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E-waste Management in Portugal: Legislation, Practices and Recommendations

Célio Gonçalo Marques[1,2,3,*], Vasco Gestosa da Silva[1]

[1] *ICT Department, Polytechnic Institute of Tomar*, PORTUGAL
[2] *CAPP, University of Lisbon*, PORTUGAL
[3] *LabTE, University of Coimbra*, PORTUGAL

*__Corresponding Author:__ celiomarques@ipt.pt

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ABSTRACT

The use of electrical and electronic devices has grown exponentially in the last years thanks to technological advances and its wide dissemination. Consequently, the number of obsolete equipment (electronic waste or e-waste) has also increased significantly, becoming a major problem for society. This paper deals with electronic waste and explains the concept and risks for the particular case of Portugal. Measures to reduce the problem such as legislation, education production R&D and social responsibility are also discussed. And finally, a survey is presented which was carried out in two Portuguese Higher Education institutions with a view to determining students' awareness, attitudes and opinions on this matter.

Keywords: ICT management, e-waste, Portugal, higher education, legislation, environment, sustainability

INTRODUCTION

According to the Portuguese Decree-Law 230/2004 of 10 December 2004 (Diary of The Republic, 2004), by e-waste is meant "an electrical and electronic equipment residue […], including all components, subassemblies and consumables which are part of the equipment at the time of discarding" (p.7051). Electrical and electronic equipment comprises "equipment whose proper function depends on electronic currents or electromagnetic fields in order to work properly, as well as equipment for the generation, transfer and measure of those currents and fields […], and designed for use with a nominal voltage up to 1000 volts for alternating current and 1500 volts for direct current" (p. 7052).

This "hazardous waste, owing to its toxic, infectious, radioactive or flammable properties, poses an actual or potential hazard to the health of humans, other living organisms, or the environment" (United Nations, 2010). The United States of America have the largest amount of total e-waste per year, with 7 million tons, China comes in second with 6 million tons and Portugal accounts for 171 thousand tons (United Nations, 2015).

Nowadays about 50 million tons e-waste are generated worldwide and according to the StEP Initiative, the annual world volume of end-of-life electronics is expected to jump to 65.4 million tons by 2017 (United Nations, 2015). The increase in population and living standards, the production of more and best technology and the fast obsolescence of the electrical and electronic equipment have contributed to aggravate the problem. The European Union has showed great concern with this matter expressed in its Directives: 2002/95/EC dated January 27, 2003; 2002/96/EC dated 27 January 2003; 2011/65/EU dated 8 June 2011; and 2012/19/UE dated 4 July 2012.

It will be necessary to implement measures and policies to protect the environment and its sustainability. Recycling should be part of this strategy as today only a small portion of electronic waste is recycled (Gerbase & Oliveira, 2012) and most of it is exported to underdeveloped countries (United Nations, 2010). Recycling not only

Table 1. Material composition of WEEE (Wilkinson et al, 2001)

Material	Amount
Metals	60.6%
Plastics	20.6%
Glass	5.4%
Printed circuit boards	3.1%
Wood & plywood	2.6%
Rubber	0.9%
Concrete & ceramics	2.0%
Others	4.6%

has large environmental benefits but also financial benefits. For instance, a ton of used cell phones (6000 phones) yields more than 14,000 € in precious metals and proper recycling of 1 million cell phones can recover 24 kg of gold, 250 kg of silver, more than 9 kg of palladium and 9 kg of copper (Electronics TakeBack Coalition, 2016).

The sustainability of the planet should also be equated in terms of equipment production. Nowadays "to manufacture one computer and monitor, it takes 530 pounds of fossil fuels, 48 pounds of chemicals, and 1.5 tons of water" (Electronics TakeBack Coalition, 2016).

How are the European directives being transposed into national laws? How is the law being applied in each country? How does the process of registration of electrical and electronic equipment work in each country? How does the management of electronic waste work in each country? How can we minimize the impact of e-waste? To answer to these questions, a program has been created called EWASTEU: Legal Regulations and Implementations on e-Waste in EU (Marques & Silva, 2014). This EU-funded Intensive Program included partners from 6 European countries and Turkey. In this paper, the solutions presented by the Portuguese representation are described. Following this program, a study was carried out with 113 students, where we tried to understand the knowledge they had about the problem and their opinion about the solutions presented by the Portuguese representation (Marques & Silva, 2017).

E-WASTE COMPONENTS

According to directive 2012/19/EU (Official Journal of the European Union, 2012), e-waste can be grouped into 10 categories: 1. Large household appliances (i.e. refrigerators, washing machines, microwaves, air conditioner appliances); 2. Small household appliances (i.e. toasters, vacuum cleaners, carpet sweepers, electric knives); 3. IT and telecommunications equipment (i.e. notebooks, telephones, printers, facsimile machine); 4. Consumer equipment (i.e. televisions sets, video cameras, radio sets, musical instruments): 5. Lighting equipment; 6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools); 7. Toys, leisure and sports equipment; 8. Medical devices (with the exception of all implanted and infected products); 9. Monitoring and control instruments (i.e. smoke detectors, thermostats, heating regulators) and; 10. Automatic dispensers (i.e. those for money, hot drinks and solid products).

These devices are made of various materials as can be seen in **Table 1**.

Some of these materials can be harmful to human health and the environment if not properly handled. In particular materials such as halogenated compounds, radio-active substances and heavy metals, among others.

E-Waste contains such heavy metals as Arsenic, Barium, Beryllium, Cadmium, Chromium, Lead, Mercury, Nickel and Selenium whose harmful effects are shown in **Table 2**.

Arsenic can be found in light emitting diode, barium in CRT monitors and TV sets and beryllium in power supply boxes which contain silicon controlled rectifiers and X-ray lenses. Cadmium, in turn, can be found in rechargeable NiCd-batteries, printer inks and toners and photocopying-machines, chromium in data tapes and floppy-disks and CRT monitors, batteries and printed wiring boards. Mercury can be found in fluorescent lamps that provide backlighting in LCDs, in some alkaline batteries and mercury wetted switches, nickel in rechargeable NiCd-batteries or NiMH-batteries and selenium in older photocopying-machines (EMPA, 2012).

Apart from these harmful materials some precious materials can be found such as gold, silver and platinum. According to UN related sources, about 320 tons of gold and 7.5 thousand tons of silver are used every year in the production of electronic equipment such as computers, tablets and cell phones (Agência FAPESP, 2012).

Table 2. Heavy metal-related diseases (EMPA, 2012)

Heavy Metal	Diseases and health problems
Arsenic	Chronic exposure to arsenic can decrease nerve conduction velocity and cause various skin diseases as well as lung cancer.
Barium	Short-term exposure to barium can lead to brain swelling, muscle weakness, damage to the heart, liver and spleen.
Beryllium	Beryllium exposure can cause lung cancer and a form of skin disease that is characterised by poor wound healing and wart-like bumps.
Cadmium	Acute exposure to cadmium fumes causes flu-like symptoms of weakness, fever, headache, chills, sweating and muscular pain. The primary health risks of long term exposure are lung cancer and kidney damage.
Chromium	Most chromium compounds are irritating to eyes, skin and mucous membranes.
Lead	Short-term exposure to high levels of lead can cause vomiting, diarrhoea, convulsions, coma or even death.
Mercury	Mercury can cause brain and liver damage if ingested or inhaled.
Nickel	Chronic exposure can cause cancer.
Selenium	Exposure to high concentrations of selenium compounds cause selenosis.

E-WASTE IN PORTUGAL

In Portugal EU directives 2002/96/EC and 2002/95/EC concerning waste electrical and electronic equipment have been transposed by Decree 230/2004 dated December 10, 2004, which replaced Decree 20/2002, dated 20 January 2002. More recently, Decree-Law 67/2014 of 7 May transposed into national law Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012, revoking the previous decree-law.

This Law comprising 49 articles and 9 annexes sets forth that the main operators in the process are: the producers, the register entity, the integrated waste management entity and the consumers.

The register is mandatory for those involved with electrical and electronic equipment within the national territory and the ANREEE (National Association for the Registration of EEE) is responsible for assuring, organizing and maintaining the mandatory register of producers of electrical and electronic equipment (Decree-law 230/2004 of 10 December, altered by Decree-law 132/2010 of 17 December) and batteries and accumulators (Decree-law 6/2009 of 6 January).

In Portugal, there are two entities involved in e-waste management: Amb3E and ERP Portugal. Amb3E is a non-profit association that aims at organizing and managing an integrated system to manage electronic waste. The ERP Portugal belongs to the European Recycling Platform (ERP) created in December 2002. The licenses were awarded in April 2006 by joint orders of the Ministry of Economy and Innovation and the Ministry of Environment and Territorial Planning (353/2006 and 354/2006).

Currently Amb3E has 60 associated enterprises, of which 57 are founders, and more than 1.300 participating firms, and 86 collection points around the country (Amb3E, 2015). Among the main Amb3E initiatives to promote e-waste recycling are Ponto Electrão, Escola Electrão and Quartel Electrão.

The purpose of Ponto Electrão (**Figure 1**) is the collection of end-of-life electrical or electronic appliances in order to ensure that they are properly recycled. Currently there are 349 in Portugal.

Escola Electrão is a partnership between Amb3E, the Ministry of Education and Science and the Portuguese Environment Agency to raise student, teacher, staff and parental awareness to the importance of recycling waste in general and end-of-life electrical and electronic equipment in particular. The campaign Quartel Electrão took place in 2011 and aimed to support the Portuguese Fire Corporations by raising awareness to e-waste related environmental issues.

Figure 1. Ponto Electrão at Vieira de Leiria Group of Schools

Figure 2. Depositrão at the elementary school of Cabanas de Tavira

The ERP founders are Electrolux, Procter & Gamble, Hewlett Packard and Sony. ERP Portugal has 33 logistic operators, 25 private e-waste management operators, 7 treatment/disposal centres and almost 500 participating enterprises (ERP Portugal, 2015).

The main initiative developed by ERP Portugal is Geração Depositrão. In Portugal, there are almost two thousands of these collection points (**Figure 2**). This project is a partnership between the Eco-Schools Program and the Associação Bandeira Azul (Blue Flag Association) that is to inform and educate children and young people, and by extension general population, on the importance of recycling and appropriate disposal of electrical and electronic waste including batteries and accumulators.

In 2015, 16.254 tons have been recovered in Portugal by ERP (ERP Portugal, 2015).

Amb3E in turn has collected about 36.845 tons in Portugal in 2015. This includes about 320 tons recovered in the Azores and about 428 tons in Madeira (Amb3E, 2015).

At the end of 2015, 1758 manufacturers, retailers own brand and importers of electronic and electrical equipment were registered in Portugal, which represents an increase of 4.6 percent compared to 2014 (ANREE, 2016). In terms of number of devices there was a decrease of 8.3 percent (**Table 3**).

In terms of equipment weight there was an increase of 6.9 percent (**Table 4**).

The per capita collection rate in Portugal was 4.4 kg in 2010 - an amount slightly higher than the 4kg per capita established by the European Directive. In 2011, that rate increased to 5.3 kg per capita but in 2012 decreased to 3.8 kg (Eurostat, 2016).

PROPOSALS FOR REDUCING E-WASTE IN PORTUGAL

As the goals set by the first directives were not reached, a new directive was required. In 2012, the European Parliament and the Council adopted directive 2012/19/EU. In what comes to the Portuguese legislation this directive was transposed by Decree-Law 67/2014 dated 7 May 2014.

The legislation already makes producers accountable but, in what comes to buyers, incentives for returning the old equipment when purchasing a new one should be created.

Table 3. Variation of units by legal category in portugal 2014-2015 (ANREE, 2016)

Comparison 2015/2014	2015	2014	△ Units
Cat. 1. Large Household Appliances	2 910 880	2 573 614	13.1%
Cat. 2. Small Household Appliances	7 941 308	7 663 632	3.6%
Cat. 3. I.T. Equipment	14 705529	21 546 447	-31.7%
Cat. 4. Consumer Equipment	3 942 853	5 864 906	-32.8%
Cat. 5. Lightning Equipment	21 099 188	18 916 809	11.5%
Cat. 6. E.E. Tools	1 263 896	1 279 652	-1.2%
Cat. 7. Toys, Leisure and Sports Eq.	3 399 793	2 922 694	16.3%
Cat. 8. Medical Devices	676 893	559 640	21.0%
Cat. 9. Monitoring and Control	1 056 906	894 614	18.1%
Cat. 10. Automatic Dispensers	489 584	466 145	5.0%
Total	57 486 830	62 688 153	-8.3%

Table 4. Variation of weights (ton) by legal category in Portugal 2014-015 (ANREE, 2016)

Comparison 2015/2014	2015	2014	△ Weights
Cat. 1. Large Household Appliances	84 058.38	75 381.24	11.50%
Cat. 2. Small Household Appliances	11 576.20	10 599.15	9.20%
Cat. 3. I.T. Equipment	12 397.47	12 985.24	-4.50%
Cat. 4. Consumer Equipment	7 480.11	8 663.57	-13.70%
Cat. 5. Lightning Equipment	6 435.58	5 838.29	10.20%
Cat. 6. E.E. Tools	5 060.28	5 154.42	-1.80%
Cat. 7. Toys, Leisure and Sports Eq.	1 192.25	1 248.33	-4.50%
Cat. 8. Medical Devices	803.58	629.09	27.70%
Cat. 9. Monitoring and Control	774.62	835.99	-7.30%
Cat. 10. Automatic Dispensers	625.60	609.03	2.70%
Total	130404.07	121944.35	6.9%

We consider that an e-Waste Education Programme should also be created to fosters the inclusion of this topic in school curricula, starting as early as elementary school. Children can easily understand that recycling, not only regular waste but also electronic appliances, is extremely important and turn it into a routine.

The production and consumption of 100% recycled products, also known by green products, should be encouraged, for instance through fiscal benefits.

In addition, the producer's responsibility should be extended so as to render them responsible for finding effective ways to reuse and recycle the components of electrical and electronic goods of waste management companies and use them in new products.

In order to ensure data privacy and security, a mechanism should be implemented in which the waste management companies would be responsible for removing or destroying all data.

To understand students' awareness, attitudes and opinions about the solutions proposed they were asked for feedback via a survey which will be described in the following chapter.

A HIGHER EDUCATION-BASED STUDY

In order to determine the level of awareness of Portuguese students about e-waste, their attitudes towards this matter and measures to be implemented to reduce the problem, we carried out a study at the Polytechnic of Tomar (IPT) and the Polytechnic of Castelo Branco (IPCB), the two institutions that have represented Portugal in the EWASTEU project: Legal Regulations and Implementations on e-Waste in EU.

This study included a survey consisting of 19 questions validated by experts in the field. The survey was designed and distributed via the SurveyMonkey software.

Due to limitations in the basic version, questions have been divided into two groups. The first group is identified from 1 to 9 (part I) and the second from 1b to 9b (part II). Questions 1, 2, 3, and 4 of Part I are intended to characterize the sample. Questions 5 and 6 of Part I and questions 3b, 4b, 5b and 6b of Part II relate to student awareness. Question 9 of Part I and questions 1b, 2b and 9b of Part II relate to e-waste solutions. Questions 7 and 8 of Part I concern the respondents' opinion about e-waste related matters. The remaining questions (7b and 8b of Part II) are intended to determine the respondents' attitude towards e-waste.

Characterisation of Participants

The invitation to participate in the study was addressed to all students enrolled in both HE institutions (IPT and IPCB) and 137 students answered to the survey. The average age of participants was approximately 27 years

Table 5. Knowledge about e-waste

Do you know what is e-waste?	**f**	**%**
No. It is the first time I read the term electronic waste.	9	6.6
I've heard about but do not know exactly what it is.	26	19.0
Just know that consists of electronic materials, computers, and mobile phones.	54	39.4
I know what it is and I try to be careful in the disposal of this type of material.	48	35.0

Table 6. Knowledge of the consequences of e-waste

Do you know the consequences of e-waste in terms of natural resources, environmental and public health?	**f**	**%**
Yes	91	66.6
No	46	33.4

Table 7. Knowledge of the law on e-waste

Do you know what law currently regulates electronic waste in Portugal? (adapted from the European Directive 2012/19/EU)	**f**	**%**
No	102	74.5
I know it partially. I have heard of it, but do not know clearly it's content.	28	20.4
Yes, I know it. I know what it regulates and what responsibilities it attributes to the industry, consumers, retailers and the government.	7	5.1

Table 8. Knowledge of the eco-tax for the treatment of e-waste

Did you know that in buying electric and electronic equipment you are paying an eco-tax for the treatment of electric and electronic residue?	**f**	**%**
Yes	48	35.0
No	89	65.0

Table 9. Knowledge of the national entities which manage and dispose of e-waste

Do you know what national entities manage and dispose of e-waste?	**f**	**%**
Yes	26	19.0
No	111	81.0

Table 10. Knowledge of the requirement to register electric and electronic equipments in ANREE

Did you know that all manufacturers and distributing retailers are legally required to register in a national entity – ANREE (National Association for the Registering of Electronic and Electric Equipment)	**f**	**%**
Yes	25	18.2
No	112	81.8

old and were mostly full-time students (86%). With regard to gender, 59,9% of participants are males and 40,1% females

Presentation and Analysis of Results

Student awareness

About 40% of participants reported knowing about the term e-waste, 19% had heard vaguely about it, whilst a minority of 6,6% had never even heard the term. Just 35% of participants knew what it was and that it required specific care in handling it (**Table 5**).

Most participants claim to be aware of the consequences of e-waste on natural resources and public health (66.6%), although a third of students do not know the direct impact of e-waste (**Table 6**).

Only 5.1% of participants knew the law on e-waste currently active in Portugal. It should be mentioned, however, that 20.4% of participants had heard about it, without knowing it's exact content (**Table 7**).

About two thirds of participants had no knowledge that in buying electronic equipment they are paying an ecological tax to deal with electric and electronic residue (**Table 8**).

The majority of participants (81%) had no knowledge of which national entities work with management of e-waste (**Table 9**).

The same can be seen about the knowledge that all manufacturers of electric and electronic equipment are required to register with a national entity – ANREE (National Association for the Registering of Electronic and Electric Equipment), amounting to 81.8% (**Table 10**).

Table 11. Places to dispose of e-waste

Please state the places where you can dispose safely of e-waste	f	%
Doesn't know any appropriate places	42	30.7
Containers near shopping malls and supermarkets	48	35.0
Green recycling bins	24	17.5
EEE stores	12	8.8
Common Waste	9	6.6
Fire Station	1	0.7
Schools	1	0.7

Table 12. Destination of end of lifecycle EEE

What did you do with your equipment at the end of its lifecyle?	Delivered it in an electronic waste recollection site	Delivered it to the store and bought a new one	Sold it to other consumers and entities	Threw it away to common waste	Kept it at home for lack of a proper disposal area	f
Desktop computer	(18.0%) 9	(6.0%) 3	(14.0%) 7	(16.0%) 8	(46.0%) 23	50
Laptop/netbook/tablet	(3.2%) 2	(9.7%) 6	(24.2%) 15	(11.3%) 7	(51.6%) 32	62
Monitor	(16.3%) 8	(10.2%) 5	(8.2%) 4	(20.4%) 10	(44.9%) 22	49
Cellphone	(5.6%) 5	(18.9%) 17	(18.9%) 17	(11.1%) 10	(45.6%) 41	90
Printer	(18.4%) 9	(10.2%) 5	(12.2%) 6	(20.4%) 10	(38.8%) 19	49
Pen-drive/External Hard Drive	(11.8%) 6	(2.0%) 1	(11.8%) 6	(27.5%) 14	(47.1%) 24	51
Modem	(12.5%) 5	(17.5%) 7	(7.5%) 3	(30.0%) 12	(32.5%) 13	40
Television	(19.2%) 10	(13.5%) 7	(15.4%) 8	(25.0%) 13	(26.9%) 14	52
Stereo/Sound System	(7.7%) 2	(11.5%) 3	(15.4%) 4	(30.8%) 8	(34.6%) 9	26
DVD player	(12.5%) 3	(12.5%) 3	(20.8%) 5	(25.0%) 6	(29.2%) 7	24
Fridge	(9.1%) 4	(29.5%) 13	(18.2%) 8	(25.0%) 11	(18.2%) 8	44
Washing Machine/Dishwasher	(8.9%) 4	(35.6%) 16	(13.3%) 6	(24.4%) 11	(17.8%) 8	45

Students' attitude towards e-waste

We could verify that over 30% of participants did not know where they could dispose safely of electronic waste in their place of residence. 35% note the special containers near supermarkets and commercial centers, 17.5% the green recycling bins, 8.8% electric and electronic equipment stores, 6.6% common garbage (landfills), 0.7% fire station as well as school (**Table 11**).

The responses regarding what the participants do when their equipment reach the end of their lifecycle cause some concern. The most common selection was "Kept it in my home due to a lack of a proper disposal area", save the fridge, the washing machine and dishwasher, where the most common option was "delivered it in the store and bought a new one", which has to do with their size. The option "Threw it away to common waste" was also one of the most common options in all equipment's, as can be seen by **Table 12**.

Opinion about e-waste related matters

Most participants (51.5%) considers that the responsibility of treating e-waste should be of the local authorities. Likewise, another 25.5% attributes that responsibility to retailers and manufacturers, whilst 23.4% reports it to the Central Government (**Table 13**).

Table 13. Responsibility for treatment and disposal of e-waste

Who should have more responsibility for treatment and disposal of e-waste?	**f**	**%**
Central Government - creating entities for proper treatment of e-waste.	32	23.4
Local authorities - municipalities must collect electronic waste in homes or collection points, for the treatment and disposal of this material.	70	51.1
Trade and industry - manufacturers and traders should be required to receive some of the waste they produce and sell.	35	25.5

Table 14. Debating the theme of e-waste

Should e-waste be debated in the education system? If so, please note in which levels.	**f**	**%**
No, the issue should not be debated in schools	4	2.9
Primary School	29	21.2
Secondary Education	34	24.8
Higher Education	8	5.8
All	62	45.3

Table 15. Willingfullness to contribute for 100% recyclable products

Would you be willing to pay an extra 10% on the value of the equipment if it was 100% recyclable?	**f**	**%**
Yes	83	60.6
No	54	39.4

Table 16. Willingfulness to pay an R&D tax

Would you be willing to pay a small tax (2% of the value of the product, for example) to develop methods to make the products 100% recyclable?	**f**	**%**
Yes	85	62.0
No	52	38.0

Table 17. Willingfulness of participants to give their former equipment when buying a new one

Would you be willing to give your former equipment in buying a new one?	**f**	**%**
Yes	122	89.1
No	12	10.9

The majority of participants thinks that the issue of e-waste should be debated in the education system, and about a half considers it should be approached on all levels (**Table 14**).

E-waste solutions

More than 60% of participants are willing to pay an extra 10% of the value of the equipment if it is 100% recyclable (**Table 15**).

Participants asked about contributing with a tax (the example given was 2% of the total value) to research on ways to make products 100% recyclable got a similar response rate to the former (**Table 16**).

The majority of respondents (89.1%) is willing to give their former equipment in buying a new one (**Table 17**).

Of the 12 respondents that answered negatively, 10 noted that they would do it if the old equipment was valued monetarily. 2 respondents state that they would never do it: one notes sentimental value, the other the possibility to use pieces in other equipment's.

We asked respondents to promote solutions and ideas that could contribute to minimize the negative impacts of e-waste. The contributions can be grouped in 4 categories:

- More recollection points;
- More information and campaigns on the issue;
- Changes in the equipment production (shift to more ecologically sustainable materials, with greater durability);
- Greater re-use of equipment.

CONCLUSIONS AND RECOMMENDATIONS FOR PORTUGAL

The speed of technological advances has contributed to the rapid obsolescence of electrical and electronic devices rendering them obsolete and ineffective. These devices are transformed into e-waste and the vast majority are thrown out in regular trash, thus constituting a serious hazard to public health and the environment. Portugal

has transposed the European directives into its national legislation in order to control e-waste growth and reduce its impact; however, in 2014 the collection rate was only 5.7 kg/capita, while in countries like Norway and Sweden the value is higher than 10kg (14.9 kg and 13.6 kg respectively). Therefore, it is necessary to implement other measures to control this problem which include the establishment of an e-waste Education Program, extended social responsibility, extended producer responsibility, support to R&D in the field of recycling and incentives to the production and consumption of recycled products.

The study revealed that students from both institutions are relatively well informed about e-waste related issues. The majority considers that it is the municipalities' responsibility to devise solutions to mitigate the effects of e-waste and that the topic should be included in the school curricula at all education levels. The majority is willing to pay more for devices and R&D if that cost has a positive impact on the environment. On the other hand, there is a huge lack of awareness about e-waste legislation and the eco-tax and most of respondents do not know that registration with the ANREEE is mandatory for all industries and businesses involved with electrical and electronic appliances. We were rather surprised that participants do not replace their electrical and electronic devices very often, and that most of them still use regular trash to dispose of their old devices. More collection points, greater information/awareness, changes in the equipment production and greater re-use of equipment were the most frequent suggestions made by respondents to help solve e-waste related problems.

These proposals can be crucial for Portugal because since 2016, each member of European Union has been obliged to collect 45% of the equipment that is no longer useful in the equivalent of the one placed on the market three years earlier. A rate that will increase to 65% by 2019 (Diary of The Republic, 2014).

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