IMPACT OF ELV RECYCLING ON ENVIRONMENT MANAGEMENT

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Abstract- Motor vehicles are one of the greatest polluters of the Earth. Their negative impact on the environment is performed during the life cycles. End-of-Life vehicles (ELVs) are additional thread to the environment. The aim of this paper is to point out the possibilities of the ELV recycling with respect to the environmental influences. In that manner the analysis of the ELV recycling process is carried out using the Life Cycle Assessment (LCA) Method on the sample of ELVs in Serbia. The results of the analysis point out to the very high positive effect of the ELV recycling. In order to achieve this result it is necessary, in the whole ELV recycling system, especially in the recycling centers, to make plans and implement coordinated activities of the environmental management, from the State and Region levels to the stakeholders in the ELV recycling process.

Index Terms- ELV, Environmental management, impact, LCA, recycling.

I. INTRODUCTION

Motor vehicles are one of the greatest polluters of the Earth, starting with their production process to the end of their life cycle. The vast amount of the ELV waste presents a significant issue in many countries nowadays. With this problem Serbia faces as well.
Serbia will, rapidly, face the problems caused by the amount of approximately 1.9 million tons of waste materials of different kind, among them will be hazardous materials as well. The amount of waste from the motor vehicles enlarges constantly through the dynamics of buying new vehicles and from the regular production and maintenance activities.
There is an assumption that more than million of old vehicles wait to be recycled, as well as that 100.000 to 120.000 of ELVs are generated each year. Not all of the later million vehicles are complete and in driving condition. The interest of the recyclers is to join this process at the national and international level through the different levels and approaches to the ELV recycling. This means that some of the recyclers, predominately microenterprises will focus on the collection, storage partial dismantling and trade with the collected reused parts. Higher level recyclers are those who have the higher level of specialization. The highest level of the ELV recycling is gained at the specially designed recycling lines that only specialized recyclers can own. In this paper we discussed the influence of the ELV recycling on the sustainable development through the analysis of the influences on the environment. The base for this is the analysis of the performances of the recycling processes which is obtained through the literature sources and Delphy studies and previously defined model of the sustainability of the ELV recycling process. The variables, processes and relations among levels in the ELV recycling process are defined, as well as the key relations to be analyzed in the ELV recycling model.
Based on the available literature, especially (Arsovski et al., 2009; Azadivar & Ordoobadi, 2012; Chen et al., 2010; Cumbul Altay et al., 2011; Eurostat, 2013), a hypothesis is established:

• H1: ELV recycling has a positive impact on the environment.

This hypothesis is proven by the analysis of the influences of the ELV recycling process on the environment. In this research it is conducted by the implementation of the LCA (Life Cycle Assessment) method [Guinée, 2002; ISO 14042:2000]. The research started for the process of recycling in the recycling centers. To form and follow the dismantling centers as well as their design to integral model the next methods, techniques and quality tools are applied: scientific observation, scientific examination and comparative method (through the analysis of the time factors: present time and the future), Delphy method and Pareto analysis (VDI 2243, 2002; Wongdeethai, 2006; Guinée, 2002). Also, the procedures of the implementation of the standards SBS ISO 14040, SBS ISO 14042 and ISO 22681:2002 are used. In the Section 2 the basics of the ELV recycling influence to the environment are described, then the influence of the recycling to the environment is described, while the Section 4 concludes the paper.

II. A MODEL OF THE ELV RECYCLING INFLUENCE ON THE ENVIRONMENT

LCA is based on the analysis of the activities and processes, which is shown in Figure 1 for the ELV recycling. The mark “Pi” shows processes, and the mark “Ri” relations.

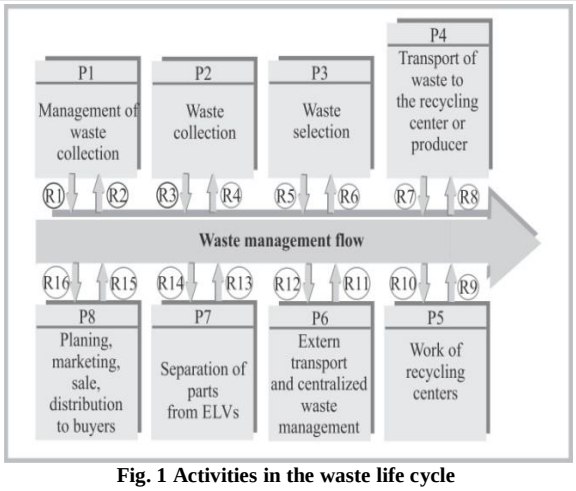


Fig. 1 Activities in the waste life cycle

Each of the later mentioned processes can be decomposed on the related activities [Arsovski, 2006]. Decomposition of the process depends on many factors related to:

- Relevance of the process for the buyer
- Possibilities for the implementation and
- Potentials for the improvement.

According to PDCA (Plan – Do – Check - Act) approach that is intrinsic in the process management, each process "goes through" next stages:

- Planning and conception of the process (P)
- Process realization (D)
- Process improvement (A).

The listed processes are analyzed to the certain level. On the other hand, for the needs of the LCA analysis not all of them are significant equally from the environmental influence aspect. That is why this analysis emphasizes those activities of the recycling process that have the highest influence on the environment. Mark "Riu" shows inputs and "Rii" outputs of each process. The analysis identified totally 16 composite relations. Each of the influences on the environment follows from the appropriate activity, its output, state and input BMW AG, 2003). According to the SETAC association that designed the LCA method the inputs in the observed system are energy, material, water, etc. while the outputs are influences on water, air, solid waste, products etc. For the needs of this study the system of waste management will be observed as a system, and each of the sub-processes (P1-P8) as a subsystem (Hsu et al., 2010; ISO, 2000; ISO/IEC 9001:2008). Standard ISO 14001, 14040, 14041 and other standards from this series give recommendations for the conception and the analysis of the multi input processes and multi output processes.

For further analysis we will stay on the outputs of the process that are evaluated using LCA method. Starting from the previous considerations for each of the listed sub-processes P1-P8, the inventories of the input and output are determined.

III. INFLUENCE OF THE ELV RECYCLING ON THE ENVIRONMENT

According to [Bahne, 2005] the total influence on the environment for the waste recycling is:

$$u = \sum_t U_j \cdot w_{j,t} \qquad (1)$$

u – total influence in the year t,

$w_{j,t}$ – amount of the waste fraction in tons,

U_j – influence on the environment of the waste fraction per ton of waste.

Regarding the fact that many waste fractions have several recycling alternatives, the right side of the equation includes the share of the possible (r_i), thus the equation (1) becomes:

$$U = \sum_i \sum_t U_j \cdot r_i \cdot w_{j,t} \qquad (2)$$

Eco-efficiency (EE) is determined as the ratio:

$$EE = \frac{\sum_i \text{costs}}{\sum_i \text{influence on the environment}} \qquad (3)$$

There can, also, be used the difference with respect to the existing solution (ES):

$$EE^I = \frac{\sum_i \text{costs} - \sum_i \text{costs of the ES}}{\sum_i \text{infl. on the environ.} - \sum_i \text{infl. on the environ. of the ES}} \qquad (4)$$

For the each solution the matrix is formed as shown in Fig. 2.

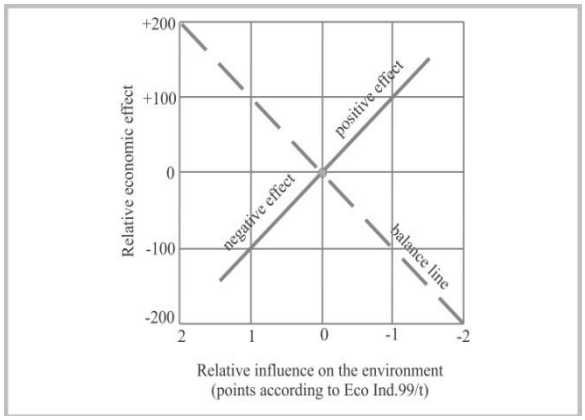


Fig. 2 Eco-efficiency of the recycling alternatives

By using the indicator Eco99 to evaluate the influence on the environment the economic benefits are analyzed and the influence to the environment of the developed system of waste management as a civil engineering resource material. Based on the previous analysis from the literature (Kleber et al., 2009; Milivojević et al., 2008; Schmidt & Leithner, 1995) for determining eco-indicators a process is implemented in five steps:

- Determining the purpose by determining eco-indicators
- Defining the product's life cycle

- Defining the material and the process
- Data analysis
- Interpretation of the results.

For the process P8: "Recapitulation of the influence on the environment, sub-process of the recycling, landfill, incineration and production for the needs of civil engineering" the influence on the environment is evaluated as well as the process P1.

Based on the analysis of the influence on the environment of the process P1-P8 in Table I is shown the total influence of the ELV recycling in Serbia on the environment.

Table I Recapitulation of the influence on the environment, sub-process of the recycling, landfill, incineration and production for the needs of reuse in motor vehicles

No.	System influence				R5	R6	R7 (other activities)	Waste incineration as a part of P7
	R1	R2	R3	R4				
1	207.3	21.4	1402	1137.3	-12.000.000	104.770	23.100	-600.000
	139.280							
2	Decomposition of Eco-Influence on sub-processes for the values of system influence				010 + 100.000	+40.000	+19.280	100.000
3	Total influence of the process on the environment				- 11.900.000	144.770	42.380	-500.000
4	Total effect				-0.12 kg = -120 /t			

If the total influence on the environment is expressed by the number of points divided by tons of waste, than the total value of eco-indicator is obtained for the whole recycling system in Serbia and its value is -1.01 which is extremely high effect.

CONCLUSION

In order to accomplish the effect it is necessary:

- To create the optimal infrastructure, especially to make technology transfer of the recycling equipment and the production of new products;
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- In order to obtain the designed effects on the environment these technologies should be implemented in the designed way;
- Production technology depends on the type of product, technological level and the capacity of the equipment, knowledge of the employees, economy range, etc.

Based on later assumption for the recycling centers in Serbia the expected values of influences on the environment and relative economic benefits are calculated. It is obvious that positive economic benefits and desirable influence on the environment are dominant for recycling whereas for production of new product dominant are positive economic benefit and negative influence on the environment.

The process of incineration provides additional positive effects through energy recovery and economic benefits. Only for the landfill of waste and recycled final products both aspects are determined to be negative.

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