhabitants' poor familiarity with collective systems. We can suppose that should these people be more familiar with these systems and should they know their services, more electronic waste would be recycled.

The research also showed that composting is very underused in the Czech Republic even though it is an effective method to get rid of our waste and moreover gain valuable material. Nonetheless, to improve recycling of material as well as use composting on the same level as for instance in Germany it will be hardly possible until landfilling is restricted in the Czech Republic. The Czech Republic wants to achieve this goal by increasing the landfill fees because currently the landfill is still more profitable option.

The European Union also presses the Czech Republic to put an end to landfill waste placement and stresses that European Union's grants may not be used for building new incinerators. The current question therefore is how the Czech Republic will face this issue and whether contemporary government will finish the new waste legislation which has been expected ever since 2007.

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7. Appendices

7.1. Questionnaire

Following questionnaire firstly focuses on opinion of the Czech Republic inhabitants and their attitude to recycling. Then the questions are concentrated on why, why not and how people sort the waste and recycle. And last questions look into the electronic waste issue, if and how people get rid of the old electronics and their familiarity with it. By filling in this questionnaire you will help to coherent perspective into these issues. The questionnaire is completely anonymous and its results will be used only for study purposes.

Thank you very much for your help.

Edita Svitakova

1. **What is you gender?**
    a. Female
    b. Male
2. **How old are you?**
    a. 14 years old and younger
    b. 15 – 25 years old
    c. 26 – 35 years old
    d. 36 – 45 years old
    e. 46 – 55 years old
    f. 56 - 65 years old
    g. 66 years old and older
3. **What is your highest level of education achieved?**
    a. Incomplete elementary
    b. Elementary
    c. Secondary school without graduation
    d. Secondary school with graduation
    e. Higher professional school
    f. University

4. **How many people live together in your household?**
    a. I live alone
    b. 2 people
    c. 3 people
    d. 4 people
    e. 5 people and more
5. **Which social class do you think you belong to?**
    a. Lower class
    b. Lower-Middle class
    c. Upper-Middle class
    d. Higher class
6. **What do you think about the waste separation?**
    a. Waste separation is a good thing, we should improve it and sort more.
    b. Waste separation is a good thing and we sort sufficiently.
    c. I don't know.
    d. Waste separation is useless.
7. **Compare the Czech Republic to other European countries, what is in your opinion the level of waste separation?**
    a. The level of waste separation is excellent
    b. The level of waste separation is above average
    c. The level of waste separation is average
    d. The level of waste separation is below average
    e. The level of waste separation is catastrophic
    f. I don't know

8. **Why do you sort the waste?**
    a. I do not sort the waste
    b. I sort it because of financial savings
    c. I sort it because I want to improve the environment
    d. I sort it because of the societal pressure
    e. Other (please indicate)…

9. Do you sort following kinds of waste?

9.1 Do you sort **plastics**?

a. Yes, I do
b. No, I do not know about a possibility to sort this type of waste
c. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
d. No, I think that it is useless
e. Other…

9.2 Do you sort **paper**?

f. Yes, I do
g. No, I do not know about a possibility to sort this type of waste
h. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
i. No, I think that it is useless
j. Other…

9.3 Do you sort **glass**?

k. Yes, I do
l. No, I do not know about a possibility to sort this type of waste
m. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
n. No, I think that it is useless
o. Other…

9.4 Do you sort **organic waste**?

p. Yes, I do
q. No, I do not know about a possibility to sort this type of waste
r. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
s. No, I think that it is useless
t. Other…

9.5 Do you sort **liquid packaging board**?

u. Yes, I do
v. No, I do not know about a possibility to sort this type of waste

w. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
x. No, I think that it is useless
y. Other…

9.6 Do you sort **hazardous waste (battery, medicine)**?

z. Yes, I do
aa. No, I do not know about a possibility to sort this type of waste
bb. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
cc. No, I think that it is useless
dd. Other…

9.7 Do you sort **electronic waste**?

ee. Yes, I do
ff. No, I do not know about a possibility to sort this type of waste
gg. No, I do not have a possibility to sort this waste (lack of collecting places etc.)
hh. No, I think that it is useless
ii. Other…

10. How do you handle the old electronics?

a. Civic amenity sites
b. Put in a landfill
c. Repurchase or giving back to producer
d. Other…

11. Which of the following collective system do you know?

a. Asekol
b. Ekolamp
c. Elektrowin
d. OFO recycling
e. Rema system
f. Retela
g. I do not know any of the following

12. **What is in your opinion the level of electronic waste recycling in the Czech Republic?**
    a. The level of electronic waste recycling is excellent
    b. The level of electronic waste recycling is above average
    c. The level of electronic waste recycling is average
    d. The level of electronic waste recycling is below average
    e. The level of electronic waste recycling is catastrophic
13. **How do you know about the possibility of electronic waste recycling?**
    a. From media
    b. From promotional materials, advertising
    c. From friends
    d. Other…
14. **If you have any comments, ideas or if you would like to specify anything, you can use this space:**
