Performance of WEEE management system in Romania

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Abstract—The use of electric and electronic equipments has proliferated in recent decades, and proportionately, the quantity of electronic devices that are disposed of, is growing rapidly throughout the world. Since the European Union designated the WEEE management as a priority and the specific legislation came into force, all the member states have developed legal frameworks. The systems currently in existence take many different forms and reach different level of performance. However, despite the growing quantity of WEEE systems, there is still no consensus on how to best measure the performance of a system. The objective of this study is to provide a picture of a performance of the WEEE management system in Romania, identifying the problems which have brought about reduced e-waste management efficiency.

Keywords—Waste from electrical and electronic equipment (WEEE, e-waste), performance, WEEE management system.

I. Introduction

WASTE from electrical and electronic equipment (e-waste, WEEE) refers to the electrical and electronic products which have reached the end of their useful life and are ready for recycling or some other form of disposal. Such products include IT and telecommunications equipment such as computers, televisions, cell phones, and PDAs, as well as large and small home appliances including refrigerators, air conditioners, washing machines, and toasters. In the WEEE Directive, the European Union (EU) formally categorizes such e-waste into the 10 categories [1].

WEEE has emerged as one of the major waste streams in the World due to the market expansion and the trend for electronic products of shortening lifecycles. Moreover, the electrical and electronic equipment industry is recognized to be responsible for 10%–20% of the overall environmental impact with regard to the depletion of nonrenewable resources [2]. While the current WEEE arising across the EU27 is estimated at 8.7 million tonnes a year the amount collected and treated is estimated at only 2.1 million tonnes or 25% [3]

Waste from electrical and electronic equipment constitutes one of the most complicated solid waste streams in terms of its composition, and, as a result, it is difficult to be effectively managed [1], [3].

The fundamental goals of any e-waste management system are: to organize and implement an efficient system for the WEEE, which begins with the collection activity and ends with the reuse of the resulting fractions, to meet the collection, reuse, recycling and recovery targets for WEEE, to promote a preventive attitude, militating for the reuse, recycling and recovery of waste in other forms, with a view to minimize the amount of WEEE discarded in an uncontrolled manner and the negative impact on the environment [4].

The performance of a waste management system is therefore characterized in terms of both environmental efficiency (e.g. the amount or percentage of waste collected, recovered or reused) and economic efficiency (e.g. the costs of the recycling system). Ultimately, both environmental and economic metrics are a function of both a given e-waste system design and the context in which the system exists [4]. E-waste management systems now exist in many locations worldwide and the amount of related legislation continues to increase.

As a result of WEEE directive appearance in the European Union in 2003, there are now many types of national e-waste system in Europe [3], [4]. The systems currently in existence take many different forms and operate in significantly diverse contexts. There are still more differences between the systems in operation than there are similarities. However, despite the growing quantity of e-waste systems, there is still no consensus on how to best measure the performance of a WEEE system.
Performance measurement is the process whereby an organization establishes the parameters within which programs, investments, and acquisitions are reaching the desired results [5]. Various terms can be used in the context of performance measurement such as: efficiency, efficacy and effectiveness [6].

Efficacy, effectiveness and efficiency reveal different aspects of the effect of an intervention. This nomenclature was originally developed in medicine by Cochrane (1972).

Efficiency describes the application of resources to inputs in order to generate outputs with minimal waste. *Effectiveness* on the other hand is not just about the ratio of input to output, but instead relates to the extent to which a measurable result is obtained. In management, effectiveness relates to "*getting the right things done*". [7].

A third related measure can also be defined, namely *efficacy*, describing the power to achieve the desired result, measured against defined objectives. Efficacy is the extent to which a measure produces a beneficial effect under ideal

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conditions, while effectiveness deals with the corresponding extent under everyday circumstances in the field. These concepts constitute a hierarchy. If efficacy is lacking, there cannot be any effectiveness, which in turn is a basic requirement for efficiency [8]. However easily and cheaply a measure can be applied, the application does not pay off if there is no beneficial effect.

The relationship between efficiency, effectiveness and efficacy may be explained if compares outcomes against objectives. Efficiency suppose that an efficient result is obtained, but without fully meeting the required objectives. Effectiveness appears when application of resources shows a definite result, but the result does not match the requirement. Efficacy shows that the outcome largely fulfils the desired objectives [6].

Every WEEE system has some form of management structure responsible for coordinating both the monetary and material flows through the system. This can be done by producers, recyclers, governmental entities, or third party organizations. System management responsibilities can include establishment and collection of recycling fees, contracting transportation logistics firms and processors, setting and enforcing processing standards, enforcing sales bans (for noncompliant producers), and advertising to increase public awareness of and participation in the system. Systems often differ with respect to the number of transportation, processing, and other options they provide to those held financially responsible [4].

Performance measurement of WEEE management system is important both at national level and for all stakeholders of the system: producers and producer associations, municipalities and their associations, the retail sector, treatment operators, environmental NGO's etc.

In Romania, the development of the WEEE management system has been mainly driven by the need to bring in line the national legal framework with the European requirements [9]. This has a considerable influence on the performance of WEEE management system.

II. Literature review

Several reports have already been commissioned by various governments and organizations from different countries to examine existing e-waste management systems. The majority of these reports focus on presenting an overview of existing e-waste recycling system characteristics with a discussion of some aspects of performance [10], [11], [12], [2]. A goup of UN University researchers estimate in [2] the quantity of e-waste being generated in Europe. Few, however, take the next step of making recommendations regarding the implementation of specific e-waste management systems.

Some of the most prominent European reports reviewing the implementation of the WEEE directive contain more specific recommendations regarding the EU-wide WEEE legislation [12] and [2], but do not address how individual member state implementations might best be modified.

The study from [13] examines alternative systems for the WEEE management in Cyprus. These systems are evaluated by developing and applying the Multi-Criteria Decision Making (MCDM) method PROMETHEE. Through the MCDM method, 12 alternative management systems were compared and ranked according to their performance and efficiency. Seventeen individual criteria were selected in total, categorized in four groups of criteria: social, environmental, technical and economical. The obtained results show that the management schemes/systems based on partial disassembly are the most suitable for implementation in Cyprus.

The report [14] provides a comparative study of the WEEE management schemes on the basis of the following criteria: effectiveness in collecting and recovering WEEE, cost effectiveness for administering and operating the scheme, impact upon business competitiveness, administrative complexity/simplicity, equity to main stakeholders, effectiveness in raising consumer awareness for WEEE and WEEE treatment, extent to which scheme fulfils the European WEEE directive requirements. The report provides a comparative overview of seven European WEEE collection and treatment schemes in six countries: Belgium (Recupel), Denmark (Municipal Targeted Tax), Netherlands (ICT Milieu, NVMP,) Norway (El Retur), Sweden (El Kretsen) and Switzerland (SWICO) [14]. The authors examine the structure, operation and performance of the schemes with particular reference to their financial and operational performance, and their impact upon industry and the competitive environment.

The paper [15] evaluates efficiency of the e-waste management system in the Lithuanian public sector, identifying the problems which have brought about reduced e-waste management efficiency. The conclusion of the paper is that efficiency of the e-waste management system strongly depends on its stakeholders. Physical and financial responsibility of e-waste management system members affects efficiency of the system.

III. Methodology and results

A. Methodology of research

The performance of WEEE management system was analyzed using quantitative and qualitative research methods: interviews with experts, statistical and other official data analysis, review of scientific papers.

Collection of the necessary information and data were in literature, government documents and national and international statistics.

B. Results of the WEEE management system study in Romania

E-waste management system has been implemented in Romania since 2005 when has been transposed in the national legislation the European Directive 2002/96/CE [9]. The E-waste management system in Romania is based on producer's responsibility. The national legislation in force, establishes clear responsibilities for all the stakeholders involved in the WEEE management: *producers* are obliged to take WEEE from the collection points, to treat, recycle and store them safely; *distributors* are obliged to take the old equipment from private households through the buy-back system; *municipalities* are charged with the organization of the WEEE

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collection from private households to collection points, from where they are transported for treatment; *users* are required to separate WEEE at source sites in order to be collected by authorized firms [16].

Figure 1 presents a general e-waste management system in Romania.

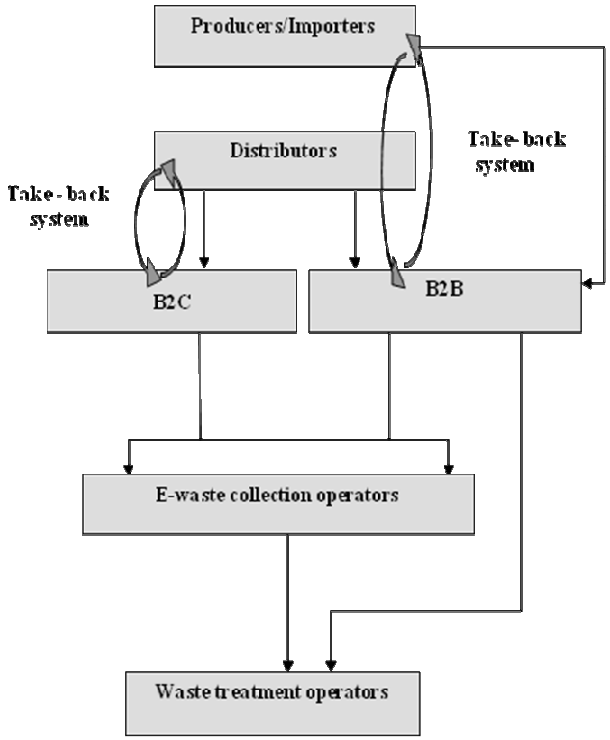

Fig.1 WEEE management system in Romania

At this moment, in Romania are authorized six collective associations which took over the responsibilities of producers of EEE, namely: EcoTic, Environ, Recolamp, Rorec, CCR Logistics Systems RO SRL and Ecosys Recycling [9].

Currently in Romania there are three collection channels for WEEE, namely: "one day collection" actions, take- back system (free of charge), the municipal collection centers. The most well known action of "one day collection" type is "The Big Get Rid of Waste" initiated by the Ministry of Environment in 2007 and carried out at national level [9].

By adopting the EU directive on WEEE, Romania is committed to meet the collection target of 4 kg of WEEE per capita per year, that mean 80.000 tons of waste electrical and electronic equipment [17]. Because of the novelty, the success of the first action in the autumn of 2007 was relatively; only 600 tons WEEE were collected. In 2008 was collected 2500 tons and in 2009 only 1.440 tons. In 2010, the campaign has proposed to collect 2.000 tons of WEEE from the population and, for efficient collection of waste electrical and electronic equipment, the campaign was conducted quarterly in both urban and rural area. In 2011 the campaign was stopped, due to poor results obtained in the previous year.

Quantities of WEEE were also collected through one day actions such as: "Your house is not a museum – Recycle!", "Throw it in the street!" and so forth.

Romania has a typically informal recycling sector, which focuses primarily on the recovery of the valuable raw materials present in e-waste and the reuse of components for second-hand equipment. This means that there is a relatively high collection rate, as end-users often sell their old appliances for reuse or recovery. The quantities that are reused and recycled are not well documented since figures are not easily available, because this informal recycling is illegal and hidden.

One study [18] shows that the situation regarding the endowment with EEE of the Romanian population would be 30 kg per capita (maximum possible according the estimations based on national statistics) and Romanian consumer behaviour would be "almost normal" in the sense that each product would be used a maximum period equal to their life span (which is eight years an average - as stated by most manufacturers), the amount of WEEE collected from population would be 3,75 kg WEEE / inhabitant / year. In fact, given the economic, geographic and demographic factors, these ideal conditions are not met, it is also impossible to achieve an index of collecting 100% of households [18].

In general, public awareness in Romania regarding the negative effects that WEEE can have on the environment and the improper waste management is very low. The situation is different regarding the knowledge of the obligations imposed by law. However there are differences between the major cities in more developed parts of Romania and less developed cities, especially between rural and urban areas. For example, in big cities people understand the messages about waste management and are prepared to contribute to the waste management improvement by changing their behaviour. In rural areas, in less developed parts of the country, people do not take into account the impact of random dumping of waste on the environment [19].

An increased living standard correlated with the access to credits for consumer goods has generated an increase in the acquisition of electrical and electronic equipments in the last 20 years in Romania.

The European average of usage for large household appliances is 8-10 years, while in Romania the duration is 13-17 years [18]. In some rural areas, household electric appliances are still used above the average recommended by the manufacturer (even decades). This is due to the economic situation (e.g. low value of the minimum wage, the high percentage of persons with revenues below 200 euro monthly etc.) and "tradition" of Romania [19], [20].

The level of public information on the organizations specialized in the recycling of electrical and electronic equipment is also very low. Regarding the discard of electrical and electronic equipment, one third of respondents of a survey carried out by [21], say they keep them in their own households, while another third prefers to give to the others. According to the study, most of the respondents said they have in the household electrical and electronic equipments that are no longer functional. This situation is explained by the fact that respondents don't know the appropriate manner to discard them. Over 50% of the respondents would give up the unfunctional equipment if they receive a price reduction at a

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new product purchase or if the equipment is collected by specialized organizations directly from the household [21].

The infrastructure of WEEE collection through the municipal collection centers is in an ongoing development process. Currently in Romania these centers exist only in communities with more than 50.000 inhabitants and the majority of the population doesn't know the location of these centers [17].

Economic factors have the greatest influence on the WEEE management. Increased living standards correlated with the access to credits for consumer goods have generated an increase in the acquisition of EEE in the last 20 years in Romania. The last years have shown that Romania is more and more a society with changing needs and this is reflected in different consumer trends and behaviours. The economic growth has been one of the main drivers encouraging consumption growth during 2005-2008. Consumption rise in Romania can be seen in the increase in the number of long-term goods purchased by the population [22].

The globalization contributed to the penetration on the Romanian market of all the international brands of electrical and electronic equipments and also to an increased volume of equipment purchased [19]. A positive effect of globalization is the attraction of foreign investments, some of them in treating and recycling WEEE. Thus, an investment group created GreenWEEE International, the largest integrated manufacturing of WEEE in Romania, inaugurated in 2009. The plant currently has a capacity of 50.000 tons per year, providing services of collecting, treating and recycling WEEE, working with organizations of collective responsibility, collectors, and large companies that have WEEE. The company also runs an investment for recycling of light (energy saving light bulbs, lamps, lighting) and has planned to build a recycling plant for batteries [9].

The development and implementation of a sustainable WEEE management system requires a long period of time. In Romania, the central and local authorities' changes that occur frequently contribute to the modification of previously adopted decisions and in this way the sustainable objectives, long-term solutions often fail to be put it in practice. One example is the indecision at the local level about the selection of spaces necessary for building treatment facilities for WEEE recovering.

The results of the research have exposed that just a little part of all e-waste is collected separately: 15-20% of WEEE fall into landfills together with municipal wastes, 30% - are recycled by unlicensed recyclers. Efficiency of the current e-waste management system is estimated as 52%. This value is insufficient to meet the requirements of the WEEE Directive.

IV. CONCLUSIONS

Significant differences can be observed between the WEEE management systems of the EU Member States: where nationwide systems for the collection and treatment have been established for several years a much better data situation can be observed than in countries without such a comprehensive system or where data collection has just been started under the requirements of the European WEEE Directive, as in the Romania's case.

The results of the research have exposed that just a little part of all e-waste is collected separately and the efficiency of the current WEEE management system in Romania is low and insufficient to meet the requirements of the EU Directive.

There is a range of factors that have an impact upon the performance of the WEEE management system: political factors, consumer behaviour and awareness, quality and standardisation of reporting data, the level of national economic development, etc.

Despite the legislative and market progress, collection of household electrical and electronic equipments in Romania remains dominated by the informal individual collectors who purchasing multifarious waste materials from households then selling collections to best price bidders afterwards.

The emergence and growth of informal recycling is the result of interactions between economic incentives, regulation gaps, industrial interdependence and the social reality of the country.

The performance of the e-waste system can be improved by collecting a greater percentage of the e-waste generated. It is possible to rise the amount of e-waste collected increasing the number of collection sites offered. The amount of e-waste collected in Romania is not solely determined by the number of collection sites offered. However, increasing public awareness can improve participation without the addition of new collection sites. Consumer participation is influenced by the distance to collection sites, age, education, income, and peer pressure.

The scope of analysis presented in the paper was limited by the data made available by existing system. In order to gain a better understanding of the system performance, more data describing the operation of current systems must be made available.

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