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The research on effectiveness of the electronic and electrical waste selective collection system in Lublin city, Poland

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Abstract: One of the consequences of the dynamic technological development is the rapidly increasing amount of electro-waste (WEEE, e-waste). Because there are no uniform legal regulations regarding the ways of collecting such waste, the separate-collection systems used in various areas are not homogeneous, and they usually also differ in effectiveness. The aim of this study was to evaluate the electro-waste collection system implemented in Lublin (the largest city in Eastern Poland). Taking into account the fact that the reliability of a collection system depends on the degree of its adaptation to the functions it performs, the evaluation consisted in determining how big a problem improper electro-waste segregation was. The article presents the results of a study of the causes of citizens' failure to properly manage e-waste and indicates what measures should be taken to amend the problem. During two research steps, 347 pieces of e-waste with a total weight of 77.218 kg were found in the analyzed waste samples (0.33% of all samples). This means that the mechanisms of selective e-waste collection still do not work correctly, despite the ten years of Poland's membership in the EU and implementation of European legislation in this area. The fact that residents throw away electric waste into municipal mixed waste containers poses a serious problem for proper waste management – even if only a part of the e-waste is disposed in this illegal way. This indicates the necessity of improving waste collection (more frequent waste reception, convenient access to e-waste containers, raising public awareness, etc.).

Introduction

The dynamic technological development is associated with a number of consequences, both positive and negative. Among the latter, the most important is the intensification of the adverse impact on the environment, which is related not only to the production and use of hi-tech equipment, but also its end-of-life phase (Marczuk et al. 2015). Recent years have witnessed a growing share of waste electrical and electronic equipment (WEEE) in the overall structure of collected waste materials (Emmanouil et al. 2013, Zhang et al. 2015). In Poland, in 2004 (the year of Poland's accession to the EU), there were only 12 Mg of selectively collected e-waste; in 2008, that number grew to 12,804 Mg and in 2013 it more than doubled to 27,139 Mg (Statistical Office in Lublin 2014). The most developed countries have successfully introduced effective WEEE management by proper legislation, logistic solutions and recycling (Morris and Metternicht 2016, Villares et al. 2016). However, in new EU member states and other less developed countries, such as former Soviet republics, WEEE management still requires much improvement, because it is mainly based on disposal and landfill activities. These solutions, as shown in the diagram in Fig. 1 (Jadhao et al. 2016), are, according to the 2012 Waste Act, the least favored options in the waste management hierarchy (Journal of Laws 2012, Li et al. 2016).

WEEE is a specific type of waste, significantly different from the other factions. It contains valuable materials that can be recovered in the recycling processes, but also highly harmful substances and chemicals (mercury, lead, cadmium, etc.), which require special methods of collection and management (Cao et al. 2016, Marczuk et al. 2015, Sun et al. 2015).

The specific nature of e-waste, and, in particular, the threats it poses to the environment, require the adoption of relevant legal instruments to deal with the problems of recovery and correct disposal (Awasthi et al. 2016). The main document legally in force in the European Union which provides detailed guidelines relating to e-waste management procedures is Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012. This document is addressed to all operators who handle electrical and electronic equipment at every stage of its life cycle, i.e. producers, distributors, consumers, and primarily to those operators whose activity is focused on the collection and recycling of used equipment (Ilic and Nicolic 2016, Kaya 2016). The provisions of this document are valid for almost all types of electrical and electronic equipment, regardless of whether it is intended for home or professional use (Directive 2012). The specific features of WEEE collection systems and the entities responsible are determined individually by Member States. Because of their different individual characteristics, each Member State requires a different system of selective WEEE collection, suited to its needs and capabilities. For that reason, European countries introduce, in addition to existing EU regulations, national legal regulations. In Poland, these are the Act of 29 July 2005 on Waste Electrical and Electronic Equipment, amended 21 Nov. 2008; the Act of 13 September 1996 on Maintaining Cleanliness and Order in Municipalities, amended 01 July 2011; the Waste Act of 14 December 2012 and the Environmental Protection Act. Just like the Directive (2012) itself, these documents do not give any specific guidelines as to what a system of selective e-waste collection should look like, and therefore the particular solutions used in various Polish cities are not uniform and bring different results.

One of the leading Polish cities in the field of selective collection of e-waste materials is Lublin, where some of the provisions of the EU Directive (2012) had been brought into effect even before the law came into force in 2016. With its relatively high efficiency of the WEEE management solutions used, the city had become a model for others, which was the reason for launching a project entitled “Establishment of the urban system of e-waste management in Lviv based on the experience of Lublin”, which was part of the Poland–Belarus–Ukraine 2007–2013 Program aimed at the transfer of best practices (Report 2013, Public Information Bulletin).

The comprehensive system of electronic waste collection in Lublin is a result of co-operation among the Lublin City Hall, the Organization for Recycling Waste Electrical and Electronic Equipment ElektroEko, the Polish Recycling Corporation in Lublin and commercial entities and other institutions (including educational ones). In accordance with the provisions of the afore-mentioned Directive (2012), all costs related to the functioning of the system are covered by the entities which bring electrical and electronic equipment to the market (i.e. producers and distributors). This system uses a variety of mechanisms, both directly related to the reception of e-waste as well as those focused on public education (e.g. information campaigns using posters, brochures, billboards, radio broadcasting and television). The desire to ensure the easiest possible access to the system for the end-holders resulted in the development and implementation of various methods for the collection of WEEE. These methods include (Report 2013, Public Information Bulletin):

- collection of e-waste every last Saturday of the month between 9.00–14.00 in six well-recognizable locations in the city (and two new ones to be added soon);
- reception of large WEEE directly from the end-holders’/end-users’ places of residence (this service can be ordered via the Internet or by phone);
- collection of old equipment by retailers when new equipment is bought, and collections of small e-waste materials;
- provision of containers for small WEEE in selected areas of the city as well as containers for used light bulbs, energy-saving lamps, batteries and accumulators in shops, public buildings and near trash cans;
- collections of mini e-waste in educational institutions (as a part of a program for schools aimed at teaching and rewarding good practice, in which mission coupons

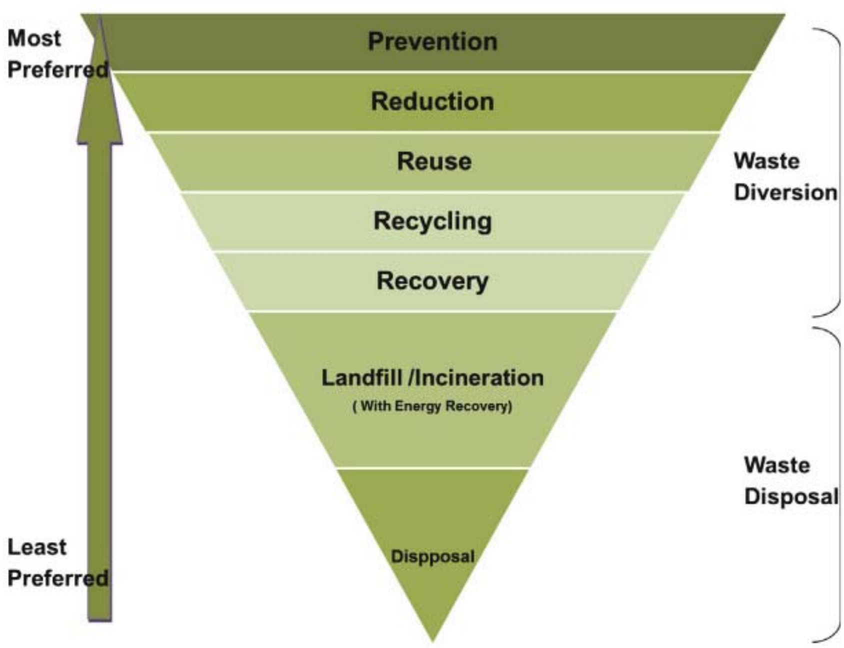

Fig. 1. Waste management hierarchy (Jadhao et al. 2016)

are awarded to schools for collected waste equipment, which are exchanged for teaching aids i.e. projectors, multimedia boards, etc.).

Proper operation of an e-waste collection system largely depends on the solutions adopted during its creation (Menad et al. 2013, Zhang et al. 2015). According to EU legislators, a methods that ensures proper processing and recycling of e-waste, while at the same time guaranteeing an adequate level of health and environment protection, is selective collection, which requires appropriate system solutions (Nelen et al. 2014). An electro-waste pickup system should be adapted, as much as possible, to the conditions in which it is supposed to function. This requires rational selection of techniques and technologies. However, this is not the only factor that determines the effectiveness of collection; another crucial aspect is the behavior of the persons getting rid of old equipment. Even the most modern solutions may not produce the desired results, if users do not act in a proper manner. Unfortunately, due to the lack of awareness or other reasons, still a certain amount of WEEE ends up in mixed municipal waste. This leads to the intensification of the harmful effects of waste on the environment and human health, and loss of resources associated with the failure to recycle (Marczuk et al. 2015). Because the effectiveness of a WEEE collection system mainly depends on consumers' behavior, the system should be as convenient and easily accessible to them as possible.

The aim of the present study was to assess the effectiveness of the electro-waste collection system implemented in Lublin city, Poland. Considering the fact that this system is a comprehensive tool that uses a range of waste acquisition techniques and technologies in combination with various educational measures, and assuming, additionally, that the system's reliability indicates the level of its adjustment to the functions performed and that the system should be robust to any disruptions, the assessment involved determination of the scale of the problem of improper WEEE segregation. The results are discussed in the context of the possible causes of citizen's mismanagement of e-waste and remedial measures are suggested. The findings of this work may provide assistance to other urban centers in setting up or modernizing their own separate e-waste collection systems.

Materials and methods

The research tasks were focused on determining the amount of e-waste that was improperly discarded by the inhabitants of the city of Lublin into general municipal waste. Material collected from selected city areas was tested in a Lublin-based company dealing with waste disposal and maintenance of cleanliness. The first stage of the research was carried out in the period from 15 October to 23 December 2013, and the second from 5 May to 31 July 2014.

Six measurements, spaced two weeks apart, were performed in each stage. During each measurement, 20 samples of municipal waste were tested (10 from a garbage enclosure of a condominium, and 10 from a single-family housing area). In each stage of the study, a total of 120 samples with a volume of 0.5 m^3 each, were tested. The samples included both sorted/dry fraction (10 samples – five from garbage bins of the housing association and five from the single-family housing area) and mixed/wet fraction (10 samples, as above).

First, a sample of sufficient volume was isolated from municipal waste, and its weight was determined. Subsequently, the samples were searched for batteries, used electronics, light bulbs, energy-saving lamps and elements of used equipment, which were then weighed.

Results

During the study, 23.125 Mg of municipal waste was tested. In the first stage of the study, the total weight of analyzed waste was 12.884 Mg, including 2.643 Mg of sorted fraction and 10.241 Mg of mixed fraction. In the second stage, 10.651 Mg of waste materials were investigated, including 2.522 Mg of sorted waste and 8.129 Mg of mixed waste. Electro-waste was identified in 174 of the 240 samples tested. A detailed list showing the number of samples containing e-waste by fractions and source (type of building) is presented in Table 1.

In the study, a total of 117,963 kg of different types of e-waste were identified, which represented approximately 0.51% of the total weight of the surveyed waste. Table 2 shows data describing the total weight and number of discarded electric and electronic devices in the individual groups of e-waste found in the two stages of the study.

In both stages of the research, the most numerous group of discarded electronics, and one that was the largest in terms of weight were elements of used equipment. This statement, however, must be qualified by the fact that this group included many elements, such as fragments of metal or plastic casings, which were not strictly e-waste. In order to determine the actual weight and number of items in this group, it was necessary to separate these elements.

Table 1. List of samples containing waste, which are the subject of research

Building type	Fraction	Amount of samples contained analyzed waste	
		research stage	
		I	II
Single-family	sorted/dry	17	21
	mixed/wet	21	27
Multi-family	sorted/dry	19	17
	mixed/wet	28	24
TOTAL		85	89

After segregation of non-e-waste, elements of used equipment were still the group with the highest weight, but in terms of numbers, they gave way to waste batteries and accumulators. In the second stage of the study, the separation procedure placed elements of used equipment in the second position, both in terms of weight and numbers. Detailed data related to the quantity and total weight of e-waste items in each group identified in the two types of fractions are given in Figs. 2–5.

A summary of all types of e-waste identified during the analysis of the samples from all urban areas is presented in Table 3.

The analysis of e-waste content in the household waste stream showed an interesting difference between winter and summer periods. The measurements performed during the late autumn and winter period from 15 October to 23 December showed a predominance of used elements of house equipment (48.3% of total weight), with household appliances/electronics ranking in the second position (45.4% of total weight) (Fig. 6). And conversely, during the late spring and summer period (from 5 May to 31 July), the household appliances/electronics fraction clearly dominated among the collected e-waste items.

The differences between the contents of the various fractions in the winter and summer waste samples were assumed to be related to human behavior. In Poland, the relatively strong winters significantly reduce people's activity related to house renovations and replacement of furniture, appliances and electronics. Those activities usually start in spring and reach a climax between June and September. A comparison of the results shown in Figs. 4 and 5 clearly proves this behavioral observation.

Table 2. Mass and number of particular groups of identified waste

Waste material	Waste codes[1]	Research stage			
		I		II	
		mass (kg)	number (pcs.)	mass (kg)	number (pcs.)
waste batteries and accumulators	16 06 02*, 16 06 04	2.313	55	1.63	50
waste appliances/electronics	16 02 09*, 16 02 10*, 16 02 13*, 16 02 14	23.56	45	15.2	45
used light bulbs	16 02 14	0.115	18	0.1112	23
used energy-saving lamps	16 02 14, 20 01 21*	0.825	11	0.13	2
used equipment elements before separation	16 02 14, 16 02 15*, 17 04 07, 17 04 09*, 20 01 35*, 20 01 36, 20 01 38, 20 01 39	47.185	76	28.924	81
used equipment elements after separation	16 02 14, 16 02 15*, 20 01 35*, 20 01 36	25.04	42	8.294	48

[1] According to the ordinance of Minister of the Environment in Journal of Law from 2014

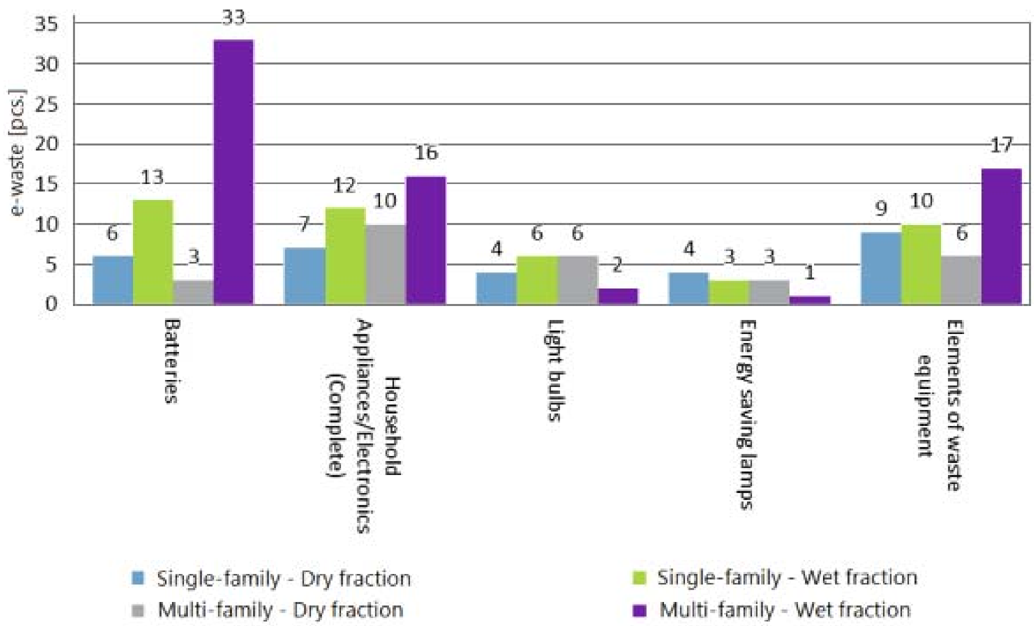

Fig. 2. Number of e-waste items found in the 1st research stage in each fraction of municipal waste obtained from different urban areas

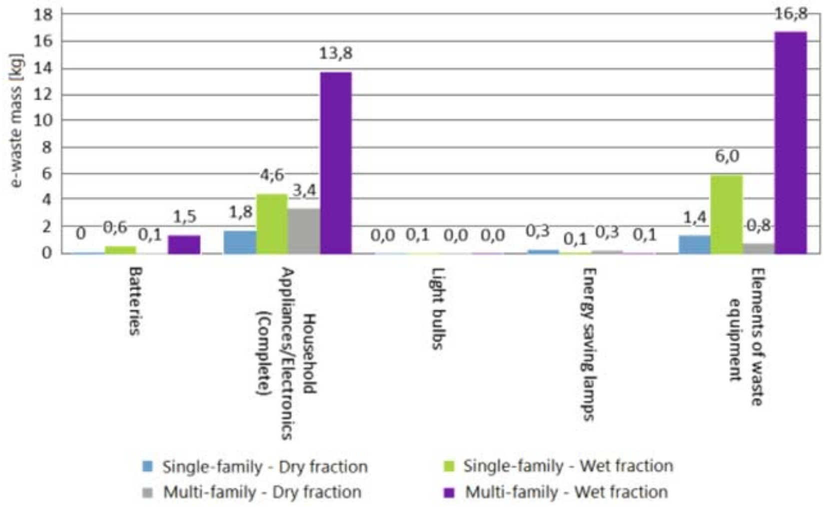

Fig. 3. Weight of e-waste found in the 1st research stage in each fraction of municipal waste obtained from different urban areas

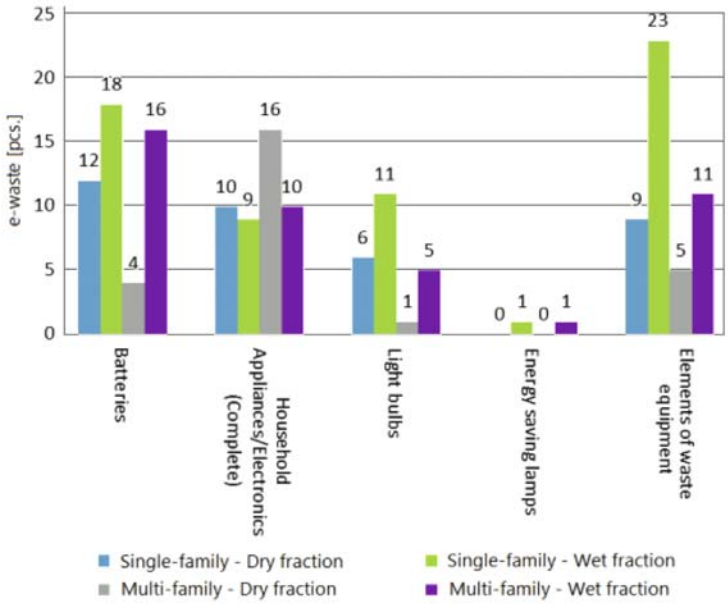

Fig. 4. Number of e-waste items found in the 2nd research stage in each fraction of municipal waste obtained from different urban areas

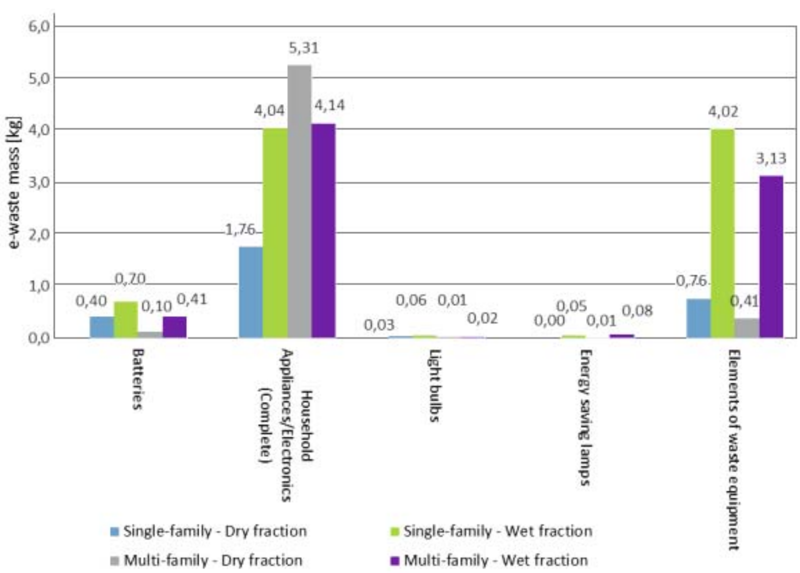

Fig. 5. Weight of e-waste found in the 2nd research stage in each fraction of municipal waste obtained from different urban areas

Table 3. Summary of the e-waste selected during the implementation of research

Lp.	E-waste	Number (pcs.)	Mass (kg)	Share in e-waste (%)	Share in municipal waste (%)
1	Battery AA	72	2.16	2.8002	0.0093
2	Ordinary light bulb	41	0.226	0.2932	0.001
3	Electrical components	35	4.434	5.7481	0.0192
4	Electric cables	32	7.85	10.1765	0.0339
5	Battery AAA	11	0.11	0.1426	0.0005
6	Battery LR20	10	1.4	1.8149	0.0061
7	Energy saving bulb	8	0.855	1.1084	0.0037
8	Loudspeaker	7	2.48	3.215	0.0107
9	Electrical outlet	7	0.64	0.8297	0.0028
10	Battery CR2032	5	0.021	0.0272	0.0001
11	Electronic clock	5	1.78	2.3075	0.0077
12	Iron	5	5.45	7.0652	0.0236
13	Headphones	5	0.24	0.3111	0.001
14	LED	5	0.1	0.1296	0.0004
15	Battery R14P	4	0.12	0.1556	0.0005
16	Power Supply	3	0.95	1.2316	0.0041
17	Mobile phone (complete)	3	0.35	0.4537	0.0015
18	Hand watch	3	0.18	0.2333	0.0008
19	Kinescope elements	3	10.97	14.2212	0.0474
20	Monitors matrices elements	3	3.98	5.1596	0.0172
21	Computer keyboard	3	1.34	1.7371	0.0058
22	Calculator	3	0.21	0.2722	0.0009
23	TV remote control	3	0.28	0.363	0.0012
24	Landine phone	3	0.96	1.2445	0.0042
25	Phone charger	3	0.18	0.2333	0.0008
26	Hair dryer	3	1.13	1.4649	0.0049
27	Electric switch	3	0.17	0.2204	0.0007
28	Electrical toy	2	0.84	1.089	0.0036
29	Battery 6LR61	2	0.1	0.1296	0.0004
30	Power strip	2	1.84	2.3853	0.008
31	Mixer	2	2	2.5927	0.0086
32	Flashlight	2	0.1	0.1296	0.0004
33	Light	2	0.48	0.6223	0.0021
34	Computer microphone	2	0.08	0.1037	0.0003
35	Power switch	2	0.03	0.0389	0.0001
36	Electrical distributor	1	0.1	0.1296	0.0004
37	Electric kettle	1	1.08	1.4001	0.0047
38	Used mixer elements	1	0.92	1.1927	0.004
39	MP3 player	1	0.06	0.0778	0.0003
40	Battery for mobile phone	1	0.032	0.0415	0.0001
41	Electronic scales	1	1.03	1.3353	0.0045
42	Router	1	0.26	0.3371	0.0011
43	Computer mouse	1	0.12	0.1556	0.0005
44	Hair curler	1	0.3	0.3889	0.0013
45	Hair straightener	1	0.38	0.4926	0.0016
46	Wireless	1	1.82	2.3594	0.0079

47	Incomplete juicer	1	1.08	1.4001	0.0047
48	Saw elements	1	1.01	1.3093	0.0044
49	Solar lamp	1	0.08	0.1037	0.0003
50	MP3 transmitter	1	0.06	0.0778	0.0003
51	Matrix display	1	0.31	0.4019	0.0013
52	Electric coffee grinder	1	0.6	0.7778	0.0026
53	Console pad	1	0.26	0.3371	0.0011
54	Notebook cooling pad	1	0.8	1.0371	0.0035
55	Webcam	1	0.17	0.2204	0.0007
56	Tuner	1	0.22	0.2852	0.001
57	Electronic Blood Pressure Monitor	1	0.48	0.6223	0.0021
58	Electric shaver	1	0.1	0.1296	0.0004
59	Solar lamps elements	1	0.16	0.2074	0.0007
60	Car radio	1	1.48	1.9186	0.0064
61	PC computer	1	7.26	9.4117	0.0314
62	Iron elements	1	0.58	0.7519	0.0025
63	Walkman	1	0.64	0.8297	0.0028
64	Mobile phone (without battery)	1	0.06	0.0778	0.0003
65	Bicycle dynamo	1	0.65	0.8426	0.0028
66	Lamp	1	0.47	0.6093	0.002
67	Electric candle	1	0.1	0.1296	0.0004
68	Electric kettle base	1	0.26	0.3371	0.0011
69	Electric heater	1	0.16	0.2074	0.0007
70	Internet cable	1	0.01	0.013	0
	TOTAL	334	77.138	100	0.3336

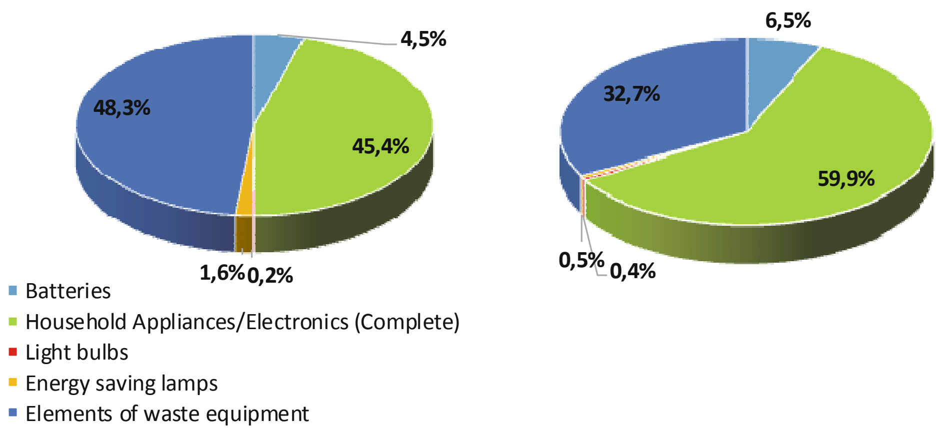

Fig. 6. Content of different fractions of e-waste during the 1st stage of research conducted in winter (on the left) and during the 2nd stage conducted in late spring and summer (on the right)

During the two phases of the study, 347 e-waste items, with a total weight of 77,218 kg were identified, which represented approximately 0.33% of the weight of the surveyed municipal waste. These numbers show that some residents find it difficult to appropriately recognize and handle this type of waste. It is difficult to determine the exact causes of the problem. Most likely, improper handling of e-waste is due to the ignorance of risks and/or the correct course of action, or a lack of knowledge of the waste disposal services offered as part of the selective collection system, or sheer underestimation of the problem. Throwing away of e-waste into mixed fraction containers may be part of a more general problem of inhabitants not knowing how to sort waste. However, it may also be the effect of people wanting to discard WEEE "fast and easy" without being caught, as the mixed fraction is, by nature, more difficult to control. Regardless of the exact reasons, the presence of e-waste in general municipal waste is a very serious problem which needs to be countered in a decisive manner. Lublin's system of selective collection of e-waste provides a number of appropriate measures for doing so. The purpose of these solutions is to facilitate the end-holders' access to collection services and to educate them how to manage e-waste.

Although these solutions guarantee amelioration of the current situation, they can be further refined in the future. For example, the frequency of e-waste collections should be increased. Stationary containers for small electro-waste are filled up too quickly and, as a consequence, residents who want to throw away unnecessary equipment, which occupies space in their houses, are forced to wait for the exchange or emptying of the containers. Situations of this kind encourage some residents to discard their e-waste in an illegal way. It is important to note that small electro-waste containers are not emptied often enough to meet the current needs, and it is obvious that the amount of this type of waste will be constantly and dynamically increasing in the future. The problem is not only related to the frequency of collection, but also to the low availability (low number) of containers. Limited access is particularly important from the point of view of elderly people (or those with mobility problems), and is also not indifferent to other citizens, who are accustomed to the conveniences offered by city life.

In order to maximally facilitate access, ideally, e-waste containers should be placed in every garbage enclosure, however; this is a costly solution. Nevertheless, it should be remembered that the costs associated with counteracting the effects of environmental pollution are usually much higher. In addition, some changes simply cannot be undone. Therefore, environmental protection should be a priority. This said, costs are a significant limitation. Therefore, it is important that the quantity, placement and frequency of emptying containers are selected based on additional studies.

Noteworthy is a service that allows end-holders to easily schedule free collection of their large electro-waste directly from their homes. This solution greatly simplifies and speeds up the process of discarding used equipment. It is particularly important for citizens who do not have their own means of transport, as well as those who would not be able to move this type of waste by themselves because of its large size and weight. This solution strictly meets the needs of society. Its only disadvantage is its relatively low popularity, which is due to the insufficient effectiveness of the information campaign carried out using media other than the Internet; some citizens (in particular the elderly) do not use this source of information. Therefore, it would be advisable that information about this service, along with contact details of the enterprise providing it, should be made available in a continuous manner in places such as stairwells, notice boards, and near containers or garbage dumpster.

Incorrect segregation of electro-waste is extremely difficult to detect and control. Solutions involving the placement of identification numbers on waste bags, or other forms of removing the anonymity of perpetrators, counteract improper practices only to a certain extent. Inappropriate are also all actions aimed at applying collective responsibility. The only right and effective approach is to facilitate access to the services offered by the existing system and to educate citizens, developing an appropriate attitude toward e-waste management. Educational campaigns are mainly addressed to the youngest (campaigns in schools). This solution is of course viable, as it provides an opportunity for future improvement, but it would also be appropriate to increase the awareness of older people, including seniors, who have no access to modern sources of digital information and often have no knowledge of the harmfulness of this type of waste and available methods of their treatment. Educational campaigns should be largely focused on informing citizens about the dangers of improper segregation of electronic waste, which would prevent them from underestimating the problem.

As mentioned earlier in this article, a substantial proportion of waste items found in the samples were components of used equipment which were not e-waste (e.g. pieces of plastic outer shells/casings). This means that some residents of the analyzed areas of the city dismantled electrical and electronic equipment before throwing it away. The may have done so to preserve valuable elements or those that could be re-used for other purposes, e.g. motors, compressors, etc. It is also possible that they disassembled those devices to separate the elements that could go to general sorted waste bins from those to be put in containers for e-waste. Due to the fact that an average user does not have adequate means and training to perform such procedures, the phenomenon is considered to be unfavorable and dangerous. It can cause uncontrolled release of gases or fluids with a negative impact on the environment and human health and life. Therefore, it is highly appropriate to include information on the risks of amateur disassembly in educational materials.

Conclusions

1. As a result of the analysis of random samples of mixed municipal waste with a weight of 23.1225 Mg, e-waste with a total weight of 77.218 kg was found (this value constitutes 0.02% of the total weight of the e-waste collected selectively in Lublin during the year), which indicates the imperfection of the electro-waste collection system operating in Lublin city and a need for improvement.
2. The presence of e-waste in mixed municipal waste means that there is a problem not only with the collection of electro-waste, but with selective collection in general, despite the fact that Poland has been part of the EU for over 10 years. Therefore, it is mandatory that the entire system be improved, not just its elements related to e-waste.
3. In order to ensure proper performance of the system while reducing costs, it is necessary to increase the number of containers for small electro-waste and the frequency with which they are emptied. The first of these problems can be solved using appropriately adapted methods for determining the location of elements of logistic networks. The second problem, due to the imperfection of forecasting methods, should be solved by selection and continuous cooperation with entities that will be responsible for monitoring the state of filling (e.g. city employees, housing estate administration workers, municipal guards).
4. Considering the increase in the amount of electro-waste discarded at certain times of the year, it would be proper to increase the number of containers or the frequency of emptying them during those periods, as well as to carry out additional (reminding) information campaigns.
5. The system requires constant adaptation to changes in the structure and amount of waste. Due to the significance of the problem, all decisions should be rationalized and taken in consideration of the fullest information possible (obtained in relevant research).

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Badania skuteczności systemu selektywnej zbiórki odpadów elektronicznych i elektrycznych w mieście Lublin, Polska

Streszczenie: Dynamiczny rozwój technologiczny niesie za sobą szereg następstw zarówno korzystnych, jak i negatywnych. Wśród tych ostatnich wyróżnia się stale rosnącą ilość odpadów w postaci zużytego sprzętu elektrycznego i elektronicznego, stanowiących zagrożenie zarówno dla środowiska przyrodniczego, jak również zdrowia i życia ludzi. Kraje wysoce rozwinięte wprowadziły efektywne systemy zarządzania tego rodzaju odpadami. Dla państw rozwijających się w dalszym ciągu stanowią one jednak istotny problem (funkcjonujące w nich systemy gospodarowania odpadami ukierunkowane są bowiem głównie na składowanie). Celem pracy było przeprowadzenie oceny skuteczności funkcjonowania systemu zbiórki elektroodpadów w Lublinie. Opracowanie zawiera wyniki przeprowadzonych badań, próbę znalezienia przyczyn niewłaściwego postępowania, a także wskazania, które stwarzają możliwość osiągnięcia poprawy. Podczas badań przeanalizowano 23,125 Mg odpadów komunalnych, w których zidentyfikowano 347 elektroodpadów o całkowitej masie 77,218 kg. Świadczy to o niedostatecznej skuteczności rozwiązań funkcjonujących na danym obszarze (obecność tego rodzaju odpadów w zmieszanej frakcji wskazuje również na ogólny problem z selektywną zbiórką). Wymaganym jest wobec tego usprawnienie całego systemu (ukierunkowane w głównej mierze na zwiększenie dostępności oraz poprawę świadomości społeczeństwa).