Aleksandar Pavlović[1)]
Milan Pavlović[1)]
Miroslav Vulić[1)]
Aleksandar Tomović[2)]

1) Faculty of Economics and Engineering Management, University Business Academy in Novi Sad, Serbia, alpa226@yahoo.com, milanpavlovic50@gmail.com, miroslavvulic@live.com
2) Faculty of mechanical engineering, University of Belgrade, Serbia, aleksandar.tomovic@hotmail.com

TESTING AND RESULTS VALIDATION OF SIMULATION OF RECYCLING PROCESS AND QUALITY OF LIFE

Abstract: *Quality of life has become the ultimate success formula funcitioning of the institutions of the state and all social substructure [1].Quality of life has illustrate through many factors which affect of the life. Analysis quality of life beside political, economical, cultural-social, health circumambience, includes natural circumambience. Many factors have influence on the environment, one of them is waste. Waste is part of the most important ecological problems of today which affect on the environment, thus quality of life. There are different types of waste, including waste from motor vehicles at the end of life vehicles (ELV).*

By identifying factors of sustainability development paper shows sustainability influence level of ELVs on the quality of life. Beside identifying problems of sustainability recycling process in the Republic of Serbia, paper also shows importance of sustainability development elements modeling as well as modeling of simulation of recyclate influence on the sustainability development elements.

Keywords:*Recycling,End-of Life Vehicles, Qualiy of life, Sustainability*

1. INTRODUCTION

Quality of life concept referring to overall well-being within society ant it is focused to allow achieving aims for every member of society (if not contrary to the law or harmful to the environment).

Quality of life can be measured through various economic and noneconomic parameters. Which leads that the approach to the concept quality of life depends not only on indicators of materials life standard but also on the variety subjective and objective factors which affect on quality of life [2].

Securing "safety" and quality environment for population is faced with problem of waste, which is considered for one of the most ecological problems of modern world. Many types of waste affect on quality of environment among which is dangerous waste [3]. A certain amount of mentioned waste comes from ELV. In order to minimize the waste from ELV, some types of materials which could be reused but materials which which constitute a hazardous waste requiring appropriate treatment and recycling.

2. RECYCLING SUSTAINABILITY OF ELV

Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life.

The strategy for sustainable development aims to promote harmony among human brings and between humanity and nature.The satisfaction of human needs and aspirations in the major objective of development[4].

Sustainability economy activity of recycling ELV is based on the quality and sustainable legislation regulating this issue [5].

Recycling of ELV in the countries on the teritory of European Union (EU) is regulated by Directive 2000/53/EC whis is defined in accordance with sustainable development principles and best practices of member countries, which already have developed this

type of recycling.

Each memeber state is obliged to conducive provision of a Directive and to adopt own legislation needs to sustainabe development[5].

The harmonization of national legislation with the Directive leads to:

- Reducing the impact of ELV on the environment leads to protection, improvement and mantianing of environment and energy saving.
- Development of new economic activity in the domestic market as well as raising the level of competitiveness at the international arena [6].
- By Directive 2000/53/EC as a prerequisite for the quality sustainability of recycling vehicles states a development of collecting network at the level of the entire communitywhich will be guided by the principles of environmental law, with special emphasis principle that the polluter pays.Investments in comepetent staff and and equipment are necessary in order to recycling industry following automotive industry therefore this principles is emphasised[5].

Recycling model of ELV implies recycling along the entire life cycle of a motor vehicle. That include the recycling of waste which which arise from production of raw materials to recycling materials and waste from ELV. Thereto it is important model aspect and design of new vehicles which allude using „environmentlly friendly“ materials and their complete recycling without rest. Also the special attention is paid to the energy intensity and energy efficiency to the motor vehicle, the entire cycle of production, exploitation and recycling. Type of model like this drastically reduce negative impact of motor vehicle to the environment which enable using the renewably energy sources and also enable sustainablity using of natural resources. By this way that recycling model affect directly and positive on the enviroment and on the energy using and throug them improve objectively quality of life of people. On the other hand, by ensuring sustainable use of natural resources to the safe quality of life for future generations, which is an essential condition for the survival of the human community [7].

Table 1 – Level impact model of ELV sustainability recycling on the quality of life [7]

Quality of life dimension	**Level impact model of ELV sustainability recycling**
Economy	Medium
Society	Medium
Enviroment	High
Science and technology	High

2.1 Sustainability and quality of life indicators

Indicators of quality of life are developing to obtain comprehensive statistics at the national level which is wider than the traditional macroeconomic indicators. A systematic approach should show the dynamics of the country in its social, economic, environmental and scientific and technological areas that are important for the quality of life. Discussion about quality of life include: Education, employment, energy, environment, health, human rights, income, infrastructure, national security, public safety, recreation and protection, science, knowledge and technology.

Quality of life indicators hav dynamic dimension because they present start of strategic and operational planning, realization, monitoring and improving the performance of the development process in the mentioned areas.

3. IDENTIFYING PROBLEMS OF SUSTAINABILITY RECYCLING PROCESS IN THE REPUBLIC OF SERBIA

Step 1. Reverse supply chain consists of three parts: Collection site, site of dismantling and the recycling place. Big number of different ELVs are placed on the dislocated collection sites. These ELVs could be clasified by type, age, level of convervations et al. Number of criterias by which to classify these ELV determines the reverse supply chain management. Respecting all identified ELV criterias, these ELV could be divided into classes that are formally presented by set of index $l = \{1,...,i,...,I\}$. The total number of

ELVs are marked as I. Group of ELVs are marked as $i, i = 1,...I$. The amount of ELV's which is located in each class are considered at the level of the reverse supply chain in a predefined period of time (usually to one year). Many parts on the collection cites could be dismantled and transported to recycling centers.

Step 2. In the dismantling centers with applying different technologies of ELV separete on the component of the same type that are dismantling on the parts which are made of the same material. Formally derived components are designated as $\eta = \{1,.., j,..., J\}$. The total number of a component is marked as J . Index component is marked as $j, j = 1,...J$. Some parts which are obtained as the final product disassembly are burning. Rubber, plastic, oil, packaging and others. These materials are burning because they have a high energy value and the process of recycling is very expensive. In the process of burning energy is generated which is further sold as a final product. Profit generated sales of energy is coming to the incinerator and the reverse supply chain. This energy can be used as thermal energy for certain technological processes, for example in the cement industry.The level of employment in the process of collecting, rough disassembly, transport to the incinerator and others are inceasing due to rising these products. In the process of waste incineration, as it is known if this waste is stored, it would be dissecting and up to 1000 years. In this way, the environmental impact would be enormous and irreversible adversely affect on the environment. The negative impact on the environment has been achieved in the process of burning. However, this problem is solved mostly by being placed in the incinerator filters. Some of these parts is a group represented by a set of index $\kappa 1 = \{1_S,..,k_S,...,K_S\}$. The total number of parts of this group is marked to as K_S. Index of parts belonging to this group $k, k = 1,..,K_S$

Step 3. In recycling centers, each group of parts j, j=1,..,J is recycled using different recycling methods. In a general case, the final products as the output of the recycling process of every group of parts may be classified in three groups. The first group contains a recyclates that can be placed on the market to end users directly. Let it be marked as $\kappa_2 = \{1_j^f,..,k_j^f,...,K_j^f\}, j = 1,..,J$. The total number of considered recyclates that are considered as final products in the reverse supply chain is marked as K_j^f . The index of recyclates that belong to this group is $k_j^f, k_j = 1,..,K_j^f$. The second type of products is the result of the application of various recycling technologies. Those are the recyclates that are used as raw materials in various production processes or that are improved in order to increase their value. They are formally presented using the set of indices $\kappa_3 = \{1_j^r,..,k_j^r,...,K_j^r\}, j = 1,..,J$. Outputs that require the landfill are also the result of recycling processes. This group of recyclates that can not be used directly or in the production processes is marked as K_j^d . The index of the recyclates that belong to the latter group is marked as $k_j^d, k_j = 1,..,K_j^d$.

Step 4. The each of the recyclates that belong to goups $\kappa_1, \kappa_2, \kappa_3, \kappa_4$ has the effect to the employment level in the region, the prosperity level of the reverse supply chain and the environment protection in a different way. The influence of the recyclates on the elements of the sustainable development is assessed by the management team (lead manager, production manager and sales manager) of the considered reverse supply chain in the cooperation to the main stakeholders (local municipality management, buyer and the corresponding ministry). The management team makes decisions of the consensus. This assumption is real to be introduced based on the size of the reverse supply chain. Also, it is considered that the stakeholders, the management team in this case, their assumption expresses more precisely using the previously defined linguistic statements, that by using the scale defined over the interval of precise numbers. This assumption is introduced based on the literature assumptions that the spoken language is the advanced way to express the human way of thinking than to project the thoughts to the set of numbers.

Step 5. The modeling using TFN method, the fuzzy number is described using a function of the possibility distribution, grananulation and domain. The authors consider that TFN decreased the calculation procedure, while the calculation precision is conserved. Total number of the linguistics expressions that describes each uncertanty, and the domains over those the TFN are defind are determined by the evaluation of the management team. There is no any reference or a guide or a rule on how to determine these two main elements of the fuzzy number. In order to understand the considered problem the elements of the fuzzy theory are introduced as well as the way of modeling of uncertaties in the considered problem[8].

4. MODELING OG THE RELEVANCE OF THE ELEMENTS OF SUSTAINABLE DEVELOPMENT

In general, the relative importance of the elements of the sustainable development differs. The each element of the environment is assessed by the management team with respect to three aspects: the sustainable development of the reverse supply chain, the strategy of development of a state and the results of good praxis in the developed countries of the EU. The relevances of these three aspects are not equal. It is considered that the greatest influence carries the strategy of development of a state. The least importance have the EU demands because this country is not a member state yet.

The relative importance of every element of sustainable development can be described using one of three linguistic expressions that are modeled using TFN:

- low importance =(y;1,1,5).
- medium importance =(y;1,3,5).
- high importance =(y;1,5,5).

Domains of these TFNs are definded over the set of real number in the interval [1-5]. The value 1 marks the least, while the value 5 marks the highest value[8].

5. MODELING OF THE INFLUENCE OF RECYCLATES ON THE ELEMENTS OF SUSTAINABLE DEVELOPMENT

The value of the influence of every type of recyclate for the each element of sustainable development is assessed by the management team. These assessments are primarily based on the registry data. In the considered problem, it is considered that these values can be described well enough using seven linguistic expressions that are modeled using TFN:

- extreme low value =(z;1,1,2,5).
- very low value =(z;1,1,2,5).
- low value =(z;1,5,3,4,5).
- medium value =(z;3,5,5,6,5).
- high value =(z;5,5,7,8,5).
- very high value =(z;7,8,9).
- extreme high value =(z;7,5,9,9).

These domains of TFNs are defined at the standard measurement scale [1-9]. The values 1 and 9 marks the recyclate with the lowest and the highest value respectively. As a high number of recyclates is studied, it is considered that seven linguistic expressions are needed to describe the influence values of recyclates on the elements of sustainable development well enough[8].

6. CONCLUSION

Recycling ELV emerging as one of the most important factors of sustainable development. Effects of ELV recycling on the environment is very large, both in terms of materials recovery, the impact on the energy dependence of Serbia, as well as the direct impact on land, water and air.

During the recycling the priority should be given to more expensive recyclate

When recycling priority should be given more expensive recycled, with a smaller impact of labor to recycling.

The most biggiest impact on the sustainable development of recycling centers has gain ollowed by employment and environmental impact in third place.

In order of improving the system of ELV recycling and by that itself rairse the level of sustainability it is necessary:

- Detailed identification of infrastructure for recycling of ELV.
- Improving the sustainability of the model ELV recycling, exploring relationships between variables in the model.
- Greater involvement and productivity factors of resilience of the recycling process.
- Greater involvement factor model of leadership in sustainable recycling of ELV etc.

Also, very important thing is raising people consciousness about the importance of adequate treatment of ELV-s.

Finally, it can be concluded that the recycling of ELVes could be a significant impetus to the promotion of sustainable development of the Republic of Serbia, and also quality of life.

REFERENCES:

[1] Vukadinovich, S. (2016). Designing of network for the dismantling centers of the end-of-life vehicles by fuzzy ABC method. 1st International conference on Quality of Life. 133-136.

[2] Gavović, B., Timotijević, S. Kvalitetdruštvaikvalitetživota. www.kvalitet.org.rs

[3] Vulić, M., Pavlović, M., Tomović, A., Stojanović, S. Đurić, A. (2016). Detoxification of ELV fluids in the function of quality of life. 1st International conference on Quality of Life. 317-320.

[4] World Commission on Environment and Development. (1987). *Our Common Future*. Oxford University Press.

[5] Pavlović, M., Arsovski, S., Tomović, A. (2013). Stanjeipotrebezakonskog portfolio u reciklažimotornihvozilanakrajuživotnogciklusanateritorijiSrbije. Festival kvaliteta. A452-A456.

[6] Directive 2000/53/EC of the European parliament and of the council

[7] Milivojević, G., Grubor, S., Kokić-Arsić, A., Đokić, S., Tonić, N. (2011). Reciklažamotornihvozilanakrajuživotnogciklusa u funkcijikvalitetaživota. Festival kvaliteta. B55-B64.

[8] Pavlović, A. (2016). *DoprinosintegrisanogmodelaupravljanjamotornimvozilimanakrajuživotnogcilusarazvojuRepublikeSrbije*. Tehničkifakultet "Mihajlo Pupin" Zrenjnian, Univerzitet u NovomSadu.

Acknowledgment: Research presented in this paper was supported by Ministry of Science and Technological Development of Republic of Serbia, Grant TR 35033.