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Efficiency Assessment of E-waste Management System in Lithuanian Public Sector

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Rapid technology change, low initial costs have resulted in a fast-growing surplus of electrical and electronic equipment waste (e-waste) around the globe. Management of e-waste in an environment friendly way according to all legal regulations carries great importance.

E-waste management system incorporates different stakeholders through the whole life cycle of electrical and electronic equipment (EEE) – producers/importers, distributors, consumers/users, collectors, recyclers. The system's efficiency depends on the environmental awareness and effective activity of each of the actors.

The public sector is dealt with in this paper describing the differences and problems of a non-household (B2B) sector in the e-waste chain. The aim of this paper is to evaluate efficiency of the e-waste management system in the public sector (PS), identifying the problems which have brought about reduced e-waste management efficiency. It is anticipated that the recommendations proposed should increase the efficiency of the PS and some of the recommendations could be applied to the e-waste management system in general.

Key words: *electrical and electronic equipment, e-waste management system, public sector*.

1. Introduction

Production and consumption of EEE have exponentially increased in recent years. According to Cui and Forssberg the production of EEE is one of the fastest growing areas (Cui et al 2003). The amount of e-waste generated in the European Union (EU) varied between 3.3 and 3.6 kg/person/year in the period of 1990–1999; as for the period of 2000–2010 it was intended to increase to 3.9–4.3 kg/person/year (EEA, 2003). The amount of electronic waste is growing three times faster than any other type of waste and the predictions of its growth have been exceeded. Nowadays, an average European citizen disposes ~14 kg of e-waste every year. This can be considered as a real threat to the environment (Streicher-Porte et al 2005), unless the e-waste is properly treated. Future projections in (Huisman et al 2008) show that each year the amount of e-waste is increasing, in Lithuania it does too.

E-waste management systems having been implemented according the requirements of legislation in the EU member states, nevertheless a big part of e-waste is landfilled without any pre-treatment (Hannequart 2005). E-waste is attributed to the hazardous waste because of various metals, acids and other toxic substances contained in it. It is the reason that the landfilling is one of the worst options for e-waste utilization. It causes a negative environmental effect and valuable materials are lost. About 70% of heavy metals found in landfills are from e-wastes (Hannequart 2005).

The main legislation regulating the e-waste management systems is the EU Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). The implementation of the WEEE Directive in the EU has a huge potential for increasing the rate of recycling in the EU, which should lead to a considerable reduction in pollution. S. Herat set off the recycling as a short term priority, which should be complimented by prevention measures (eco-design, extended producer responsibility), a long time process, which could resolve the issues associated with the current level of existing and potential e-waste generation (Heart 2007, Gurauskienė 2008). According to this Directive, the EU states had to

collect 4kg/person/year of e-waste generated in households until 2006. The other EU member states, which joined the EU after 2004, gained the extension until 2008.

A revised version of the WEEE Directive incorporating new requirements was released in 2008. A new collection rate was defined - 65% of all supplied EEE to the EU market (including non-household equipment). This rate should be reached until 2016 and each year after this date (Proposal for a Directive… 2008).

During the whole life cycle of electronic equipment its stakeholders are concerned with the e-waste problem. Producers, importers and recyclers bear determined responsibilities in the e-waste management systems:

Producers are expected to be responsible for the electronic products through their whole life cycle (extended producer responsibility). They have to take into consideration the e-waste problem at the production stage (eco-design, cleaner production, the EU Directives: RoHS, EuP, REACH) and to participate in the e-waste management system fulfilling the requirements of the EU Directives and the National Laws.

Distributors are responsible for collecting e-waste according to a principle 'one-for-one' if the obsolete equipment is of the same type and performs the same functions as the supplied one (Barba-Gutiérrez et al 2007).

Recyclers consider e-waste to be business; therefore they are concerned about collecting and recycling it.

Municipalities are responsible for organizing and developing e-waste collection sites for household users (Plepys et al 2007).

Consumers are playing two roles in the life cycle of e-waste: that of a customer and e-waste holder. Both roles express a middle phase of the product life cycle, namely the use phase, and a middle phase between other stakeholders, namely - producer and recycler. Both roles are very important when solving the e-waste problem, there is no need to talk about the efficient e-waste management only from the disposal point of view. (Gurauskienė 2008) Waste prevention and raw material conservation are the most important functions in waste management (Sharma 2009). Consumption is also an important point, because the growing amount of EEE consumption stipulates huge amounts of obsolete electronics, much of which is still operational. (Electronic Waste: Finding Sustainable Solutions… 2005).

That is why the e-waste management system can not be efficient and sustainable unless consumers are actively involved in it, unless they have environmental awareness and information about it. Both sustainable consumption and sustainable production are two sides of a coin, and it has to be incorporated on purpose to decrease an environmental impact from EEE. The same approach fits to an increase in e-waste management system efficiency – when consumers are active and aware of it, the efficiency can be greatly increased. According to the EU laws, consumers have neither legal nor financial responsibilities in the e-waste management system. There some differences arise between household (B2C) and non-household (B2B) consumers. According to the 9th Article of the WEEE Directive B2B consumers have to take financial responsibility for the historical waste (products put on the market before 13 August 2005) (Directive 2002/96/EC). Non-household users are not independent users; their activity is governed by various institutional and national laws and orders.

Main reasons to choose the public sector for research of the B2B e-waste management system have been the following:

- Public sector (PS) represents a great share in the EU economics according to the amount of procurements – the expenditures of PS constitute 16% GDP in the EU, and 14% GDP in Lithuania;
- The process of purchase is pursued according to the method of public procurement, where the option is based on defined criteria;
- Public sector representing the governance of the public matters of the state has a great state involvement in the activity;
- E-waste flows from the PS have not been studied before;
- PS could be as an example for a private sector if the activity were properly managed.

Many aspects influence the e-waste management system in the public sector, but there are great opportunities to manage it properly and efficiently because the management of public institutions is conducted by various rules and the measures like monitoring or control tools could be applied to it.

2. Methodology and results

2.1. Methodology

E-waste management system was analyzed using quantitative and qualitative research methods. The quantitative research is designed to confirm the existing management system in the public sector. Qualitative research helps for better analysis of the current e-waste management system in the public sector (Valackienė et al 2008). To clarify the quantity and quality of e-waste management system efficiency, research has been carried out applying the following methods: anonymous survey, interviews, statistical and other official data analysis, review of scientific papers.

According to a selection method, the education and research sector has been selected as a representative of the general public sector for having the greatest share of organizations/institutions – 23% (2,055 from 7,807- various types of organizations). The questionnaires have been sent by e-mail to 115 respondents reflecting geographical distribution in Lithuania and representing various kinds of

institutions. Feedback has been received from 54% respondents. This value is statistically important, therefore, according to the received data conclusions can be drawn to describe the e-waste management system in the public sector.

Interviews are the most important method of qualitative research data collection. The interview method has been used as an additional method of obtaining the information (Valackienė et al 2008). Two kinds of interviews were conducted with 6 respondents: a telephone conversation and face-to-face.

2.2.1. Results of e-waste management system study in Lithuanian public sector

2.2.1 E-waste management system in Lithuania

E-waste management system has been implemented in Lithuania since 2005. Separate waste collection is a habit in Western Europe countries, while people in Central Europe countries (including Lithuania) have just started the practice of waste separation (CECED direktyvos apžvalga dėl EEĮA surinkimo ... *2006)*. It has a great influence on the e-waste collection rate (2.9 kg/person/a in 2006, and 4.8 kg/person/a in 2007) (Aplinkos ministerijos informacija www.am.lt). The E-waste management system in Lithuania is based on producer's responsibility. The approach taken in Lithuania is a representation of the spectrum within the competing collective system, where management of WEEE is left in the hands of free market. However, there exists the first and the biggest entity in Lithuania called "EEPA" that has the license to fulfill producers' responsibility on their behalf. The WEEE collected at the kerbside or collection points are transported to recyclers, among which the largest are EMP Ltd. and Kuusakoski Ltd. (Lietuva neįvykdė… EEPA. 2009, CECED direktyvos apžvalga dėl EEĮA surinkimo ... *2006*). Figure 1 demonstrates a general e-waste management system in Lithuania. Households and organizations are aggregated as one stakeholder – consumers/ waste owners. During the general e-waste management process different responsibilities and features of the B2B sector are not excluded. For this reason the research lays account on the deeper analysis of the specific consumer PS and its role.

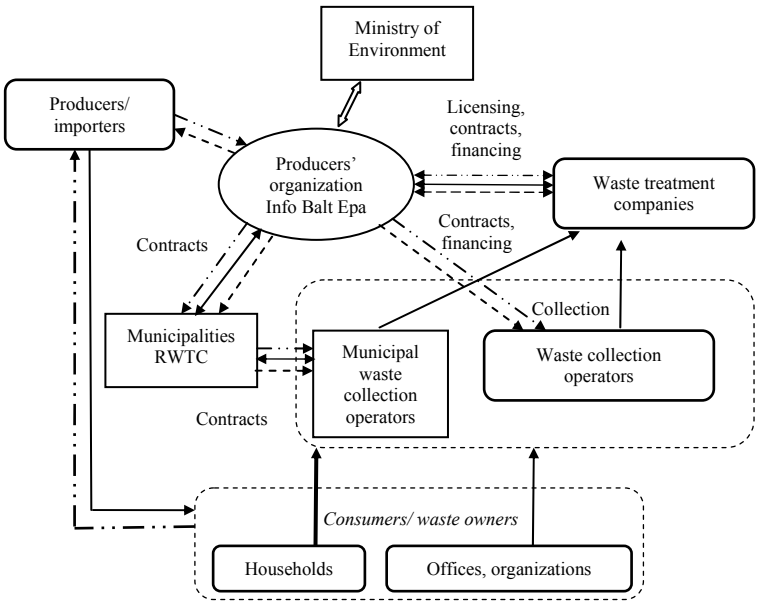

Fig. 1. E-waste management system in Lithuania

The other obvious problem in Lithuanian e-waste management system is the fact that producers are concerned about the collection rates, not about the prevention and education of consumers (CECED direktyvos apžvalga dėl EEĮA surinkimo ... *2006*). There is a lack of initiatives to promote higher priorities (according to the hierarchy of waste treatment) than recycling. Reuse does not figure on the official e-waste management system. Some activities in the informal sector could be noticed as to the reuse of EEE, the auction system in the PS (described further in the paper). According to S. Herat (Herat 2007) recycling could be as a short term priority, which should be complimented by prevention measures (eco-design, extended producer's responsibility), a process taking a long time, which could resolve the issues associated with the current level of existing and potential e-waste generation.

The data obtained from all the biggest electronic waste collectors/recyclers show that by the requirement of the WEEE Directive the collection rate in Lithuania in 2008 is unfulfilled. According to this rate, it has to be collected at least 4 kg/person/year of household generated e-waste in Lithuania annually (about 13,500 tons of e-waste). This amount is not reached. According to the data gathered by the Association EEPA, about 10,000 tons of household e-waste were collected. However, in the tentative

annual report of 2008, the Ministry of Environment indicated 13,228 tons of collected e-waste (Lietuva neįvykdė… EEPA. 2009). Discrepancies in the collected e-waste quantities give some doubts regarding e-waste monitoring system's accuracy in Lithuania.

During the social interview with e-waste recycling companies it has emerged that the most common type of contract is lump contracts. This type of contract takes 93.5% compared to the long-term ones. It has also become evident that education and research institutions usually do not sign any e-waste recycling contracts at all.

The biggest part (60%) of all education and research institutions has pointed out that they have to pay to the e-waste processing company for e-waste pickup, 30% have claimed that they dispose of e-waste free of charge, and 10 % have stated that they have income from this activity.

2.2.2 Results and interpretation of the survey

According to the data obtained from the survey and official data analysis, the algorithm of the present e-waste management system in PS has been set up (Fig. 2).

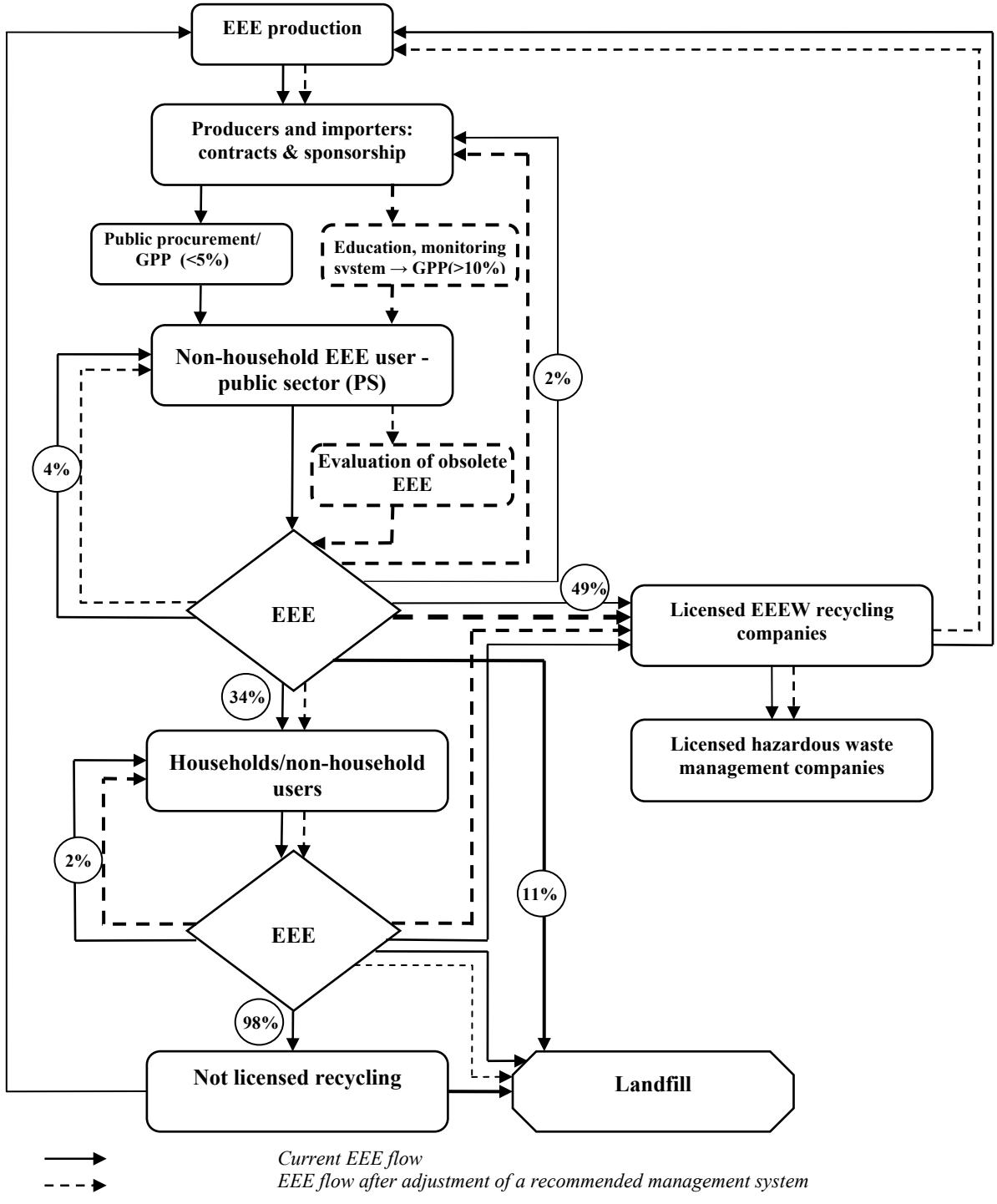

Fig. 2. E-waste management system in Lithuanian public sector incorporating recommendations of improvement

The solid lines in the figure represent the current EEE flows among different stakeholders, whereas the dotted lines describe the changes of the EEE flows after implementation of the proposed recommendations (further in the paper).

According to the survey results most of education and research institutions are medium sized (Fig.3), having 50 -250 employees.

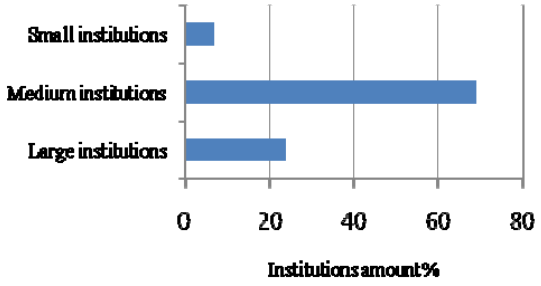

Fig.3. Number of education and research institutions by size

The PS (as consumer) purchases the EEE using public procurements. It has been found out that less than 5% of all public procurements are made using Green Public Procurements (GPP) (Fig. 4), when public purchasers take account of environmental factors when buying products and services (Europos komisija 2005).The EEE is mostly selected according to the price not without evaluation of future costs in the period of use, or disposal. The Public sector could be as an example for other companies. A bigger amount of implementing GPP will have positive significance in e-waste management system efficiency. Furthermore, public procurement plays an important role in the development of the market of products with reduced environmental impacts contributing to sustainable development.

According to the national green procurement implementation programme, public institutions should apply environmental criteria in time of public procurements at least for 10% of all executed procurements in 2008, 15% – in 2009, 20% – in 2010 and 25% – in 2011 (LR Vyriausybės nutarimas 2007).

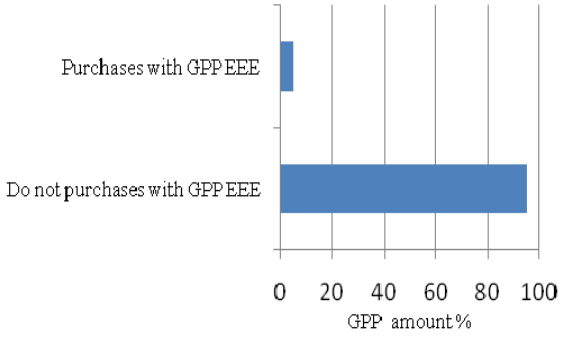

Fig. 4. Applicability of green public procurement in education and research institutions

The results of survey establish three main categories of EEE used in the PS (Fig. 5): IT and telecommunications (>85%), lighting equipment (5%) and monitoring and control equipment (~10%).

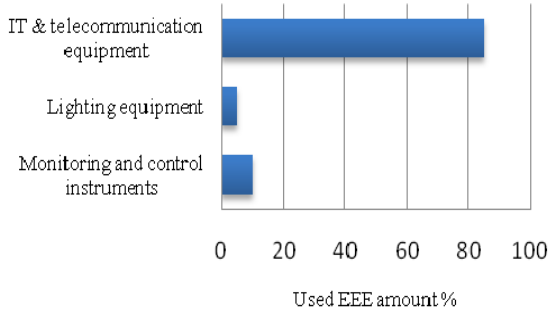

Fig. 5. Most common categories of EEE in education and research institutions

The answers of respondents show (>90.3% respondents) that the average life span of the equipment from the mentioned categories is more than 5 years. 25% of investigated education and research institutions reuse some equipment. Usually there are computers reused in schools. This fact is proved by the answers that 84% of e-wastes are "historic" wastes (produced more than 5 years ago).

Public institutions manage obsolete EEE according to the use and disposal of the state-owned and municipal property law. (Lietuvos respublikos valstybės ir savivaldybių turto valdymo… įstatymas. 2007) When the EEE becomes unusable (in case of functional deterioration or breakdown) the stuff manager of the public sector institution has the right to decide whether the EEE will be: transmitted in trust; invested; sold at auction; demised for the property of the state or municipalities. In case none of the options mentioned above have been chosen, EEE could be delivered for recycler. The same measures for treatment of e-waste are used as for the other mangy property (stuff), though it is quit specific stuff.

49% of all e-wastes are delivered for recyclers, 34% - sold at auctions and almost 11% are disposed of with municipal solid wastes. Trivial share goes to reuse and back to manufacturers.

During the interview with recyclers it has been identified that manufacturers and importers accomplish their obligations and sign financial agreements regarding e-waste management. Under these agreements, a part (25%) of e-waste recycling and transportation costs is funded by manufacturers and importers.

Few interviews have been conducted with the managers of auctions gaining the stunning information that most of EEE (98%) sold at the auction is inoperative; the revenue from the auctions is trivial (nominal). The implication could be made, that PS is prone to sell obsolete EEE at auctions trying to escape financial responsibility for historic waste. Hence it can be concluded that the vendee at

the auction is illegal recycler and the system of auctions stimulate illegal dumping of e-waste.

When evaluating the effectiveness of the e-waste management system in public sector, two options – reuse and recycling - are considered to be effective ways of e-waste management, and selling at the public auctions and landfilling are considered as activities decreasing the efficiency of the e-waste management system. According to the presumptions mentioned above, the efficiency of the current e-waste management system in PS is estimated as 56%.

The accomplished research has revealed the fact that e-waste management system in public sector is insufficiently efficient and the measures have to be initiated for increasing efficiency of the e-waste management system.

3. Recommendations

In accordance with the analysis of literature on the subject and research data, to improve efficiency of the e-waste management system in Lithuanian public sector the following recommendations are proposed (Fig. 2):

1. Green public procurement. Public sector organizations could practice GPP, by introducing environmental criteria into their tender specifications (possibility of collecting old equipment, ISO 14001-certified suppliers, etc.). Thus the contacts between producer/importer and consumers could be more collaborative.
2. Dematerialization – the public sector organizations seem to be one of the best objects to implement product servicing system, instead of buying the product it could be leased as the service from a producing/importing company (Plepys 2004).
3. Contracts could be made between producers and consumers to collect the obsolete EEE or to afford service of equipment repair. According to Sharma,A. (Sharma et al 2008), marketing (having boundary-spanning role) is ideally situated in the supply chain to "close the loop" of it and to ensure that the goals of environmental sustainability are not only effectively implemented, but also are economically viable. The author remarks on the models of recycling and remanufacturing that currently ignore the critical role of the end customer. It has been suggested that for effective customer participation in the reverse supply chain there must be relationship orientation and commitment with customers (Daugherty et al 2003). Moreover, in reverse supply chains, the business customer's role is quite different — it is that of a supplier (Anderson et all 2005). To ensure customer participation, the economic incentives for business customers must be aligned to those of manufacturing. In its expanded role, marketing becomes the key player not only in incentives alignments, but also in building the critical relationships needed to implement reverse logistics effectively.
4. Capacity building initiatives in the institutions of the public sector should be implemented and exercised to implicate all the employees.
5. Take back system (2:1) – and no financial responsibility. It is supposed that B2B end-user arranges and pays for collection while sharing the costs of WEEE compliance (diminishes the need to put up prices) (Turnbull 2007). It make sense in the business sector, but what about the public sector? Analysis shows that organizations sell obsolete equipment at auctions trying to avoid the fee without any financial contribution to the recycling sector and even making harm to the environment (illegal dumping). According to the practice of Italy (Turnbull 2007) a take back system (2:1) twice more e-waste (by weight) to be returned instead of one new purchased is suggested to implement in Lithuanian e-waste management system in PS using GPP. It is expected that PS consumers would be motivated to dispose of e-waste in a proper way and it is supposed that PS would be encouraged to use GPP.
6. Obsolete EEE should be evaluated according to technical, environmental and economical criteria prior the process of auction. Only that equipment which has the confirmation of being fit for exploitation could be sold at the auction that it would not become the "bait" for illegal recyclers. Efficient reuse of EEE could be warranted if this option were implemented.
7. Implementation of EEE monitoring at the public sector, the PS being a specific customer. It could be regulated by various laws, so it could be very useful to implement the monitoring of EEE flows in the PS.

The suggested measures could increase the efficiency when solving the problem of illegal dumping of e-waste from PS, stimulating efficient occasions of reuse. Collaboration between producers and PS consumers is likely to have benefit for both sides. Initiatives of capacity building and some changes in the management of PS could make all the measures mentioned above embodied. Implementation of monitoring could be an interlink between the measures of improvement and control.

4. Conclusions

1. Electronic waste is the fastest growing type of waste which causes many environmental problems unless it is managed in an environment friendly way. 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.

2. The results of the public sector survey have exposed that just a little part of all e-waste is collected separately: 11% of e-waste fall into landfills together with municipal wastes, 33 % - are recycled by unlicensed recyclers. Efficiency of the current e-waste management system in PS is estimated as 56%. This value is insufficient to meet the requirements of the WEEE Directive.
3. Public auction system creates opportunities for unlicensed processing. Equipment sold in a public auction is unusable, so 98% of it is processed by unlicensed companies.
4. The recommendations proposed in this paper could increase the efficiency by solving the problem of illegal e-waste dumping from PS, stimulating efficient occasions of its reuse. Collaboration between producers and PS consumers is likely to have benefit for both sides. Initiatives of capacity building and some changes in the management of PS could embody all the measures mentioned above. Implementation of monitoring could interlink the measures of improvement and control. The suggested e-waste management system will increase the efficiency of e-waste management in the public sector and it will help meet the WEEE Directive requirements.

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Elektros ir elektroninės įrangos atliekų, susidarančių Lietuvos viešajame sektoriuje, valdymo sistemos efektyvumo vertinimas

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(gauta 2009 m. birželio mėn.; atiduota spaudai 2009 m. rugsėjo mėn.)

Sparti technologijų kaita, mažos pradinės išlaidos lemia sparčiai didėjantį elektros ir elektroninės įrangos atliekų (EEĮA) kiekį visame pasaulyje. EEĮA svarbu valdyti aplinkai palankiu būdu laikantis visų nustatytų teisinių reikalavimų.

EEĮA valdymo sistema yra neatsiejama nuo atskirų šios sistemos dalyvių: gamintojų ar importuotojų, platintojų, vartotojų, surinkėjų, perdirbėjų ir kt. EEĮA valdymo sistemos efektyvumas priklauso nuo aplinkosauginio sąmoningumo ir efektyvios EEĮA valdymo sistemos dalyvių tarpusavio veiklos.

Tyrimui atlikti pasirinktas viešasis sektorius siekiant nustatyti skirtumus ir problemas ne namų ūkio (B2B) sektoriuje, EEĮA valdymo sistemoje. Darbo tikslas – įvertinti viešajame sektoriuje susidarančių EEĮA valdymo sistemos efektyvumą. Taip pat nustatyti EEĮA valdymo sistemos problemas, kurios yra mažėjančio efektyvumo priežastys. Pateikiamos rekomendacijos, kaip didinti viešojo sektoriaus EEĮA valdymo sistemos efektyvumą, dalis siūlomų rekomendacijų gali būti naudojamos visoje Lietuvos EEĮA valdymo sistemoje.