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6TH INTERNATIONAL SYMPOSIUM ON ENVIRONMENTAL AND MATERIAL FLOW MANAGEMENT

Plenary lectures:

CAN UNIVERSITIES ENHANCE THE ECONOMIC DEVELOPMENT OF REGIONS?

Prof. Dr. Dr. h. c. Peter Schulte

Scientific Representative of the Institute for European Affairs INEA for the Scientific Cooperation of South-Eastern-Europe Universities

Abstract: The potential contribution of universities to the successfully economic development of the countries, especially of regions, could be

- a demand oriented impact, and/or
- a supply oriented impact.

The demand oriented impact results from the spending of the students, the lecturers and the other employees of the university and the spending of the university buying goods and services.

The supply oriented impact results from the use of the university and its activities of education, training and research as a special infrastructure; this means,

- the employment of university's graduates,
- the cooperation between companies, enterprises or other private or public institutions and the university in order to use the research activities and realize innovations, and
- the continuing education.

The successful economic development of regions requires especially:

- structures, which make economic dynamics possible, as well as increasingly structural changes,
- ideas, which facilitate successful innovations, especially innovations which are real novelties,
- and especially humans, personalities with optimism, energy, persuasive power, enthusiasm, passion and a "no giving up" attitude.

Creative and trustful cooperation between businesses and universities can help to realize these needed necessities.

Cooperation between businesses and universities don't only require the collaboration between institutions but essentially the collaboration between humans, the collaboration of humans

- with different interest and different mentalities of working,
- but with the intention to reach a joint economic goal with benefits for both sides.

Consequently it is very important to realize a suitable process of communication and cooperation between scientists and managers. This requires different goal-oriented strategies and activities. For example, the scientist and the entrepreneur should accept their different interests and way of working, but the cooperation should be based on common or compatible objectives.

Cooperation could mean individual projects of technology transfers; it could also mean working within a strategic partnership between the university and businesses, for example within a concrete regional cluster.

Decisive condition of a successful cooperation must be mutual trust between scientists and enterprisers/managers.

It is one of the objectives of the South-Eastern European network "Entrepreneurship and Innovation", to enhance the cooperation between universities and businesses as well as to improve the entrepreneurial spirit in regions.

THE STUDY OF THE IMPACT OF ATMOSPHERIC POLLUTION ON THE AGRICULTURAL SOIL IN THE ENVIRONMENT OF IRONWORKS IN ZENICA

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Abstract: This paper analyzes the results of the monitoring of heavy metals in the air and agricultural land in Zenica region in order to examine the impact of atmospheric deposition on the contamination of agricultural land with heavy metals emitted primarily from the metallurgical plants. The aim is to assess the impact of industrial emissions on the environment and human health, so measures of remediation of contaminated agricultural land could be performed.

A cause-effect relationship between the content of heavy metals (Pb, Cd, Zn, Ni, Cu, Co, Mo, As) in the precipitated dust and agricultural land around the ironworks in Zenica has been revealed using Pearson correlation coefficient. Emission of heavy metals from metallurgical power plant of ironworks in Zenica affects their accumulation (immission value) in agricultural land by means of atmospheric deposition.

According to the results of monitoring, agricultural land in the surroundings of ironworks in Zenica is moderately to severely polluted, depending on the position of the site and the type of heavy metal. Therefore, it is necessary to carry out technical and technological measures in order to reduce emissions of heavy metals from metallurgical plants as much as possible and to implement measures of remediation of contaminated land in order to protect public health and the balance of the ecosystem, and in order to ensure sustainable development.

Keywords: precipitated dust, heavy metals, monitoring of heavy metals, heavy metals in soil.

1 Introduction

The area of Zenica region in Bosnia and Herzegovina, is subjected to continuous impact of increased emission of heavy metals and other pollutants that primarily originate from metallurgical plants [1]. Heavy metals emitted from industrial sources become part of the biogeochemical cycle in the biosphere. They get to land by means of atmospheric deposition and there they accumulate and remain for years and decades. Heavy metals are eliminated from the soil by crops and washed away with water and thus they are included in the biogeochemical cycle and food chain where they may cause various damage to all elements of the food chain, including people. Understanding of the factors that influence the dispersion and transmission of heavy metals in the biosphere and their redistribution in soil is of great importance for protection of environment and health of people [2, 3, 4, 5].

Increased concentration of heavy metals in the soil and populations of different plants in Zenica region has been identified after longtime monitoring. This is the result of decades of environmental overload with emissions from metallurgical plants. That affects their more intense anthropogenic redistribution and availability to consumers, and because of that they can cause different effects on plants, animals, humans, and ecosystems subjected to increased industrial emission [6].

The monitoring of heavy metals in soil, plants and other elements of the environment in industrial and urban areas, like is the area of Zenica region, is of great importance in protection of human health due to the presence of longterm overload of the environment and an increased content of heavy metals in the soil [6, 7].

This paper analyzes the results of the monitoring of heavy metals in the air and agricultural land in Zenica region in order to examine the impact of atmospheric deposition on the contamination of agricultural land with heavy metals emitted primarily from the metallurgical plants. The aim is to assess the impact of industrial emissions on the environment and human health, so measures of remediation of contaminated agricultural land could be performed.

2 Material and Methods

The research was performed at 12 sites which were set at different distances (0.5 to 24.5 kilometers straight-line distance) from industrial sources of emission of heavy metals from ironworks in Zenica.

At selected sites Begerhoff method of sampling of the precipitated dust was performed in a continuous period of 12 months. The determination of the total content of heavy metals (Pb, Cd, Zn, As and Ni) was performed with method of atomic absorption spectrophotometry on the prepared samples of precipitated dust.

The criteria, that is limit values, for precipitated dust and heavy metals regulated by the provisions of the Ordinance on the Way of Perfoming Air Quality Monitoring and on Defining of Types of Polluting Substances, Limit values and Other Air Quality Standards - Annex XV: Limit and tolerance values for purpose measurements, were used for interpretation of the results [8].

Limit values of precipitated dust and heavy metals in the precipitated dust are given in the following Table.

Table 1. Limit values of precipitated dust and heavy metals.

Polluting substance	**Sampling period**	**Average annual value (mg/m^2/d)**	**High value (mg/m^2/d)**
Precipitated dust-total	One month	200	350 *
Pb in precipitated dust	One month	0,1	-
Cd in precipitated dust	One month	0,002	-
Zn in precipitated dust	One month	0,4	-
As in precipitated dust	One month	0,004	
Ni in precipitated dust	One month	0,015	

* Note: Refers to the month of the year with the highest values of the deposition / precipitation.

The gathering of soil samples was carried out in the same sites on the vertical side of the open profile, with 0-25 cm depth in the appropriate pedologically homogeneous surfaces. Experimental polygons were placed on agricultural land. Kopecky cylindes were used for sampling. Soil samples were prepared for chemical analysis in the laboratory by a standard procedure as air-dried samples. Determination of the total content of heavy metals in soil samples (Pb, Cd, Zn, Ni, As) was done according to the procedure of atomic absorption spectrophotometry. All laboratory tests were carried

out according to ISO 11466 and ISO 11047.

For interpretation of the results in this study the criteria and limit values prescribed by the Ordinance on Identification of the Allowable Amounts of Harmful and Hazardous Substances in Soil and Methods of their Examination are used. They are given in the following table [9].

Table 2. Limit values for heavy metals in soil

Heavy metals (Overall form)	**Limit values depending on the texture of the soil (mg/kg of the soil)**		
	Sandy soil	**Silty - loam soil**	**Clay soil**
Lead (Pb)	50	80	100
Cadmium (Cd)	0,5	1,0	1,5
Zinck (Zn)	100	150	200
Nickel (Ni)	30	40	50
Cuprum (Cu)	50	65	80
Cobalt (Co)	30	45	60
Molibden (Mo)	10	15	20
Arsenic (As)	10	15	20

Note: These values refer to the soils with acid reaction. These values can be increased by 25% in the alkaline and calcareous soils.

3 Results and Discussion

3.1. Monitoring of precipitated dust and heavy metals in precipitated dust

Average annual and maximum amounts of precipitated dust and content of heavy metals (Pb, Cd, Zn, Ni, As) in precipitated dust around the ironworks in Zenica are given in the following table.

*Table 3. Review of the monitoring results of precipitated dust and heavy metals in the precipitated dust around the ironworks in Zenica (*mg/m^2/day*).*

Location	**Precipitated dust**	**Lead (Pb)**	**Cadmium (Cd)**	**Zinck (Zn)**	**Nickel (Ni)**	**Cuprum (Cu)**	**Cobalt (Co)**	**Molibden (Mo)**	**Arsenic (As)**
L1	**665**	**0,2364**	**0,0103**	**1,0057**	**0,0854**	0,089	0,1162	0,00078	0,000695
L2	188	0,0339	**0,0022**	0,2603	**0,0406**	0,055	0,0017	0,00065	0,000083
L3	**322**	0,0795	**0,0022**	0,3137	**0,0348**	0,073	0,0036	0,00041	0,000043
L4	**217**	0,0399	0,0019	0,1987	**0,0296**	0,035	0,0012	0,00025	0,000207
L5	158	0,0154	0,0011	0,1021	0,0123	0,028	0,0006	0,00020	0,000187
L6	75	0,0129	0,0005	0,0828	0,0057	0,019	0,0004	0,00022	0,000024
L7	151	0,0162	0,0014	0,0940	0,0105	0,029	0,0002	0,00023	0,000020
L8	**201**	0,0223	0,0009	0,1011	0,0078	0,028	0,0005	0,00019	0,000242
L9	68	0,0138	0,0009	0,0722	0,0114	0,027	0,0004	0,00026	0,000002
L10	91	0,0062	0,0005	0,0784	0,0115	0,015	0,0003	0,00031	0,000015
L11	84	0,0084	0,0007	0,0549	0,0049	0,013	0,0002	0,00015	0,000002
L12	129	0,0078	0,0013	0,0783	0,0028	0,010	0,0003	0,00032	0,000015

Based on the results of one-year monitoring of precipitated dust and content of heavy metals (Pb, Cd, Zn, and As) in the precipitated dust performed at 12 locations around the ironworks in Zenica, it can be concluded that atmospheric deposition of dust particles emitted from metallurgical plants has certain specific impacts on the environment depending on the distance of the area of industrial emission sources, position of the location and the direction of dominant winds [2,3,7].

The highest average and maximum amounts of precipitated dust are registered at the sites in the radius up to 2.5 km from ironworks (L1, L2, L3 and L4) and they declined as the distance from the ironworks, which loads environment with its emissions, increases. The farthest localities (L11 and L12) have minimal impacts of industrial emissions.

The concentration of heavy metals has similar dynamics as precipitated dust. Accordingly, the maximum values of tested heavy metals registered in the localities near industrial sources of emissions and in the direction of the dominant winds, had a decreasing trend with distancing from the source of the dominant emissions of dust which contains heavy metals. The most distant sites have minimal atmospheric deposition and minimal ecosystem overload with heavy metals emitted from metallurgical plants.

Besides emissions from industrial sources, direction and velocity of dominant winds and natural barriers have a significant impact on the pollution of the environment with precipitated dust and heavy metals, as well as with other polluting substances. Wind has significant impact on dispersion and transport of air contaminants (polluting substances), their atmospheric deposition, and their contamination of soil and vegetation. The dominant wind flows come from SW and S quadrants, but north and northeast wind flow is significant as well. The wind rose like this one significantly affects the dispersion of dust and heavy metals and the intensity of environmental pollution [1, 6].

3.2 Results of monitoring of heavy metals in the soil

The results of the monitoring of heavy metals (Pb, Cd, Zn, Ni, Cu, Co, Mo, and As) in the total form, performed in the 2013, in the soil of Zenica region are shown in the following table.

Table 4. Review of results of the monitoring of heavy metals in the soil around Ironworks in Zenica (mg/kg air-dryed sample)

Location	Distance from Ironworks [km]	Pb	Cd	Zn	Ni	Cu	Co	Mo	As
L1	0,5	**219,50**	0,95	**261,5**	**169,33**	**76,37**	44,10	1,08	2,17
L2	1,6	**120,70**	0,79	**229,7**	**165,17**	58,80	36,67	0,66	1,54
L3	1,7	**134,37**	0,46	174,2	**178,07**	73,00	46,50	1,37	0,58
L4	2,5	**122,83**	0,85	**179,8**	**130,10**	63,57	32,70	1,51	4,33
L5	4,6	64,83	0,60	105,2	**103,13**	54,53	35,50	1,02	0,80
L6	4,8	46,03	0,24	100,5	**214,33**	**75,97**	**46,30**	1,35	0,39
L7	5,4	47,53	0,29	81,67	**77,13**	48,83	44,40	0,84	0,49
L8	7,8	**52,80**	0,62	**118**	**44,43**	33,17	22,17	0,65	0,76
L9	9,5	60,50	0,93	243	**180,03**	48,27	34,17	0,42	0,85
L10	14,6	31,53	0,23	62,83	**615,67**	62,10	**74,13**	1,05	1,05
L11	18,4	41,83	0,20	81,67	**49,63**	**86,13**	**37,17**	0,41	0,26
L12	24,5	47,60	0,30	87,50	38,70	57,77	41,47	1,56	0,33

It is noticed, from the results presented in Table 4, that the content of heavy metals in the soil around the ironworks in Zenica is increased in regard to the natural state and that this content is above prescribed limit values in the area to about 2.5 km^2 straight line from the ironworks. The nickel and manganese content in the soil is greater than the permissible value on the entire area of study. Therefore, the land in Zenica region is moderately to severely polluted with nickel and manganese. The content of heavy metals in the soil varies depending on the position of the site and its distance from the source of emission. The largest content of tested heavy metals was registered in the soil at sites close to the ironworks and had a decreasing trend when moving away from the source of industrial emissions.

According to the results of monitoring, agricultural land in the surroundings of the ironworks in Zenica is moderately to severely polluted, depending on the position of the site and the type of heavy metal. Therefore, it is necessary to carry out technical and technological measures in order to reduce emissions of heavy metals from metallurgical plants as much as possible and to implement measures for remediation of contaminated land in order to protect public health and the ecosystem.

3.3 Correlation between content of heavy metals in precipitated dust and in agricultural land

In this study, we started from the hypothesis that atmospheric deposition of heavy metals, due to high emissions from the metallurgical plants, has significant impact on the content of heavy metals in the agricultural land in the surroundings of the ironworks in Zenica.

The impact of emissions of heavy metals from metallurgical plants of ironworks on their content in agricultural land in Zenica region was analyzed using Pearson correlation coefficient (r) between these two variables in order to test the cause-effect connection between the content of heavy metals in the precipitated dust (independent variable) and the content of heavy metals in agricultural land (dependent variable). The Pearson correlation coefficient is based on a comparison of the actual impact of the observed numerical variables to one another in relation to the maximum possible impact of two variables.

Table 5. *Correlation coefficients between content of heavy metals in the precipitated dust and in agricultural soil.*

Heavy metals	**Pb**	**Cd**	**Zn**	**Ni**	**Cu**	**Co**	**Mo**	**As**
Correlation coefficients	0,909	0,529	0,651	0,054	0,23	0,071	0,093	0,478

According to the obtained values of the correlation coefficient between the heavy metal content in the precipitated dust and agricultural land, it can be concluded that the relation is positive in character for observed locations. The connection between two tested variables is significant in case of zinc, lead and cadmium (0.5 to 0.75), moderate in case of arsenic (0.25-0.5), and in all other cases there is no connection (0-0.25). Based on the obtained values of the correlation coefficients, the set hypothesis that atmospheric deposition of heavy metals, due to high emissions from metallurgical plants, has significant impact on the content of the agricultural land in the surroundings of the ironworks in Zenica, is accepted for zinc, lead, cadmium and arsenic, and rejected for all other heavy metals.

4 Conclusions

A cause-effect relationship between the content of heavy metals (Pb, Cd, Zn, and As) in the precipitated dust and agricultural land around the ironworks in Zenica has been revealed using Pearson correlation coefficient. Emissions of heavy metals from metallurgical plants of the ironworks have significant (Zn, Pb, Cd), moderate (As) and insignificant (Cu, Mo, Co, and Ni) impact on their content in the observed agricultural land. Therefore, the emissions of most heavy metals from industrial sources influence their anthropogenic redistribution in agricultural land, as well as in other environmental elements. The amount of heavy metals in the precipitated dust and in agricultural land had a declining trend when getting away from the ironworks, so the highest values of content of heavy metals were registered at the sites closest to the ironworks and at the localities on the dominant wind directions. The lowest values were registered in the farthest locations and sites outside the dominant wind flow. This shows that industrial emissions burden the environment, particularly in the area of about 2.5 km from the source of industrial emissions of heavy metals.

According to the results of monitoring, agricultural land in the surroundings of the ironworks in Zenica is moderately to severely polluted, depending on the position of the site and the type of heavy metal. Therefore, it is necessary to carry out technical and technological measures in order to reduce emissions of heavy metals from metallurgical plants as much as possible and to implement measures for remediation of contaminated land in order to protect public health and the balance of the ecosystem, and in order to ensure sustainable development.

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INNOVATION - THE ROLE OF TRUST

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Abstract: Innovations and constant change are inevitable parts of our everyday lives. It is not only because advanced technologies are more effective, but mostly because in the 21st century more and more realise that scarce resources – among them the safe and clean environment as such - necessitate a paradigm change. This revolution is easily trackable in the organisational and (supra) national policies. However, it is seldom investigated from the individuals' point of view.

In case of most environmental friendly products or technologies consumers and users are not aware of the technical, technological details of the given innovations. Their decision to purchase is solely based on the hope that by their conscious purchase they contribute to a more environment friendly economy/society. This hope is based on trust. Trust in the producers, and their promises to create a more environment-friendly product or technology. Trust in something new to be better than the usual, normal, ordinary one. A trust so immense, that they are willing to change habits for the sake of it.

Trust however is not only prevalent on the costumers' side. Producers, service providers are also acting on the basis of trust when innovating. Changing patterns technologies has its price. They are willing to invest (enthusiasm, energy and very often a lot of money), because they trust the potential customers to realise the value of their innovation.

The present paper endeavours to explore the notion of trust and its antecedents and consequences in relation to innovations, especially those of environmental friendly products and technologies. The aim is to provide assistance to both parties – costumers and providers – to develop trust in each other and hence foster further innovations and development.

MODELLING THE PROCESS OF GROUND-LEVEL OZONE FORMATION AND ITS DISTRIBUTION IN URBAN AREAS

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Abstract: The aim of this study was to give a contribution to the generation of mathematical models, which provide the ability to control the emission of pollutants, as well as to control the adverse effects of industrial production and traffic exhaust emissions to the environment, especially to the health of people who are living in urban areas. Different techniques, like multivariate and nonlinear methods, were used, in order to analyze the problem. Models which are used are those which for a given data set and given research provide the best results.Data were collected at automatic measuring station located in urban area (Zrenjanin). Selected urban areaais characterized by different pollution sources, in that way all factors that can contribute to ozone formation were tested. The results have shown that, based on the available data set, it can be determined the source of primary pollutants that contribute to ozone formation, and make predictions of future ozone trends.

Keywords*:* ground-level ozone, primary pollutants, meteorological parameters, MLRA, ANN.

1 Introduction

Tropospheric or ground-level ozone (O_3) is one of two most dangerous air pollutants regarding its harmful effect on human health, after particulate matter [1]. Global enhancement of the O_3concentration, which has negative influence on human health, is noticeable during past twenty years. The tendency of increasing ozone concentration is recorded in the EU countries, USA and in almost all parts of the world [2, 3]. These facts lead to establishment of the monitoring systems for ozone concentration measurement in the ambient air, in almost all European countries. Because of its harmful influence on human health [4], as well as to vegetation in the rural area, new European Directive 2008/50/EC is limiting the ozone concentration in the ambient air according to the AOT40 index [5]. AOT40 index could be used to evaluate the potential risk that ozone could pose to the vegetation in the investigated area during the plant growing period. This index equals to the sum of the differences between hourly concentrations greater than 80 µg/m3 and 80 µg/m3 using only the 1-h values measured between 08.00 and 20.00 hours Central European Time (CET) each day. According to the new European Directive 2008/50/EC the objective value of ozone concentration for the protection of vegetation, starting in 2010, is 18,000 µg m−3 h. Above this limit it is considered that exposure to the pollutant could result in significant damage to plants.

Researchers started to examine O_3 in the second half of the 20th century. Monitoring of O_3 during the second half of the nineteenth and early twentieth century show that the highest concentration were in spring and autumn[6, 7, 8]. It was assumed that then the annual cycle of O_3 levels depended on the annual cycle of stratospheric ozone and the process of exchange between the stratosphere and the troposphere. Increasing concentrations of primary pollutants, especially from the 1950s years, have contributed to the fact that the annual change in O_3 in industrial environments depends on the long summer period (April to August), mainly due to photochemical reactions in the atmosphere [9, 10].

In recent literature, the researchers examined not only the impact of primary pollutants, but also of meteorological factors on the formation and transport of ozone. Duenas [11] and his colleagues examined daily and seasonal variations in ozone and concluded that the highest ozone levels occur during the day and summer, while the lowest during the night and in the winter, because of the reduced temperature and solar radiation. On the other hand,Lal and his colleagues [12] also examined seasonal variations in ground-level ozone in urban areas of India and noted that during the winter and autumn were the highest concentrations of ozone, which is different from all other research.

Bearing in mind the proven harmful effects of O_3 and the consequences of its increased concentration, a large amount of research was devoted precisely to this problem. O_3 is a strong oxidant and reacts with a variety of cells and biological materials. The greatest effects ozone has on respiratory system and as a result the increase in mortality was observed in areas with increased concentrations of O_3[13, 14, 15]. How large will the consequences be true depends on the concentration of O_3, time and level of exposure.

During their studies, the researchers have used various methods, such as: Principal Component Analysis (PCA), Multipe Linear Regression (MLR), Principal Component Regression (PCR), Partial Least Squares (PLS) and Artificial Neuron Networks [16, 17, 18, 19, 20].

2 Methodology

Although ozone is a major threat to human health, very few studies regarding the impact of O_3 concentration on the air quality and human health were conducted in South and South-East Europe. Republic of Serbia is also part of the European network for continuous monitoring of ozone concentration. Ozone concentrations are measured at 14 locations around the country (Figure 1). Their control and calibration is supervised by the official Agency for Environmental Protection, which operates under the Ministry of Urbanism and Environmental Protection. Air quality data are available on the Agency website in real time (www.sepa.gov.rs). The main sources of pollution in Serbia are anthropogenic in origin, mostly industry and traffic. The aim of this study was to develop mathematical models, which can provide possibility for reliable prediction of O_3 concentrations in urban areas, with the aim to reduce the risk to human health. Based on literature research and set objective we defined hypothesis which was tested during this research.

H: By using methods MLRA and ANNs it can be defined dependence of concentration of ground-level ozone concentrations on primary pollutants in ambient air and meteorological parameters and to determine the level of contribution of individual pollutants on its creation.

The main motive for this research was to draw conclusions about the possibilities of predicting the O_3 concentration in the ambient air, under different environmental conditions and based on the influence of different predictors (other pollutants present in the air). As the input parameters (predictors) we considered the following: SO_2, CO, H_2S, NO, NO_2, NOx, PM_{10}, Benzene, Toluene, m,p-Xylene, o-Xylene and Ethylbenzene concentration in the air. Also, meteorological parameters: wind direction, wind speed, air pressure, air temperature, solar radiation and RH; were considered as input parameters. Consequently, these predictors were divided in three groups: first group consisting only of non- organic compounds (SO_2, CO, H_2S, NO, NO_2, NOx and PM_{10}) was called NOx group; second group containing volatile organic compounds (Benzene, Toluene, m,p-Xylene, o-Xylene and Ethylbenzene) was called VOC group and the third group was consisted only from the meteorological parameters (wind direction, wind speed, air pressure, air temperature, solar radiation and RH). Constituents of the first group (NOx) were labeled as X_{11} to X_{17}, respectively. In same manner, constituents of the second group (VOC) were labeled as X_{21} to X_{25}. Constituents of the third group (meteorological parameters) were

labeled with X_{31} to X_{36} respectively. The output parameter (labeled Y), whose possibilities of prediction were analyzed, is the O_3 concentration.

2.1 Study area

The chemical process of formation and destruction of ozone in the troposphere and the lower layer is highly nonlinear. Therefore, it is necessary to develop numerical models for an understanding of the process of ozone formation, but also for prediction of future concentration. None of the currently proposed models do not cover the process of creating ozone at all levels (from local to global), so it is necessary to develop several different but related models.

Many linear [21] and non-linear models were proposed. Although linear models are easier to use and are considered to be acceptable, they do not take into account the non-linear nature of ozone. These shortcomings, on the other hand, can be recovered using neural networks.

Following trends in literature, we check whether the method of artificial neural networks is more reliable than the linear regression model in predicting the future ozone concentrations in urban areas. The study was conducted in an urban area of Zrenjanin, 2009. Data collected on the automatic measuring station which is located in the city center were used. Both models have been developed using the same data set, which include the concentration of pollutants and meteorological parameters.

Continuous measurement of the air pollutants is facilitated using automatic measurement station, located in the urban part of Zrenjanin city. Coordinates of the measurement station are: 20° 23' 53'' at the altitude of 75m (Figure 1). Measurements are repeated on 2 minute intervals, with calculation of the hourly average value for each hour in the 0 – 24 interval.

Figure 1. Investigated Serbian Banat region and its position in the Europe

3 Results

3.1 Linear Regression Analysis

Multiple linear regression is a statistical method that helps the understanding of the links between the dependent variable and a set of independent input variables.

Before the model building phase, all the extreme points were examined for potential outliers. After this, 1477 data sets remained for further analysis. For the purpose of MLRA analysis, the assembly of 1477 input and output data sets was divided into two groups. The first group consisted of 1030 (70 pct) randomly selected data lines, and it was used for training of the model, whereas the second group consisted of 447 (30 pct) of the remaining data lines from the starting data base, and it was used for testing of the model.

Linear dependence of ozone concentration in the air (Y) on influencing parameters ($X_{11} - X_{36}$) was obtained using SPSS software application Version 18.0. The complete linear model, developed during training of the model, is as follows:

$$Y = 80.362 + 0.091 \times X_{11} - 3.210 \times X_{12} - 2.225 \times X_{13} + 2.023 \times X_{14} - 0.003 \times X_{15} - 0.782 \times X_{16} + 0.164 \times X_{17} - 3.311 \times X_{21} + 3.466 \times X_{22} + 11.299 \times X_{23} - 23.383 \times X_{24} - 9.7 \times X_{25} + 0.013 \times X_{31} - 4.279 \times X_{32} + 1.162 \times X_{33} + 0.004 \times X_{34} + 0.013 \times X_{35} - 0.435 \times X_{36} \quad (R^2 = 0.663) \quad [1]$$

The multiple correlation coefficient (R^2) presents the linear correlation between observed and model predicted values of the dependent variable. Its large value (0.814) indicates a strong relationship. R^2, which is the coefficient of determination, is the squared value of the multiple correlation coefficient. It shows that approximately 66 pct of variation in Y is explained by the model, as is indicated already by the regression to residual ratio.

After developing the model in the training stage, validation of the model was performed in the testing stage using the second part of the data base (total 447 vectors). During the testing phase of the MLRA model, the calculated coefficient of determination (R^2) was slightly increased in comparison with the testing phase and now it equals 0.672. Figure 2 illustrates a comparative presentation of the measured and the calculated values using the MLRA approach. Surprisingly, a better fit was obtained on the test set than on the training set, which suggests that most of the remaining extreme points that are more difficult to model are in the training set. The selection of the variables for the training and the testing stage was performed using a random number generator, and it was not subjectively influenced.

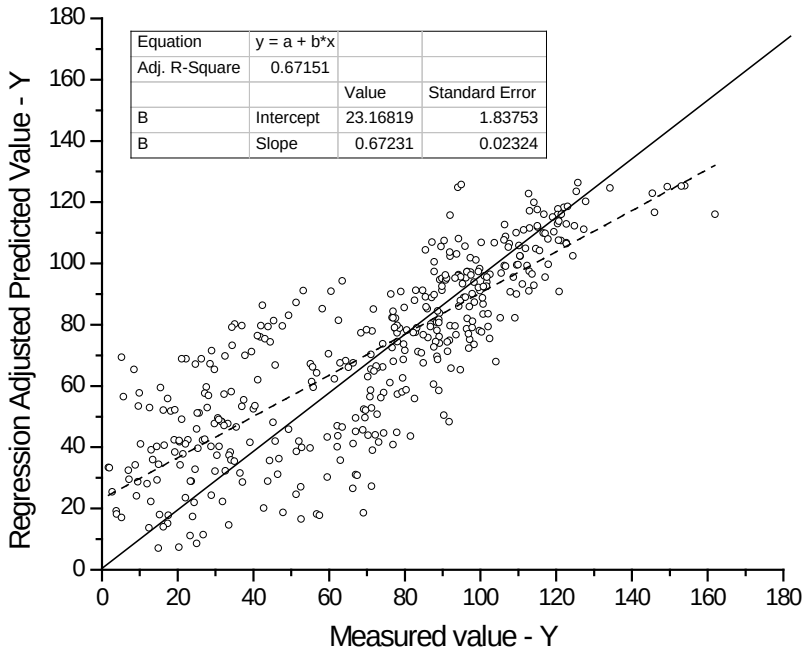

Figure 2. Dependence between the calculated and measured values of the ozone concentration in the air (- ideal position; --- regression line; o values calculated using MLRA model in the testing stage).

3.2 Artificial Neural Networks (ANNs)

Artificial neural networks represent a class of tools that can facilitate the exploration of large systems in ways not previously possible. These methods have observed explosive growth in the last decade and are still being developed [22].

Generally, a neural network contains one input layer, one or more hidden layers, and one output layer. Each layer comprises one or more neurons. The neurons are interconnected using weight factors. A neuron in a given layer receives information from all the neurons in the preceding layer

The ANN used in the model development is depicted in Figure 3. As shown, this network consists of three layers of nodes. The layers described as input, hidden, and output layers. The number of the nodes *i* in the ANN network input layer is equal to the number of inputs in the process whereas the number of output nodes *k* equals the number of the process outputs. However, the number of hidden nodes *j* is an adjustable parameter magnitude.

ANN methodology was applied for modeling the ozone concentration. The same as in the MLRA procedure, the assembly of 1477 input and output data sets was divided into two groups. The first group consisted of 1030 (70 pct) randomly selected data lines, and it was used for training of the network, whereas the second group consisted of 467 (30 pct) remaining data lines from the starting data base, and it was used for testing of the network. For the development of relational ANN configuration, we used previously defined input parameters X_{11}–X_{36} and output parameter Y. The appropriate number of neurons in the hidden layer was determined by training and testing several networks. This process is necessary because too few neurons in the hidden layer produce high training and testing errors as a result of underfitting and statistical bias. On the contrary, too many hidden layer neurons lead to low

training error but high testing error as a result of overfitting and high variance. In this study, we used the iterative approach to determine the optimal number of hidden layer neurons. This way, we have tried 13 networks, ranging from 2 to 14 neurons in the hidden layer. The best results were obtained with the network architecture presented in Figure 3.

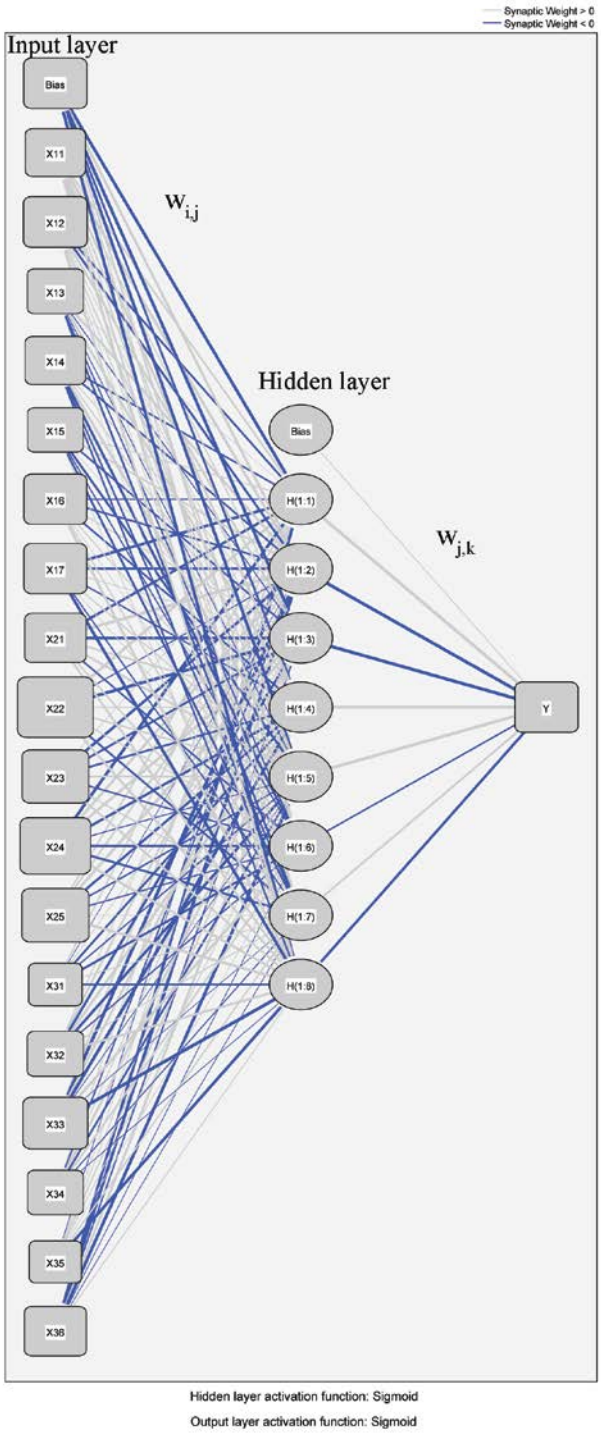

Figure 3. The ANNs architecture

For such a network, the obtained coefficient of determination is $R^2 = 0.919$ for the training phase. During the ANN testing phase, the calculated coefficient of determination (R^2) was slightly decreased in comparison with the testing phase, and now it equals 0.873. If compared to the MLRA approach, completely different situation occurred, which means that a better fit was obtained on the training set than on the testing set. The explanation for this is in the fact that the MLRA modeling is sensitive on distribution of the extreme points in the training and the testing data set. On the other hand, ANNs as the nonlinear modeling approach are not affected with this. The obtained results indicate that the data collected in this study can be used to predict ozone concentration in the air.

4 Conclusions

This study presents the results of measurements and analysis of ozone concentrations, primary pollutants and meteorological parameters collected during 2009 at automatic measuring stations located in Zrenjanin. The dependence of ozone concentration on defined input variables was defined using the MLRA and the ANN methodology, with a coefficient of determination (R^2) 0.672 and 0.873, respectively. Obtained linear and non-linear correlations, based on data collected from automatic measuring stations in the urban area of Zrenjanin, allow prediction of ozone depending on the input parameters. High concentrations of ozone are associated with anthropogenic activities in the Banat region during the entire study period, especially during the growing season. The measured values of ozone concentrations were above the prescribed value of the European Union for the protection of human health and vegetation. Thus they represented a hazard to the environment. The present results show that it is necessary to continuously record the episodes of high ozone concentrations and take measures to reduce the emission of primary pollutants, mainly NOx and VOC.

The obtained linear and nonlinear correlation dependences, using data from the measuring station located in the urban region of city of Zrenjanin enable the prediction of ozone concentration in the air as the dependence on the input parameters. The results presented in this paper will serve as the baseline for the following investigations.

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TOWARDS THE ZERO EMISSION COMMUNITIES, STUDY CASE OF THE COMMUNITY OF MORBACH

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Abstract: The aim of the study to investigate how the Zero Emission concept can be realized on the community level and give the recommendations for achieving this objective by the optimization of the energy sector, especially switching form centralized energy supply to decentralized renewable energy systems.

In the first part, empirical survey of Zero Emission concept, Material Flow Management (MFM) and Circular economy, followed by the EU targets for the GHG emissions reductions are discussed. GHG emission reductions are considered as one of the most important issues of the nowadays society and around 30% of all emissions are originating form energy sector on the European Union level. Due to that fact, but also taking into account increasing depletion of fossil fuels, it is of big significance to develop and implement new concepts in energy sector which will contribute to emission reductions, but also at the same time give a new solutions for a sustainable energy supply. Consequently, this kind of concepts should allow synchronized development of economic, environmental and social queries. Zero Emission strategy is one of them.

Through the Study case of the Community of Morbach, the study examines how the Zero Emission concept and its tool MFM can be introduced on the community level. In a detailed central section, the study provides the information of status quo in the community concerning the energy sector. Following, the energy efficiency and renewable energy potentials of the Community of Morbach will be introduced and analyzed.

In conclusion, the study argues which energy efficiency measures and renewable energy potentials will give the best contribution to the community in the scope of GHG emission reductions, but also crating the regional added value. This study anticipates to offer useful recommendations for other communities how they can by implantation of Zero Emission strategy and MFM contribute in GHG emission reduction but at the same time make a benefit on economic and social level by using and exploiting local resources and in that way increase regional added value.

Conference papers:

ARTIFICIAL LOW STREAM FLOW TIME SERIES GENERATION OF PERIGIALI STREAM, KAVALA CITY, NE GREECE

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Abstract: The present study generates artificial low stream flow time series of an entire calendar year based on the stream flow data recorded during a certain period of the year 2016. We examined the goodness of fit of six theoretical probability distributions to low stream flow data acquired at the exit of the Perigiali stream, Kavala city, NE Greece watershed, during May to July 2016 using a 3-inches U.S.G.S. modified portable Parshall flume and calculated the corresponding probability distributions parameters. The six specific probability distributions used in this study were the following: (1) Gumbel min (Minimum Extreme Value Type 1) distribution, (2) 3-Parameter Log-Normal distribution, (3) Pearson Type 5 distribution, (4) Pearson Type 6 distribution, (5) Two-Parameter Weibull distribution and (6) Wakeby distribution. The Kolmogorov-Smirnov, Anderson-Darling and Chi-Squared, GOF tests used to show how well the probability distributions fitted the observed data and the results were depicted through interactive tables enabling us to effectively decide which model best fits the data. The Mersenne Twister algorithm which generates number of very high quality was employed to simulate a range of daily low stream flow time series values on a yearly basis, using the the discrepancy ratio performance metric between the observed and the simulated values along the stream flow record period until all simulated values for low stream flows were in very good agreement with field observations such that most observations remained within 50% and 200% of the simulated values. The simulated values, of the year selected, preceding and following the low stream flow data acquisition period were adopted as complementary to constitute a full year simulated daily low stream flow data time series on a yearly basis.

Keywords: artificial time series, discrepancy ratio, goodness-of-fit tests, low flow data, modified Parshall flume.

1 Introduction

Artificial stream flow time series generation is a means of paramount importance in hydrology and water resources management in order to handle efficiently precarious or doubtful situations, pertinent to a natural watercourse's flow regime, associated particularly to a short period of stream flow rate data acquisition. The increasing water demands worldwide, caused primarily by the global population increase and exacerbated by the water scarcity due to the climate change, especially in North-Eastern Europe, gives significant prominence to the wise use of the available water resources, showcasing stream flow rate monitoring as a factor of paramount importance with the view to design water storage reservoirs and other water resources management infrastructure works. Therefore, the necessity to minimize dubiety and ambivalence in estimating the flow regime of a natural watercourse constitutes a challenging task in the sector of hydrology and water resources management. This

difficulty can ony be adequately worked out employing artificial stream flow time series generation procedures and techniques, as a common process. These processes are essentially stochastic ones and described in detail within the field of stochastic hydrology. The significance of artificial stream flow rate time series data generation in the area of hydrology and water resources management is pointed out by both the low probability of occurrence in future of a given, real-time captured sequence of stream flow rate time series data, and that the given, real-time acquired sequence of stream flow rate time series data constitutes only a unique sample of a long-lasting record period of stream flow rate time series data acquisition. World Meteorological Organization suggested that low flow is the "flow of water in a stream during prolonged dry weather" and is often mentioned associated together with drought which is a more general phenomenon than low flow and can be characterized by more than low stream flows; a low flow is a seasonal phenomenon (e.g., the "dry season") and is an important component of the flow regime in any river or stream; while droughts include low flows, a continuous seasonal low-flow event is not necessarily a drought; for low-flow calculations, April 1 through March 31 is typically used (EPA 2016). The objectives of this study are numerous: First of all, by acquiring unique raw hydrological low flow data we can compile an as much accurate, consistent and sustainable watershed management plan, allocating in the best possible way the available water resources associated with the Perigiali area watershed and the associated stream drainage network for irrigation and other agricultural purposes, for domestic water use purposes, for recreational purposes, for environmental purposes, for riparian areas, habitats and ecosystems conservation, maintenance and preservation purposes etc. Furthermore, we can compute several hydrological low flow indices, such as the Q95, which, has been been established in mst European countries as an alarm value, below which any abstraction of groundwater is forbidden and the 7-days minimum flow which is essentially the lowest 7-day moving average of lows captured during all the record period of low stream flow rate measurements acquisition as well as the median low flow which has een established especially in Denmark as the most important ow-flow value indicator when compiling watershed management plans. Moreover we can calculate several hydrological drought indices, such as the Stream Flow Drought Index or abbreviated as "S.D.I.", which was invented and established by the Greek famous hydrologist, I. Nalbantis, belonging to the academic and scientific personnel of the Laboatory of Reclamation Works and Water Resources Management, School of Rural and Surveying Engineering, National Technical University of Athens, capital of Greece, central Greece. Additionally, we can perform a low flow frequency analysis, as well as a distribution analysis of low-flows and low-flows time series modeling, forecasting low-flow values for the future. Furthermore, we can build rainfall-runoff models as well as regression models, relating the low-flow values estimation with several geomorphologic characteristics of the Perigiali area watershed, such as the stream density f its stream drainage network, the bifurcation ratio, the mean elevation of the watershed, the catchment area etc. Moreover, we can compile charts depicting low-flows duration curves which essentially provide us information pertinent to the percentage of times, each individual low-flow value is either equaled or exceeded during all the record period f low stream flow rate values acquisition. Additionaly, we can calculate the total evapotranspiration of the Perigiali area watershed, by carrying out consequtively performed pairs of stream flow rate or discharge measurements, scheduled to take place on a regular daily bass, early in the morning and late in the evening, and multiplying the difference between those consequtively performed pairs of stream flow (discharge) measurements by the time interval between them, yielding a product which essentially wil be the total evapotranspiration of the Perigiali area watershed either in litres (ltrs) or in cubic metres (m^3); It should be noted here, tht, this particular computation becomes of paramount importance when calculating either the water balance or the water budget of either.the particular Perigiali area watershed or any watershed in general. Furthermore, we can evaluate the suspended solid sediments transport rate of the Perigali area stream,

by collecting water samples at the exit (downstream side) of the stream fow rate measuring device and sending them, e.g., to laboratory operating under the auspices of the Department of Environmenal Engineering, Faculty of Engineering, Democritus University of Thrace (abbreviated as "D.U.Th.") located by the perspective of its headquarters, in the citυ of Xanthi, northern Greece, where, the responsible personne, could evaluate the total content of suspended solid sediments contained into those water samples and then, by correlating the total content of suspended solid sediments, contained into each water sample with the corresponding stream flow rate (discharge) measurement, we could essentially evaluate the suspended solid sediments transport rate of the Perigiali area stream at any specifically given time. Finally, we can compile complete hydrographs, being able to monitor, follow up and record the complete evolution of the stream flow rate (discharge) during each rainfall event starting monitoring from the commencing point of the rising limb of the hydrograph, then, reaching the maximum (peak) stream flow rate (discharge) during each rainfall event, and then, finally, following up downwards, the recession limb of the hydrograph, until we reach aain back the groundwater base flow conditions. Last but not least, by having been able to record the maximum (peak) stream flow rate (discharge) during each rainfall event, we become simultaneously able to estimate in the most accurate way the particular coefficient of discharge (denoted as "c") of the Perigiali area watershed, by solving for the coefficient of discharge, the equation provided by the rational method in hydrology, having recorded, as already above mentioned, the maximum (peak) stream flow rate (discharge) during each rainfall event, as well as by having been acquainted with the intensity of each rainfall event by the meterological authorities and having calculated geometrically the entire watershed area by means of either Arc-GIS and/or Autocad software packages.

2 Literature review

The fit of four theoretical probability distributions, namely (1) Gumbel's limited probability distribution of the smallest value, (2) 3-Parameter Log-Normal probability distribution, (3) Pearson Type III probability distribution, and (4) Pearson Type V probability distribution, of low stream flow rate data, recorded at several gaging stations in the U.S.A., was investigated by 1963, where the goodness of fit was based on the relation between the skewness and kurtosis of the observed low stream flow rate data and the results proved that the Gumbel's limited distribution of the smallest value and the Pearson Type III distribution, fitted the data equally well and were more representative of the probability distribution of the observed low stream flow data than either 3-Parameter Log-Normal or Pearson Type V probability distribution functions [1]. A mathematical model, consisted of a second order Markov chain, using standardized variates, where daily flows were firstly classified by calendar month, and their frequency characteristics (logarithmic mean, standard deviation, and skew coefficient) for each calendar mon [3] were determined from observed stream flow rate data, used for daily stream flow simulation by U.S. Army Corps of Engineers, Hydrologic Engineering Center by 1968 [2]. Low stream flow rate data frequency hypothesis tests (probability plots and the probability plot correlation coefficient, denoted as PPCC) for the Two-Parameter Log-Normal probability distribution (LN2) and the Two-Parameter Weibull probability distribution (W2) were employed to test the hypotheses that annual minimum seven-day, low stream flow rate data in Massachusetts arose from each of those distributions selecting twenty-three of the U.S. Geological Survey's stream flow rate gaging stations in Massachusetts assuming sites are independent [3]. Considering that the low stream flow rate regime of a river may be described in terms of various characteristics (indices) and that these characteristics may also have multiple use in different areas of water related research and practice and uncertainty often exists as to which low-flow characteristic is the most suitable for the specific purpose, low stream flow rate time series data observed at several gauging stations of more than 200 rivers from the whole of

South Africa and smaller data sets for two primary drainage regions in the country, revealed that many low stream flow rate time series data characteristics exhibit a strong intercorrelation and therefore one low-flow index may often be derived from another by means of regression relationships which were established between low-flow indices estimated from a long-term annual flow-duration curve and several other types of low-flow characteristics, representing frequency of extreme low-flow discharges recession rate, relative baseflow contribution to stream flow and continuous low-flow periods, proving that these regression relationships might be particularly appropriate for use at ungauged sites establishing either by regionalization or observed daily flow time series, at a site, a flow duration curve (as a source of primary low-flow indices), or, alternatively, by mapping on a regional basis using observed daily data, the required primary low-flow indices Q75 and Q95, which could also be estimated from monthly flow data using the regression technique [4,5]. Extreme value type III probability distribution for smallest value (Weibull) arises when the extreme is from a parent distribution that is limited in the direction of interest and it is also known as the Weibull probability distribution and it has found its greatest use in hydrology as the distribution of low stream flows (drought analysis) since the low flows are naturally bounded by zero on the left [6]. Implications of spatial variations in the timing of low flow events for a specific type of simple multivariate models for predicting , average annual natural flow duration statistics through relationships with catchment characteristics, were investigated in several UK catchments, demonstrating that differences in the timing of the mean day of occurrence of the annual Q95 flow in UK catchments can be identified with low flows occurring earlier in the year within impermeable dry catchments and later in the year for wet permeable catchments [7]. Taking advantage of the availability of pan-European hydrological data, drought event definitions were elaborated, allowing the investigation of dry periods and drought across the entire Europe, allowing, in turn, a comparison of the identified events across the different European geographic and climatic regions; Furthermore, synoptic meteorological situations causing droughts were investigated and a relationship was deducted to study the impact of climatic variability [8]. An R&D (W6-064) project which reviewed the use of parametric estimation methods within low flow frequency analysis, and examined the ability of different candidate probability distributions to describe the occurrence of D-day annual minima flow events and was based on data for 25 UK rivers having long, stable and natural flow records, (where 20 of those were located in upland areas, including three in Wales and 14 in Scotland, whilst only five were from the aquifer dominated regions to the south east of England) , and examined durations included, ranging D=1, 7, 30, 60, 180 and 365 days, and also examined different methods of deriving the minima, ensuring that those were both stationary and independent, was conducted, providing valuable guidance for frequency analysis of annual minimum flows, promoting a consistent approach to low fow frequency analysis in the UK. [9]. The Centre for Ecology and Hydrology conducted a review research paper, defining environmental river flow requirements, describing the various types of methods and frameworks used in different parts of the world in order to determine environmental flows, contrasting a priori objective-based approaches with those based on comparison of alternative scenarios, since the necessity for the scientists to be aware of the environmental flow regime requirements of rivers ecosystems has worldwide became of paramount importance in order to either conserve or restore the ecological health and functioning of rivers and their associated wetlands for the benefit of people and biodiversity (10). In hydrology, the EVIII probability distribution has most often been applied to the analysis of low flows, particularly the annual minimum flows and it is particularly attractive because of its fixed limits; By "turning-over" the curve, the limit becomes a lower rather than a upper limit and this is accomplished by fitting the probability distribution to (-x) rather than (+x), and, for this special case, it is known as the Weibull probability distribution, after Weibull, who first used it in an analysis of the strength of materials [11]. In Turkey, a case-study was conducted, aiming to derive

appropriate probability distributions for frequency analysis of 7-day annual low flows at three gauging stations (No 1404, 1409 and 1424 respectively) of the Cekerek stream, where the lowest 7-day flow rate series were constituted from daily flow data for 7-day periods of each year, employing two goodness-of-fit indices, including MADI and MSDI, in order to compare the performances of the candidate probability distributions for fitting, proving that, according to results, the best performance was obtained for Generalized Pareto (GPA) probability distribution [12]. The L-moment method was used to analyze the regional frequency of low flows of Dongjiang basin (the water of which had been the key source of water supplies for Hong Kong and its neighboring cities in the Pearl River Delta in South China since the mid-1960s), China, using five probability distributions all having three parameters: (i) (3P) Generalized Logistic, (ii) (3P) Generalized Extreme Value, (iii) (3P) Log-Normal, (iv) (3P) Pearson Type III and (v) (3P) Generalized Pareto, employing the Hosking-Wallis goodness-of-fit statistical criterion and the L-kurtosis criterion, proving that the 3-parameter (3P) Log-Normal distribution was identified as the most appropriate probability distribution for the respective homogenous study region [13]. In order to investigate the influence of riparian forests on groundwater levels and groundwater sustained strem baseflow, an empirical and a hydraulic version of a new method were developed to calculate evapotranspiration values from riparian zone groundwater levels, by testing the new technique on the hydro-meteorological data set of the Hidegviz Valley (located in Sopron Hills at the eastern foothills of the Alps) experimental catchment comparing the evapotranspiration values of this new method to the respective Penman-Monteith evapotranspiration values on a half hourly scale and to the Wwhite method evapotranspiration values on a daily scale, proving, after performing a sensitivity analysis, that the more reliable hydraulic version of our ET estimation technique is most sensitive (i.e., linearly) to the values of the saturated hydraulic conductivity and specific yield taken from the riparian zone [14]. In order to assess the daily baseflow variations and forest evapotranspiration, diurnal variation of baseflow from a small partially waterlogged experimental forest catchment (32.6 ha) in the Orlicke hory Mts (NE Bohemia), was investigated during the rainless periods in summer hydrological half year 1997 and 1998, proving that the evapotranspiration in riparian vegetation to be the main cause of diurnal variation of streamflow [15]. A very simple and effective hydrological index, the Stream flow Drought Index (SDI), was proposed based on cumulative stream flow rate volumes for overlapping periods of thre, six, nine and twelve months within each hydrological year, allowing the definition of drought states which were modeled as a non-stationary Markov chain, validating the applied methodology using data from two river basins in Greece (Eevinos and Boeoticos Kephisos) which provide water, by diversion, for water supply of the Athens Metropolitan Area [16]. The Weibull probability distribution was employed for estimating the T-year event for two example Australian catchments (No 223207 and 223204 respectively) and their low-flow data, estimating the probability distribution parameters, and calculating the extreme quantiles or design values for the given problem [17]. In order to assess the statistical characteristics of river flow variability in the Odra River Basin, south western Poland, daily discharge time series data recorded at 15 sites from November 1971 to October 2006 were examined, fitting to them several theoretical probability distributions, proving that, among them, the 5-parameter Wakeby probability distribution provided the best overall fit, and, subsequently was employed in order to calculate the respective return periods. [18]. A scientific research paper which reviewed the diurnal fluctuations in shallow groundwater levels and stream flow rates and interpreted them stated that the characteristic evaporation-induced diel signal in groundwater levels and stream flow rates occur in areas where: (a) the typically shallow groundwater becomes influenced by evapotranspiration and (b) replenishment of the depleted groundwater storage during low ET periods is possible through a local hydraulic gradient in the saturated zone, where, the latter is typical in groundwater discharge zones and in areas where a considerable upward hydraulic gradient exists; Moreover, it claimed that in groundwater recharge areas, with no sufficient replenishment

mechanisms, the ET-induced signal may take up a step-like pattern and noticeale mostly in the soil moisture values, and only rarely in the groundwater levels of the shallow groundwater system [19]. Ascientific research, conducted in Germany, evaluated potential adoption measures to sustain minimum runoff in small catchments in Brandenburg, Germany, and similarities of these catchments regarding low flows, addressing the following guiding questions: (i) Which first-order controls on low flows and related time scales exist? (ii) Which are the differences between small catchments regarding low flow vulnerability? (iii) Which adoption measures to sustain minimum runoff in small catchments of Brandenburg are appropriate considering regional low flow patterns? It concluded, among others, that the evapotranspiration was the first-order control on groundwater recharge and subsequently low flows on the particular time scale 1995-2006, whilst, at the same time, it was more important variable to explain low flows in catchments with a high low flow risk; Furthermore, the potential evapotranspiration and precipitation of the prevous 3 months were found to be additionally useful to pre-diet low fows on shorter time-scales [20]. The impacts of climate change on the seasonality of low flows were analyzed for 134 sub-catchments covering the River Rhine basin, upstream of the Dutch-German border, using the output of an ensemble of bias-corrected regional climate simulations and models to drive a hydrological model, were investigated and three seasonality indices were for low-flows were estimated, namely, the seasonality ratio (SR), weighted mean occurrence day (WMOD) and weighted persistence (WP), concluding, among others, that, significant differences were found between seasonality indices based on observed low flows and simulated low flows with observed climate as input due to the uncertainty arising from hydrologica model inputs and structure, proving that the weighted mean occurrence day (WMOD) and the weighted persistence (WP) in the two Alpine sub-basins showed larger differences compared to the rain-dominated sub-basins [21]. In Gediz Basin, Turkey, the attempt to derive appropriate probability distributions for frequency analysis of annual minimum flows at 6 gauging stations, by applying 10 diferent probability distributions, six different parameter estimation methods and 3 fitness tests, proved that the Person 3 probability distribution and General Extreme Value distribution were found to give optimal results [22]. Aiming to identify the major runoff components and to characterize the interplay of groundwater-surface water sources on different spatiotemporal scales to conceptualize water fluxes in a small catchment, the following questions were addressed during a scientific research project which was carried out in the Vollnkirchener Bach catchment, which is part of the Schwingbach main catchment which are low-mountainous creeks both of them being part of the "Study landscape Schwingbachtal of the Justus Liebig University Giessen", located in Huttenberg ($50^{o}30'0"$N, $8^{o}37'0"$E, Hesse, Germany) in an anthropogenic-influenced landscape (altered physical structure of stream system: channeled stream reaches, pipes, combined sewer overflow, drainage systems, fishponds): 1.Does stream flow respond equally to rainfall input throughout the whole stream reach and which runoff sources are contributing to storm flow? 2. Is the study stream a gaining or losing system? 3. Do groundwater head levels and flow dynamics respond to variations in stream stage and is this flow behavior changing throughout the year? Through this scientific research project, a conceptual model was developed proposing the principal flow system and interaction of surface water and groundwater along the Vollnkirchener Bach reach orientated south to north [23]. A scientific research study which conducted to investigate the reasons that low flows of the Ilmenau River ($1434km^2$) in northwest Germany had decreased by about 25% between 1965 and 2015, whilst, in the same period, moderate climate changes had taken place and annual groundwater abstractions for sprinkler irrigation had increased by up to 50 hm^3 (million m^3), with a strong variation due to the respective prevailing weather conditions, stated that multiple regression analysis allowed distinguishing and quantifying the influence of different climatic and man-made variables such as precipitation, temperatures, and, groundwater withdrawal on annual low flows

and found that groundwater abstraction for irrigation in the Ilmenau Basin accounted for an average decrease of low flows of about 25% as well as that the groundwater levels and long-term volumes recover during the winter season and the annual abstraction volume was highly correlated with rainfall depth in the vegetation season, summer air temperature, and irrigation area, therefore, it became evident that groundwater abstractions in the Ilmenau Basin were based closely on actual irrigation requirements [24].

3 Materials and methods

3.1 Study area

The stream flow rate gauging station, (it should be noted that since it is located just a few decades of metres upstream the sea shore and simultaneously at the exit of the entire Perigiali area watershed, between the sea shore and the Oold National Rroad connecting the eastern exit of the city of Kavala with the city of Xanthi, drained by the homonymous Perigiali area stream, the associated stream flow rate measurements provide essentially valuable scientific information pertinent to the total availability of the water resources of the Perigiali area watershed), which was established in Kavala city area, a coastal city, located at the north of the Aegean Sea, across the Thassos Island, and surrounded by the Lekani mountain series branches to the North and East and the Paggaion Mountain ramifications to the West, (established in the proximity of the city urban web center and at the eastern exit of the city as well), located at the specific co-ordinates $40^{o}56'727"$ N and $24^{o}25'929"$ E, Perigiali city area, and operated continuously, spanning a time interval period from 14.05.2016 to 30.08.2016, as illustrated in "figure 1".

Figure 1. Parshall flume gauging station, Perigiali area, Kavala city, Greece (Source: Google Earth)

3.2 Sample collection and data used in this study

A total number of 203 individual stream flow rate (discharge) measurements were performed within 109 consequtive days, between 14.05.2016 and 30.08.2016 during which a thorough presentation of the methododology and procedure followed was analytically supplied, whereas, all of them were recorded and uploaded on the first author's personal Youtube platform web-site, namely, "Thomas Papalaskaris" [25]. The first stream flow rate (discharge) measurement (14.05.2016) lasted 1 hour sharp [26] and the last one (30.08.2016), respectively, 48':01" [27]. Night patrols pertinent to stream flow rate measurements were performed as well in order to further investigate the stream flow rate performance under lowest evapotranspiration conditions prevailing throughout the associated watershed under study [28].

3.3 Sample analysis

Mathwave EasyFit and StatAssist software packages was employed to estimate the best probability distribution (based on the Anderson-Darling, Chi-Squared and Kolmogorov-Smirnov goodness-of-fit criteria tests), together with the associated parameters, fitting the daily lowest stream flow data, as well as the goodness-of-fit of all the other candidate probability distributions. Moreover,

after having calculated the parameters of the examined probability distributions, we generated a sequence of high quality random numbers for each individual candidate probability distribution with the same parameter values to the origina calculated ones. It should be noted here that Mathwave EasyFit uses the Marsenne Twister algorithm which generates very high quality pseudorandom numbers. The generator has a period of 2^{19937}-1 (more than 10^{6000}) and passes numerous tests for statistical randomness, including the well-known Diehard tests (a number of statistical tests measuring the quality of a set of random numbers). These qualities, along with its high speed, make the Marsenne-Twister generator an algorithm of choice for most statistical simuations [29]. The Kolmogorov-Smirnov test (KS-test) tries to determine if two datasets differ significantly, whilst, it has the advantage of making no assumption about the distribution of the data (technically speaking it is non-parametric and distribution free) [30].

MS Excel software is employed in order to plot the real observed (recorded) against the artificial (generated, forecasted) low stream flow rate (discharge) data.

3.3.1 Checking the goodness of fit

The parameters of the six examined candidate probability distributions are calculated for one low stream flow rate (discharge) time series data employing EasyFit and StatAssist softwares implementing the method of moments to compute the parameters of the probability distributions providing availability for the moment estimates whilst the maximum likelihood estimate and least square estimate are used for other types of estimations and are illustrated within "table 1" below. The calculation of these probability distribution estimates are of paramount importance as they enable further computation of daily low stream flow rate (discharge) data for various return periods, in accordance with the desired requirements of any potential future scientific research project.

Table 1. Calculated parameters for the examined probability distributions, for the Perigiali area, Kavala city Greece, gauging station, data series, (Source: EeasyFit, Probability Distributions Parameters Summary Table)

Distribution	Perigiali Gauging Station
Gumbel min. (2P)	σ=0.28926 μ=0.47973
(3P) Log-Normal	σ=0.86710 μ=-1,49990 γ=-0.01399
Pearson type 5 (3P)	α=2.77490 β=0.69937 γ=-0.07700
Pearson type 6 (3P)	α1=2.00360 α2=3.92090 β=0.45200
(2P) Weibull	α=1.27790 β=0.30107
Wakeby (5P)	α=0.29249 β=1.13370 γ=0.07797 δ=0.51471 ξ=0,01503

The goodness of fit tests are performed in order to evaluate which distribution fits to the low stream flow rate data series in the best possible way. The values of Anderson-Darling statistics, Chi-square ($\chi 2$), Kolmogorov-Smirnov (D) respectively are computed and illustrated within "table 2" for the entire low stream flow rate (discharge) time series data. It should be underlined that, employing an improvised scoring system, the superscript number makes reference to the order ranking of the probability distribution which best fits the low-flow data, ranging from 1 (the best one) to 3 (the worst one). Further, the ranking score values of numbers 3, 2, and 1, are, inversely assigned to the already given, (as above mentioned followed procedure), ranking scores 1, 2, and 3 correspondingly.

Table 2. Goodness of fit tests results for the Perigiali area, Kavala city Greece, gauging station, data series, (Source: EeasyFit, Goodness Of Fit)

Distribution	Perigiali Gauging Station			
	Anderson - Darling	Chi-Squared	Kolmogorov - Smirnov	Highest final goodness of fit score obtained
Gumbel min. (2P)	14.01100	N/A	0,27659	
(3P) Log-Normal	0.24105^{2}	3.07620	0.06329	2
Pearson type 5 (3P)	0.24638^{3}	4.19120	0.07197	1
Pearson type 6 (3P)	0.20310^{1}	3.02400	0.06005^{3}	4
(2P) Weibull	0.50906	4.05040	0.05391^{2}	2
Wakeby (5P)	4.04710	N/A	0.05279^{1}	3

It can be identified from "table 2" that all the examined probability distributions can be accepted to fit to the low stream flow rate (discharge) time series data at the significant level α of 0.05, except Gumbel min. (2P) and Wakeby (5P) probability distributions, based on the Chi-squared goodness f fit test, whilst, at the same time, based on all three individual goodness of fit tests, Pearson type 6 (3P) obtained the highest score of four. The probabity density function of Pearson type (3P) probability distribution is depicted within "figure 3", below,

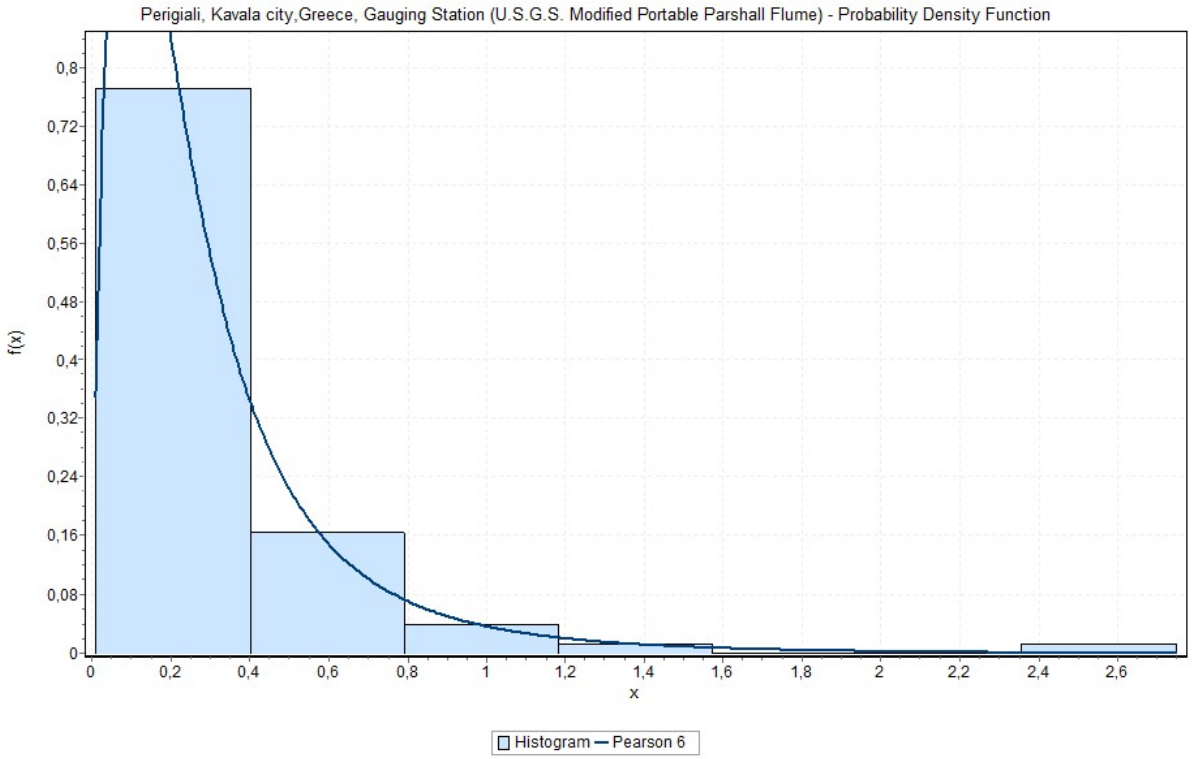

Figure 2. Plot of Pearson type 6 probability density function for observed low stream flow rate time series data for Parshall flume gauging station, Perigiali area, Kavala city, Greece (Source: EasyFit plot compilation)

Visually inspecting the "figure 3", where the real observed (recorded) low stream flow rate (discharge) time series data are plotted against the artificial (generated, forecasted) ones, for the same time period (14.05.2016-31.07.2016) we can identify that both, by first sight, coincide remarkably well.

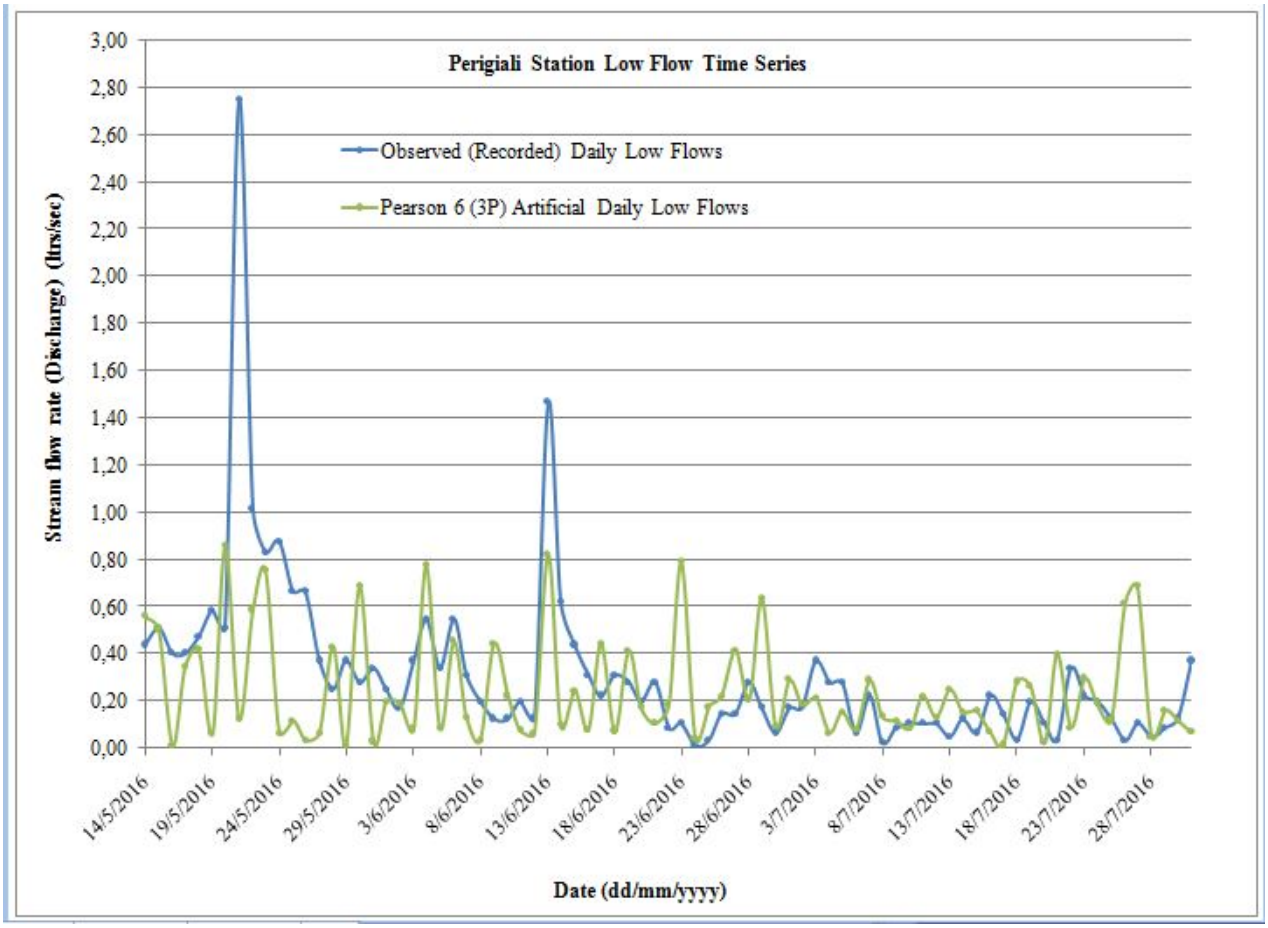

Figure 3. Plot of observed against artificial low stream flow rate time series data for Parshall flume gauging station, Perigiali area, Kavala city, Greece (Source: Author's plot compilation)

3.4 Hydrodynamic methods and equipment for sample data collection and analysis

Due to the extremely shallow waters, in conjunction with the extremely low water stream flow velocity prevailing at the gauging station, it is impossible to implement the area-velocity method in order to assess the stream flow rate (discharge), using a current meter mounted on a wading rod, owing to the fact that there isn't available depth to submerge the current meter as well as the extremely low water stream flow velocity is not sufficient enough to trigger the operation of a current meter; Under those particular circumstances the only alternatives are the use of either a small-sized portable weir (which in turn is rejected due to the fact that weirs, in general, require a relatively great head loss which is not available at areas in proximity to watersheds' outlets, where, in most cases, the natural slope of the channel bed is extremely low if not zero) plate or a small-sized flume which, eventually, was our final selected option, more specifically, a "3-inch U.S.G.S. Modified Portable Parshall Flume" [31,32,33,34, 35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58], constructed by means of sea plywood, covered with a sprayed thin smooth polyester coating similar. to that the industry usually covers the outside surface of high developing speed sea vessels, in order to reduce the friction between the otside area of those sea vessels and the sea water, thus ensuring that the friction developed between the bottom as well as the walls of the "3-inch U.S.G.S. Modified Portable Parshall Flume" are minimized/restricted to a minimum, as illustrated in "figure 4".

Figure 4. Parshall flume gauging station, Perigiali area, Kavala city, Greece (Source: Author's personal photo archive)

The Parshall flume is a sophisticated hydraulic device which comes into use wherever we have open channel flow measurements requirements. The Parshall flume is very accurate and it can measure and handle efficiently a wide range of flows. It can handle efficiently high amounts of sediment transported by roll-waved streams, reaches and creeks without losing accuracy. We can find the Parshall flume both within natural, mountainous, forested watersheds watersheds in order to measure the stream flow rate (discharge) of mountainous forested watercourses as well as with urban watersheds in order to measure the stream flow rate (discharge) of urbanized, channelized, modified, regulated streams. We can also find the Parshall flume installed both at the inlet as well as at the outet of wastewater treatment plants in order to measure both the influent as well as the effluent of those wastewater treatment plants. The Parshall flume was invented by Ralph Leroy Parshall who was a Civil and Irrigation Engineer, who developed the flue within the years range 1915 and 1922, performing numerous experiments within the hydraulic aboratories of the Colorado Ste University, United States of America, and launched it finally into the market by 1922 with its origina option and configuration the so-called conventional option of Parshall flume. The conventional option of Parshall flume consists of three different between each other, still incorporated together in order to form an entire assembly, sections, namely the convergence section where the flow firstly comes into, then the throat section where the flow secondly comes into and it is contracted and the divergence section, where a mild controlled hydraulic jump is produced,

where the flow finally comes into before it leaves behind the entire assembly of the Parshall flume, entering again into the original stream channel. The particular present option of Parshall flume, employed to assist the realization of this present scientific research project, so-called as the 3-inch U.S.G.S. Modified Portable Parshall Flume", differs from the equivalent conventional option of Parshall flume of equal size, 3.00 inches in our particular occasion, in terms of, following the direction of the flow, the fina section, namely, the divergence section, and it was developed by 1931, by Troxell and Taylor, who were two civil, hydraulic and hydrologic engineers, working correspondingly, during that time, for the United States Geological Survey and United States Department of Agriculture, seeking both of them, during that time, a lighter in weight and, consequently, more easier to be transported and installed on site flume. The Parshall flume uses the critical depth principle; The principle for flow measurement in a Parshall flume, is the channel restriction at the throat section, produces a calibrated change in liquid level and flow velocity as the flow rate varies. The Parshall flume should be installed on site in a way that it absolutely level both lengthwise/longitudinally and crosswise/laterally at al times and this leveling can be achieved by applying a carpenter's spirit level at the crest of the Parshall flume both lengthwise/longitudinally and crosswise/laterally; Otherwise the flume will be tilted, causing erroneous readings and recordings of the accurate water elevation or liquid head measurement, leading unavoidably and consequently to miscalculations and miscomputations of the entire stream flow rate (discharge) measurement as a whole jeopardizing the entire stream flow rate (discharge) measurement as a whole. We install the Parshall flume on site in a way that subcritical flow conditions prevail into the stilling pool created upstream the temporary check dam; The existing and continuously growing dense natural vegetation constitutes an unquestionable proxy that subcritical flow conditions prevail into this pool. It is unquestionable (it goes without saying) that supercritical flow conditions prevail at the exit of the Parshall flume. Hence, critical flow conditions, take place (occur, develop) as the flow passes through the Parshall flume assembly, hence, in turn, a mathematical equation, relating the flow "Q" to the liquid head measurement (water elevation), as it is recorded at a specific point of the convergence of the Parshall flume, can be established. This particular point is more specifically located 2/3 the total length of the convergence section upstream the specific point where the convergence section and the throat section of the Parshall flume assembly are permanently connected where a plastic, transparent, calibrated staff gage has been incorporated vertically into the outer sides of the inner walls of the convergence section of the Pparshall flume assembly, facilitating the easy reading and record of the accurate water elevation (liquid head measurement) which can be easily converted afterwards into a certain stream flow rate (discharge) measurement using a rating table. Of course if we are talking about portable editions of flumes, in general, a temporary dam, usually constructed by means of sand berms, should be constructed around the flume in order to force al the available flow accumulated (concentrated) upstream this temporary check dam passing (flowing) through the Parshall flume and perform an as much consistent and accurate stream flow rate (discharge) measurement as possible. Of course, this dam should be constructed in a way that all the potential leakages both between the sand berms themselves as well as between the sand berms and the adjacent sand levees, between the sand berms and the concrete stream bed, between the sand berms and the Parshall flume itself and between the Parshall flume itself and the concrete stream berms are, if not completely eliminated, still at least, restricted to a minimum. In our particular present scientific research study occasion, al the abovementioned plausible leakages were completely eliminated without experiencing any either lateral or hyporheic bypass of the water flow accumulated/concentrated upstream the temporary check dam and this task was fulfilled by filling in, very carefully, all the crevices, unavoidably created, between the sand berms themselves as well as between the sand berms and the adjacent sand levees, between the sand berms and the concrete stream bed, between the sand berms and the Parshall flume itself and

between the Parshall flume itself and the concrete stream berms, with extracted from the stream channel's bed downstream the temporary check dam, mud, and other natural materials commonly found around the stream channel's area.

4 Results and discussion

A total number of 203 individual stream flow rate (discharge) measurements were performed within 109 consequtive days, between 14.05.2016 and 30.08.2016, at the Perigiali area, Kavala city, north eastern Greece, at the exit of the homonymous watershed and main stream channel by means of a "3-inch U.S.G.S. Modified Portable Parshall Flume". The daily lowest flows were undergone a probability distribution analysis and six candidate probability distributions were fitted to the low stream flow rate time series data proving that the Pearson 6 (3P) probability distribution best fitted the data based on three different goodness of fit tests. As normally anticipated the stream flow rate (discharge) observed early in the morning, late in the evening and during the night patrols were (due to decreased evapotransiration rate and especially the transpiration rate of the vegetation of the riparian areas of the stream drainage network of the entire Perigiali area watershed, stemming from the relatively lower temperature, solar radiation and dry wind intensity values hitting, in turn, the entire Perigiali area watershed) relatively higher that those performed around mid-day hours and early in the evening.

5 Conclusions

Perigiali mediterranean watershed and main stream channel can sustain extremely low flow conditions which are essential for low flow studies in order to compile an as much consistent, accurate and sustainable drought management pan and bridge the research and knowledge pertinent to the south eastern part of Europe were, as generally admitted, only a few stream flow rate (discharge) measurement gauging stations exist and transfer the acquired knowledge to ungauged watersheds as well, in accordance to the suggestions of the Braunschweig Declaration [59]. Furthermore, Perigiali Mediterranean watershed could be proposed to be incorporated within the global network of long-term small hydrological scientific research basins network the importance of which has been worldwide acknowledged [60,61,62].

6 Further research

More future measurements would contribute to production of extended stream flow rate (discharge) time series data which are of paramount importance in hydrology in order to compile accurate, consistent and sustainable watershed balance and budget and drought management plans, low-flow frequency analyses, distribution analyses of low flows, low-flow time series analysis modeling in order to forecast low-flow values for the future, water resources availability investigation, agricultural irrigation schedules compilation, scientific research studies, training of new scientists, educational field trips performances and resentations to school students with a view to improve awareness pertinent the importance of trying to preserve, conserve and maintain the available water resources and natural habitats for environmental purposes etc..

Acknowledgements*: In order to perform such stream flow rate (discharge) measurements, we were inspired by Mr. Emmet McGuire, a Hydrologic Technician, working for the United States Geological Survey, who uploaded a relative video with related topics, on the Yoube web-platform, during which he performs such a similar stream flow rate (discharge) measurement, by means of a galvanized steel sheet "3-inch U.S.G.S. Modified Portable Parshall Flume", under extremely low flow conditions, at the Charleston Gage, San Ppedro River, Tucson, Arizona State, United States of America. The authors also wish to express that they feel grateful to Prof. Vlassios Hrissanthou, Department of Hydraulic Structures, Department of Civil Engineering, Faculty of Engineering, Democritus University of Thrace, for the valuable scientific knowledge within the general context of Stochastic Hydrology, he kindly transferred through the module, named, Stochastic Model Building in Hydrology taught as a part of the MSc. In Hydraulic Engineering, performed by the above mentioned department.*

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SUSTAINABLE AGRICULTURAL DEVELOPMENT IN LATVIA

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Abstract: Entrepreneurship and innovation in business are the leading factors in the national economy. In recent years, a focus has been put also on sustainable resource consumption, environmental protection and the quality of food being pure and free from chemicals.
The current trends in agriculture in Latvia indicate two very different courses of development of farming: on the one hand, there is agricultural production intensification, which involves the concentration of agricultural production in large farms still increasing in size and higher productivity that results in higher value-added agricultural products, while, on the other hand, a lot of farms are still small in size, and such farms in particular can practise organic farming, thereby contributing to the sustainable development of rural areas, the preservation of natural assets in rural areas and the retention of jobs for rural residents. In Latvia, there are approximately 3500 agricultural holdings certified as organic, and the organic farming area, just like in the other Baltic States, tends to increase.
Innovation is important in organic farming just like in any other kind of business. According to a survey of organic farmers in Latvia, most of them believed that cooperation with the science and research sector in introducing innovations was important; yet, almost half of the respondents were convinced that this sector did not work on solutions to organic farming problems, and only 8.4% of them had successful cooperation with the sector. Since organic farming is a management system based on traditions, in which innovations emerge from existing ideas, knowledge and resources in everyday life, it is difficult to identify the innovations because they are imitative in terms of their nature; yet, it does not decrease their role in organic farming.

***Keywords*:** sustainable agriculture, organic farming, innovations, conventional farming

1 Introduction

Agricultural land occupies a third of the planet's surface, and agriculture is the key occupation for many individuals. Rural residents, farmers, farms and family enterprises are the managers of most land resources. The agricultural area increases fast in the world. However, farming can overexploit land resources, particularly sensitive lands and those unsuitable for agriculture. There are concerns about the sustainability of agricultural systems, which is directly associated with environmental protection.

The global conventional food system, to a great extent, is based on centralised processing and packaging, which is often done far away from the producer and the consumer. Food transport possibilities, in combination with fuel subsidies, allow shipping conventional food at large distances at relatively low costs. Organic food sometimes does not involve such stages as packaging, transporting, selling to intermediaries and even harvesting. Local food comes either directly from the producer or through retailers and institutional schemes [1]. Compared with conventional farming, organic farming practices make mainly positive effects on the environment if measured per unit of area, but not always per unit of agricultural output. Fore example, organic farming usually features a higher content of organic matter in soil and a reduced loss of nutrients (less leaching of nitrogen and smaller emissions of nitrous oxide and ammonia) per unit of field area. However, the mentioned indicators per unit of

agricultural output for organic farming could be even higher than those for conventional farming, as a larger land area is exploited to produce the same quantity of agricultural products [2]. For this reason, it is important for countries where agriculture plays an essential role, such as Latvia too, to develop sustainable agriculture that balances economic, human wellbeing and environmental requirements within both the country and any farm. The aim of the paper is to analyse development opportunities for an agricultural holding in the context of innovation as providers of sustainable agriculture in Latvia. To achieve the aim, the following tasks were set: 1) to assess the conventional and organic farming systems; 2) to compare performance indicators for organic farms in the Baltic States within the European Union context; 3) to analyse the results of a survey on innovation on organic farms in Latvia.

2 Conventional and organic farming

Rural areas provide the society with resources needed for the sustainable development of any country – agricultural products as well as landscapes –, the rural areas are important for a traditional lifestyle and for maintaining the environment. In agriculture, with the opportunities for modernisation and the application of various innovations, manual work has considerably decreased over the last 20 years, which led to a decrease in the number of agricultural employees, although the number of employees in agriculture increased in many countries. In Latvia, 66.3 thou individuals were employed in its agriculture, forestry and fisheries in 2014, accounting for 8% of the total employees in the country. Such as a proportion of employees may be regarded as significant and shows that the agricultural industry plays an important role in the creation of jobs – in remote rural territories in particular [3]. In addition, it has to be taken into consideration that many more employees are engaged in the primary processing and retail trade of agricultural products.

In developed countries, conventional farming makes up the largest share of the present agricultural system. It uses synthetic plant protection products and fertilisers and raises livestock intensively in large herds. Such a system features a high level of mechanisation and minimum labour consumption. Food produced under the conventional farming system is the cheapest due to high crop yields.

To raise crop yields under the organic farming system, life processes are induced by means of various techniques instead of providing crops with nutrients, e.g.: plants being able to absorb nitrogen from the atmosphere (papilionaceous pants and legumes can absorb 200-300 kg of nitrogen per ha) have to be included in crop rotation; plant nutrients are supplied by means of manure (solid manure, liquid manure, digestate etc.) and manure crops (clover, oil radish, mustard etc.); soil tillage techniques contributing to the functioning of microorganisms (soil inversion, earthing up, deep tillage) are applied; no fertilisers and pesticides are used.

The organic farming system is less productive than the other systems and use more land resources, although scientists have not yet come to a single conclusion on whether crop yields in organic farming are lower than under the other agricultural systems. A number of research investigations were conducted to find it out. A report by Cornell University on agricultural experiments done by the U.S. Rodale Institute revealed that in the experimental period of 22 years wheat and soybean yields in organic and non-organic farming were the same, but organic farming consumed 30% less energy and less water and no synthetic pesticides were used.

Agricultural modernisation, new technological solutions and various innovations were specific to the agriculture of Latvia after the country's accession to the European Union. Table 1 shows how it

influenced the output and yields of key agricultural products; it presents data for the last three years and 2004 when Latvia became a full member of the European Union and 2005 – the first year after the accession.

Table 1. Total output and yields of the most significant agricultural products in Latvia

Year	Average crop yields cnt/ha				Total output			
	grain	rapeseed	potato	vegetables	meat thou t	milk thou t	eggs mln pcs	honey t
2004	24.3	19.0	128	122	73.2	786.4	527.4	746
2005	28.0	20.4	146	123	76.7	810.3	545.7	916
2013	33.4	23.1	182	148	80.3	915.1	629.5	1666
2014	34.0	18.5	189	217	84.3	971.8	648.3	1704
2015	44.9	32.9	201	225	85.4	978.1	698.2	2091

Source: data of the Central Statistical Bureau of Latvia

As shown in Table 1, the total output of agricultural products rose for all the product groups, even though the agricultural area did not increase during this period. As regards crop yields, they almost doubled over this 10-11-year period, which was possible due various innovations in the agricultural sector. It has to be noted that the data in Table 1 mainly refer to the sector of conventional agriculture because, for example, in 2009 in terms of output, grains were the most significant group of crops produced organically, accounting for 4.8% of the total area under grains; the production of organic grains was equal to 2.6% of the total output of grains in the country, while organic milk made up 7.6% of the total milk output. The global economic crisis, which reduced milk exports to Latvia's traditional markets – the Baltic States and Russia – contributed to an increasing interest in organic farms in recent years.

Organic farming as a radical alternative to conventional farming emerged in the beginning of the 20th century along with the increasing mechanisation of agriculture, the application of chemicals (fungicides, insecticides, pesticides and fertilisers) and agricultural specialisations. Organic farming techniques are based on maintaining a sustainable ecosystem through establishing a maximally closed production cycle, completely excluding the application of synthetic fertilisers and pesticides and reducing environmental pollution as much as possible. In 2004, more than 1000 farms certified as organic were registered in Latvia. Joining the EU gave a new stimulus to organic farming, as farms could receive not only additional funding from the EU Funds for the modernisation of their machinery, the selection of their herds and other farm development projects but also payments for their farmed area. Organic farms received larger payments, e.g. 104% more for their grassland, 115% more for their area under grains, which served as a compensatory payment for lower yields. At present, there are more than 3500 registered organic farms in Latvia, which is a relatively small number, as there are totally 80.1 thousand economically active farms engaged in the agricultural sector.

In the opinion of the authors, organic farming is a complicated agricultural system, as it requires a lot of knowledge and efforts to comply with the organic farming standards under the organic farming control scheme. This means that the conversion of farms involves systemic changes – appropriate crop varieties and livestock breeds have to be introduced, housing and husbandry conditions have to be adapted to the standards and a system has to be developed with regard to how to farm the sown area without using fertilisers and pesticides. A transitional period that usually lasts for 2-3 years has been set in the EU Member States to register a farm as organic and to acquire a certificate. The result that becomes apparent in a long-term and the relatively long transitional period reduce the attractiveness of organic farming. However, if there is an idea that someone wants to implement and if it is harmony with the individual's conviction, good farm economic performance results can be achieved under the organic

farming system if introducing innovations. Entrepreneurs engage in the commercialisation of ideas and the new knowledge is materialised particularly through entrepreneurship, reaching the customer. The innovation process is continuous and endless, which, by its nature, involves development and change aimed at enhancing efficiency and competitiveness [4].

Compared with the advantages of conventional farming, those of organic farming are not unambiguous. The advantages of organic farming have to be viewed from both the economic, environmental and social perspectives, as organic farming is associated with social prestige, profitability and satisfaction [5]. Therefore, one can say that organic farming is mainly oriented towards a sustainable farming system, as a much greater focus is placed on the natural environment, human wellbeing and care about human health because, unlike conventional farm products, organic food contains no chemicals. However, a discussible issue is profitability for organic farms, which are subsidised in the European Union. Among conventional farmers, too, the transition to organic farming is often regarded as risky, which is associated with potential decreases in crop yields and profits. A research study "Diversification practices reduce organic to conventional yield gap" found that yields in organic farming were 19.2% lower than those in conventional farming. The yield gap can be reduced by up to 8-9% in two ways: growing several crops in the field and/or practising the rotation of crops [6]. The price level of organic food is different, and a large price difference can be observed in Latvia, ranging from 14 to 52%. Organic food is more expensive than conventional one, depending on the group of products, the ways of shopping and sales etc.

In comparing the organic and conventional farming systems, potential profit is one of the most essential factors influencing farmers' decisions on introducing innovations; both systems can be brought closer through the innovations. Organic farming combines tradition, innovation and science to benefit the shared environment and to contribute to fair relationships and promote a good quality of life for all involved [7]. An anthropological research study "A human and work in the rural areas of Latvia" pointes out that innovations are created through directly interpreting traditions: "culture is strengthened through innovation" [8]. To establish what makes innovation a unique driver in national economies, the term's definition has to be examined in detail.

3 Innovation as an additional advantage

If science (research) is a process in which money is turned into knowledge, then innovation is a process where knowledge is turned into money; so, the knowledge creates extra advantages for making profit, which is the key pillar and driver of economic activity. Herbert Simpson believes that innovation is closely linked with the ability to change amazing and unusual phenomena [9]. M.E.Roger, however, points out that innovation may be a new idea, an object or an activity that considerably differs from usual practices and, in general, features progress and change. Besides, the subjective position of an innovation implementer is crucial – if the idea is new for the implementer, it is an innovation [10]. The new idea can become apparent at various stages – as pointed out in his research by Fagerberg, any innovation emerges from existing ideas, knowledge and resources as a new combination of traditional practices [11]. Abilities and skills to see the diverse nature, uniqueness and potential usefulness of things and events have to be developed to create an idea [12].

An innovation may be characterised by the ability to introduce it and the degree of novelty at an enterprise, in an industry or on a greater scale [13]. There are innovations whose results are new in a particular country, enterprise or industry, e.g. innovations in green industries, rural innovations or eco-

innovations. In the opinion of the authors, agriculture may have three development strategies through which innovations have to be implemented: 1) *modernisation*, which involves investment in new technologies, equipment and machinery. The purpose of the activity is to produce products of higher value-added and enhance their competitiveness; 2) *social innovation*: new social organisational forms among producers and new relationships with other food chain agents (collective producer initiatives, direct links with consumers, e.g. direct marketing clubs, craftsmen stores etc.). The purpose is to contribute to social inclusion as well as the development of rural territories and the wellbeing of residents in general; 3) *diversification of economic activities*: new or enhanced economic activities or agricultural development on farms (tourism, processing, energy crops, crafts as well as organic farming etc.).

The scientific literature most often refers to two kinds of innovation: radical and incremental or continuous. *Radical innovation* involves considerable enhancements, eliminating the usual practices, and contradicts the institutionalised opinion on what is acceptable, appropriate and desirable. Radical innovation is the introduction of new goods and services, which have been developed by new enterprises or "discoverers" of a completely new industry, which considerably changes the entire industry [14]. However, in the case of *incremental innovation* goods and/or services are continuously improved and perfected [15]. A comparison of the two kinds of innovation allows concluding that any incremental innovation may be introduced in entrepreneurship through making insignificant changes in the business model, whereas any radical innovation involves changes in the usual practice, norms and values.

The scientific literature also refers to the third kind of innovation – *imitative innovation* –, which involves the introduction of an existing innovation in a new environment or situation. Due to their transfer and imitation, such innovations are not often considered to be "real" ones, as they lack originality and creativity. However, such "overtaken" innovations require essential additions and adaptation to the new conditions; consequently, they are not anymore a copy of the original innovation [5]. Imitative innovations, in the authors' opinion, may be partially attributed to incremental innovations, as it is difficult to define the final product, its potential and the possible market size.

Under the organic farming system, innovations emerge from existing ideas, knowledge and resources in daily life when the manager of an organic farm enhances or transforms products, introduces new technologies and new marketing or sales techniques. In organic farming, it is difficult to identify innovations because in terms of their nature, they are imitative – an idea is new to the farmer, while it has been known to the society.

4 Organic farming in the European Union

In the EU, the demand for food grown and processed organically continuously rises, and the sector and market of organic farming develops. In the period 2009-2014, the number of farms in the EU, on average, increased by 2.8%. In Latvia and its neighbouring countries – Lithuania and Estonia –, too, the organic farming sector develops (Table 2), even though a decrease in the number of organic farms was reported in Latvia and Lithuania by, on average, 2.1% and 1.3%, respectively, whereas in Estonia it increased by 3.2%. In 2014, there were registered 3477 such farms in Latvia and 2445 in Lithuania and 1542 in Estonia. In the EU, the average number of such farms is three times greater than, on average, in Latvia. The number of organic farms changes from year to year, while the organic UAA

tends to increase both in the Baltic States and, on average, in the EU where the average indicators tend upwards.

Table 2. Certified UAA area in the period 2009-2014 in the Baltic States and on average in the European Union

Year	Latvia		Lithuania		Estonia		on average in the EU	
	UAA, thou ha	*Annual change rate, % - $t_{m(a)}$*	UAA, thou ha	*Annual change rate, % - $t_{m(a)}$*	UAA, thou ha	*Annual change rate, % - $t_{m(a)}$*	UAA, thou ha	*Annual change rate, % - $t_{m(a)}$*
2009	161.2	x	129.0	x	102.3	x	316.6	x
2010	166.3	3.2	143.6	11.3	121.5	18.8	339.9	7.4
2011	184.1	10.7	152.3	6.0	133.7	10.0	356.0	4.7
2012	195.6	6.3	156.5	2.8	142.0	6.2	359.4	0.9
2013	200.4	2.4	165.8	6.0	151.2	6.4	368.4	2.5
2014	207.6	3.6	164.3	-0.9	155.5	2.9	360.1	-2.2
Average tm (a), %	x	4.4	x	4.2	x	7.4	x	2.2

Source: authors' calculation based on EUROSTAT

Over a six-year period, the fastest increase was reported in Estonia where the UAA certified as organic rose, on average, by 7.4%, while in Latvia and Lithuania it increased by 4.4% and 4.2%, respectively. If analysing the data for 2014 in absolute terms, 207.6 thou ha were farmed organically in Latvia, which made up approximately 11% of the total UAA in the country. Of this area, 179 082 ha were certified as organic, more than 10 266 ha were in the transitional period and the transitional period was started for 14 095 ha. In the period 2009-2014, the average size of organic farms increased in Latvia and Lithuania, while in Estonia and, on average, in the entire EU both the number of organic farms and the certified UAA increased. In 2014 in the EU, an increase in the transitional period area in Greta Britain was the smallest, at 3.5%, while the most active engagement in the organic farming control system, in terms of area, was reported in Malta (49.7 %), Croatia (55.1%) and Bulgaria (68.3 %).

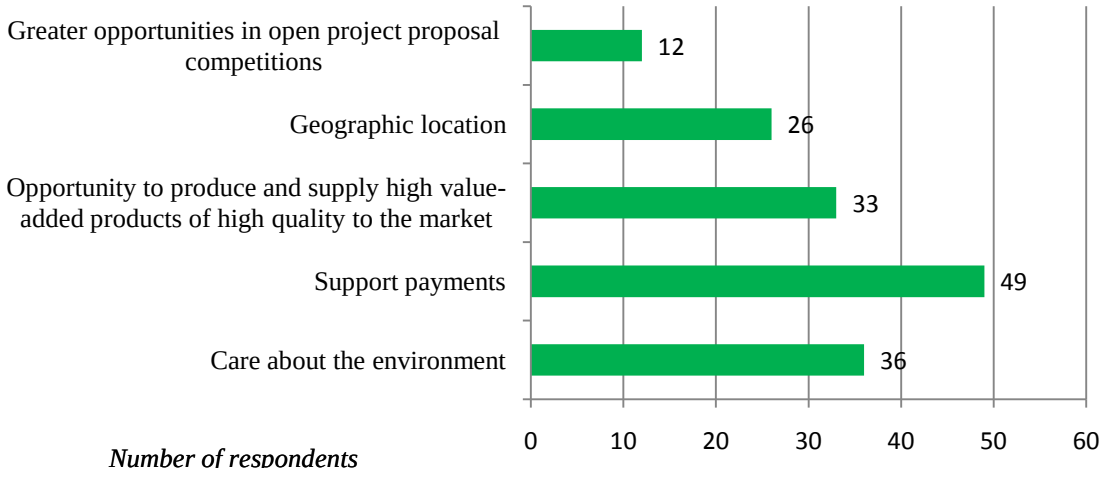
In the context of the EU, the most popular organic products were fresh fruits and vegetables, comprising about a fifth of the sales of organic products in Italy, Ireland, Norway, Sweden and Denmark. In the Nordic countries, the proportion of organic dairy products is high, while organic meat products are popular in Belgium, the Netherlands, Finland and France, accounting for about 10% of the total organic products. A significant market share of organic food in Croatia and France is represented by organic beverages, wine in particular, comprising more than 10% of the total wine market (Organic farming statistics..., 2015). In Latvia, grains, milk, potato and honey are the most produced organic products; if measured as a percentage of total output, honey with 13.6% is the most significant product produced organically.

The EU's organic farming system progresses, and it has to be noted that it takes place owing to significant financial assistance, which serves as a stimulus for farms to engage in this activity. As shown by also the authors' practical research on organic farms in Latvia, particularly the funding of the EU is an essential factor encouraging farmers to shift to the organic farming system. In this case, no

opinion prevails that organic farming is sustainable or that entrepreneurs wish to apply innovations and see their advantages.

5 Practical research results

The practical research employed a survey to identify the opinions and attitudes of entrepreneurs. The survey's participants were the owners of organic agricultural enterprises (farms) in Latvia. The survey included questions about business activity, obstacles to the introduction of innovations and the motivation to expand economic activity, information channels and cooperation with scientific research institutions and the innovations introduced over the last five years. The questionnaire survey was conducted from 2 February to 29 March 2016. The survey involved 83 respondents.



Source: data of the authors' 2016 survey

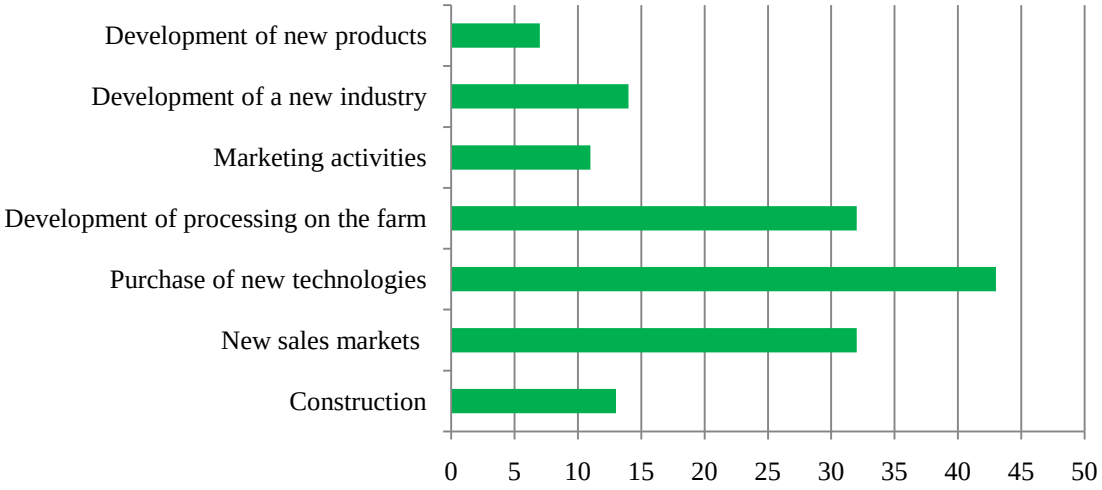
Figure 1. Factors determining the motivation of entrepreneurs to engage in the organic farming system

The motivation of entrepreneurs to employ environment-friendly techniques is determined by a set of several factors. The survey results presented in Figure 1 indicate that the opportunity to receive additional support payments was mentioned as the primary factor for engaging in organic farming by 59.03% or 49 respondents; besides, 43.37% referred to care about the environment and 39.75% or 33 respondents mentioned the opportunity to produce some niche products. The location of an enterprise and competitive advantages in open project proposal competitions to receive EU co-funding for business expansion were a less important factor.

In 68.67% instances, organic farms were family enterprises where no additional paid labour was used, and the annual turnover in the last financial year for more than half of the farms was less than EUR 15000.

The entrepreneurs themselves viewed the need for new technologies as the most efficient way of enhancing their economic performance indicators (Figure 2). It was a positive fact that relatively many – 32 respondents – thought that agricultural processing needed to be expanded and new sales markets

had to be sought for. Marketing activities and the development of new products were considered to be less effective ways, which indicated a low interest in cooperation with scientific research institutions.



Source: data of the authors' 2016 survey

Figure 2. Necessary innovations to be introduced at organic farming enterprises in Latvia

To find out whether the enterprises planned and implemented an innovation, investment in research and development by the farms in 2015 was employed as one of the indicators, see Table 3.

Table 3. Investment in research and development by organic farming enterprises in Latvia in 2015

Investment in research and development as % of net turnover in 2015	Investment in *development* by organic farming enterprises		Investment in *research* by organic farming enterprises	
	Number of respondents	as % of total respondents	Number of respondents	as % of the total respondents
0	6	7.23	76	91.57
0.01 - 5.00	16	19.28	7	8.43
5.01 - 10.00	52	62.65	0	0.00
10.01 - 15.00	9	10.84	0	0.00
more than 15.00	0	0.00	0	0.00

Source: data of the authors' 2016 survey

In 2015, investments in development activities were done by 92.77% of the enterprises surveyed. Only 7.23% said they did not make any investment in their economic activity. The proportion of the enterprises that invested their funds in development activities in the range from 5 to 10% of their 2015 net turnover was high (62.65%), while investments of more than 10% of the net turnover were done by 10.84% enterprises. Not a single entrepreneur made an investment of more than 15% of the disposable

funds. A considerably smaller number of the enterprises invested significantly less in research to create new jobs or to enhance their goods and services as well as in marketing activities or management techniques. Of the respondents, 91.57% mentioned that in recent years they did not invest in research, and only 8.43% said they invested up to 5% of their disposable funds in 2015. The key sources of finance, indicated by the entrepreneurs, for expanding their economic activity were their own capital (46.20%), while bank loans and leasing operations (16.6%), guarantees (4.10%) and EU structural funds (25.50%) were less popular sources.

The key activities aimed at acquiring knowledge, skills and competences, according to the entrepreneurs, involved reading magazines and using the Internet, followed by experience exchange trips to other organic farms, as well as quite a lot of them attended various seminars and courses. The entrepreneurs acquired less knowledge, skills and competences by attending exhibitions, visiting friends and acquaintances as well as by joining foundations and associations.

The present research also performed a dispersion analysis, which showed that the entrepreneurs with higher education, particularly higher agricultural education, introduced innovations more frequently and with pleasure than those with no such an education.

6 Conclusions

1. Organic farms may be considered to be an important participant of the economic system, which contributes to the national economy and sustainable agriculture that meets economic, human wellbeing and environmental requirements. In the EU Member States, organic farms are subsidised, which reduces the economic system's efficiency (if no spillover effects are taken into account); that is why it is important to work on innovations in the organic farming sector.
2. Under the organic farming system, innovations emerge from existing ideas, knowledge and resources in daily life when the manager of an organic farm enhances or transforms products, introduces new technologies and new marketing or sales techniques. In organic farming, it is difficult to identify innovations because in terms of their kind, they are imitative – an idea is new to the farmer, while it has been known to the society.
3. Farmers engage in the organic farming scheme mainly because it allows receiving additional support payments, which provides greater opportunities to develop their businesses. Cooperation with the science and research sector was regarded by 39.75% of the surveyed farmers in Latvia as important; yet, 48.19% of the respondents believed that the academic sector did not work on solutions to organic farming problems, and only 8.43% had cooperated with researchers and their cooperation was successful.
4. Organic farming offers profit-making opportunities for farmers, which is logical from the producer perspective; yet, the profit increase aspect should mainly involve the creation of new techniques, new technologies and new product distribution networks, in which scientists, researchers and also the public that shapes the demand for part of agricultural goods should be involved much more actively.

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CURRENT TENDENCIES IN THE DEVELOPMENT OF LATVIAN AGRICULTURAL FARMS AND GHG MITIGATION POSSIBILITIES

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Abstract: This paper aims to evaluate current development trendsin the development of Latvian agricultural holdings in the context of greenhouse gas mitigation possibilities. The study results show that the current trends in the agriculture of Latvia point to two very different courses of development in farming: on the one hand, agricultural intensification may be observed, as the largest farms concentrate agricultural production, and productivity increases, which promotes the production of higher value-added agricultural products. On the other hand, 90% of the total agricultural holdings are still small, which are inefficient from the economic perspective; yet, their existence and operation are important in the context of regional development. The segment of these farms is the one that develops organic and non-traditional farming as well as contributes to rural tourism in Latvia. Since 2006, along with an increase in economic activity, greenhouse gas emissions from Latvia's agricultural sector have tended to increase. In this paper authors have discussed options how to reduce direct nitrous oxideemissions from the use of nitrogenfertilisers' trough different GHG emission-reducing measures, like precision fertiliser application which is binding for intensive cereal farms; fertilisation planning and introduction of organic farming which are more binding for small farms.

Keywords*:*agriculture, greenhouse gas emissions, Latvia.

1 Introduction

Exploiting available natural resources is one of the most important objectivesto ensure economic growth inthe rural areasof Latvia.Farms of various types and sizes that produce food and non-food products to meet the market demand are involved in the exploitation of the resources. An analysis of the economic development processes taking place on agricultural holdings in Latvia shows that overall growth in the agricultural sector is ensured by increasing the exploitation of emission-intensive factors of production. Historically, economic growth in a market economy is calculated employing gross domestic product (GDP) as the key indicator. However, such an approach is not perfect if calculating growth in the agricultural sector, as it does not take into account environmental impacts caused by agricultural output growth. In a long-term, the economic growth model for the agricultural sector is not feasible if it is not in compliance with European Union (EU) Council Directive 2010/75/EU [1] that lays downrules on integrated prevention and control of greenhouse gas (GHG) pollution for the Member States and EU Council Directive 91/676/EEC[2] concerning the protection of waters against pollution caused by nitrates from agricultural sources.Farming very significantly affects carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions from soil. Every EU Member State is responsible for GHG and nitrate emissions from their agricultural sectors and has to introduce low-emission production technologies, thereby reducing the environmental impacts. Nutrient management is important in achieving these indicative targets. The key risks relate to the imprudent application of nitrogen fertilisers and decreases in organic carbon (organic substance) in soil.

Nitrogen is one of the key nutrients for crops. Nitrogen fertilisers largely contribute to agricultural output; consequently, their consumption tended to increase considerably. However, not all agricultural holdings assess the land resources being at their disposable and their soil use systems in terms of potential nitrogen use. According to research findings, nitrogen loss risks are the lowest for forest stands, whereas the highest risks are specific to intensive horticulture [3]. The latest research investigations relate to uses of papilionaceous plants for symbiotic nitrogen fixation. The production systems introduced allow adapting to the changing economic and financial situation through diversifying the assortment of products and the reduced application of artificial nitrogen fertilisers. Growing papilionaceous plants would reduce agricultural effects on the quality of the surrounding environment and on global climate change. According to research data, the dry matter of a tonne of white clover can fix 3-46 kg, while that of red clover – 24-36 kg of N [4; 5]. In Latvia, the most productive atmospheric nitrogen-fixing plants are hybrid alfalfa with a rate of even 433 kg ha^{-1} N [6]. Different emission-reducing measures have to be applied to every farm type in terms of size andspecialisation.

Such situation analysis set the aim for this study –to evaluate current development trends in the development of Latvian agricultural holdings in the context of greenhouse gas mitigation possibilities. To achieve the aim, two specific research tasks were set: 1) to analyse the main trends in the development of agricultural production and agricultural holdings in Latvia; 2) to evaluate the current situation in Latvia in the field of GHG emissions from agriculture. To achieve the set aim and tasks of the research, the authors have used the publications and studies of foreign and Latvian scientists, legislation, reports and recommendations. The research authors widely have applied generally accepted research methods in economics, i.e. monographic descriptive method as well as analysis and synthesis methods to study the problem elements.

2 Trends in the development of agricultural production and agricultural holdings in Latvia

The specifics of and trends in the agricultural sector are mainly determined by the value of output in crop and livestock farming (Figure 1).

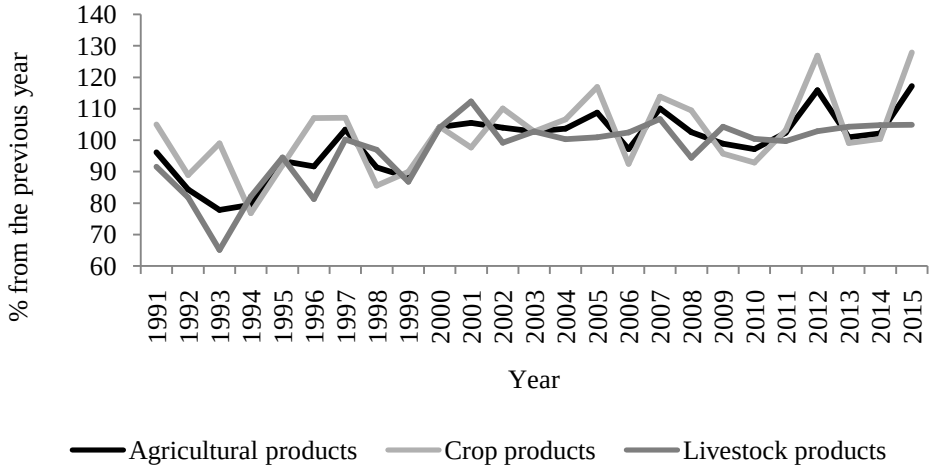

Figure 1.Changes in agricultural product indexes in Latvia (in constant prices) (% from the previous year) in the period 1991-2014 (Source: authors' construction based on[16])

An analysis of the changes in the agricultural product indexes (Figure 1) reveals that the output of agricultural products has constantly increased, and a decrease was observed only in a few years.

However, if analysed by agricultural industry, growth in crop farming was the fastest, while the output of livestock products grew,but at a considerably lower rate. The changes in the crop product index represent the years of good or poor harvests, for example, 2007 was a year of a good harvest and the year 2012 was a year of a record harvest. Overall, the changes in the crop product index allow concluding that the key factor influencing the output of crop products is weather conditions and their effect on the harvest, whereas economic shocks and the global crisis did not considerably affect this industry.

A slightly different situation is observed for the livestock industry that is much more sensitive to various economic shocks and therefore this industry grew at a lower rate. After the fast decrease in the output value of livestock products in the beginning of the 1990s, when the key reason was that the livestock industry lost the status of a priority agricultural industry owing to the collapse of the Soviet Union, the livestock industry has started growing faster and steadier only since the year 2000.

An analysis of changes in the area under key crops in Latvia for a longer period (Table 1) reveals that although the crop industry grew dynamically, yet, there are potential reserves for growth. If compared with 1938, the total sown area in 2014 comprised only 61.3% of the total area under crops in 1938.

Table 1. Changes in the area under key crops (thou. ha) in Latvia in the period 1938-2014

Crop	1938	1980	1990	1995	2000	2005	2010	2014	2014/2005, %
Total sown area	1877.4	1673.6	1627.0	930.2	881.1	999.6	1102.7	1150.5	115%
Cereals	1005.2	688.3	675.4	408.4	420.0	468.9	541.5	655.2	140%
Winter wheat	104.7	129.9	370.2	198.7	336.0	498.1	774.5	525.6	106%
Rye	365.0	129.2	323.6	71.3	110.7	87.2	69.4	114.3	131%
Barley	214.0	439.1	692.8	271.4	251.8	357.1	184	409.5	115%
Spring wheat	81.5	0.2	1.6	45	91.4	178.4	198.5	941.9	528%
Oats	433.2	96.4	176.1	73.2	79.6	122	100.6	155.1	127%
Rapeseed	0	0	1.9	1.1	6.9	71.4	110.6	100.1	140%
Sugar beet	13.2	13.0	14.7	9.5	12.7	13.5	0	0	0%
Potato	133.6	105.9	80.3	75.3	51.3	45.1	30.1	26.8	59%
Vegetables	12.9	15.3	10.8	17.5	9.7	12.9	8.1	8.2	64%
Flax	63.5	17.8	11.9	1.4	1.9	2.4	1.1	0.6	25%

Source: authors' calculations based on [16]

If analysing the key trends in crop production, one can find that considerable changes have occurred since Latvia joined the European Union. Over the last decade in Latvia, the area under cereals and rapeseed increased by 40%, whereas the area cropped with potato and vegetables decreased by 40%.

Such changes indicate that an increasing role in crop farming is played by intensive crops that are produced for export (wheat and rapeseed), while the proportion of produce grown for the domestic market declines. Such a trend allows assuming that Latvia's role in the supply of food to the world's population is going to increase over next years.

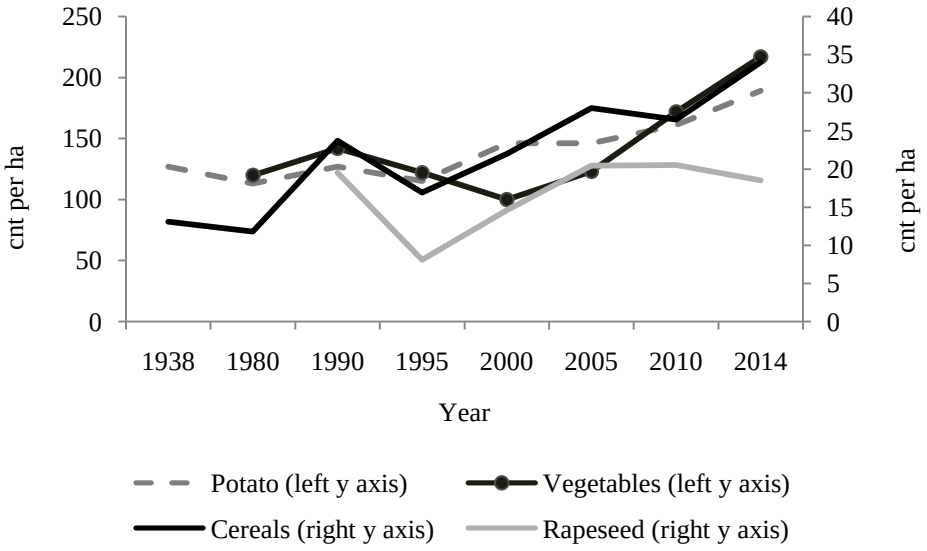

Figure 2.Changes in the yields of key crops (cnt per ha) in Latvia in the period 1938-2014 (Source: authors' calculations based on [16])

An important indicator, when analysing trends in the crop industry, is increase in the yields of key crops. The situation in Latvia shows that the yields of key crops – cereals, potato and vegetables – constantly rose, which indicates that crop farming got more efficient and intensive. The only crop, the yield of which did not increase over the last five years, was rapeseed (Figure 2).

Like in the crop industry, various structural changes were observed in the livestock industry as well. If comparing the numbers of livestock in 1938 and 2014, one can find that based on the changesinthe previous years, it is possible to considerably increase the number of livestock (Table 2).

Table 2.Changes in the number of livestock (thou.) in Latvia in the period 1938-2014

Agricultural animal	1938	1980	1990	1995	2000	2005	2010	2014	2014/2005, %
Cattle	1195	1427	1439	537	367	385	379	422	110%
incl. dairycows	856	580	535	292	204	185	164	166	90%
Pigs	797	1759	1401	553	393	428	390	349	82%
Sheep	1328	203	165	72	29	42	77	93	221%
Goats	0	6	5	9	10	15	13	12	80%
Horses	391	35	31	27	20	14	12	10	71%
Poultry	4287	11158	10321	4198	3105	4092	4949	4414	108%

Source: authors' calculations based on CSB data, 2015

An analysis of the changes in the numbers of livestock over the last decade reveals that the number of sheep rose the fastest – it more than doubled. The reason was EU and national financial assistance for sheep farming as well as greater opportunities for sales for this industry. The number of poultry rose by 8%; their raising is concentrated on a few large farms for poultry fattening and egg

production. The number of cattle increased by 10%; yet, only the number of meat cattle rose, as the number of dairy cows constantly declined in Latvia. The numbers of pigs (18%) and goats (20%) also considerably decreased.

An analysis of the indicators of productivity for livestock (Figure 3) allows finding that the productivity in livestock farming also constantly increased. Only the average amount of wool per sheep remained at the same level – the level of 1940.

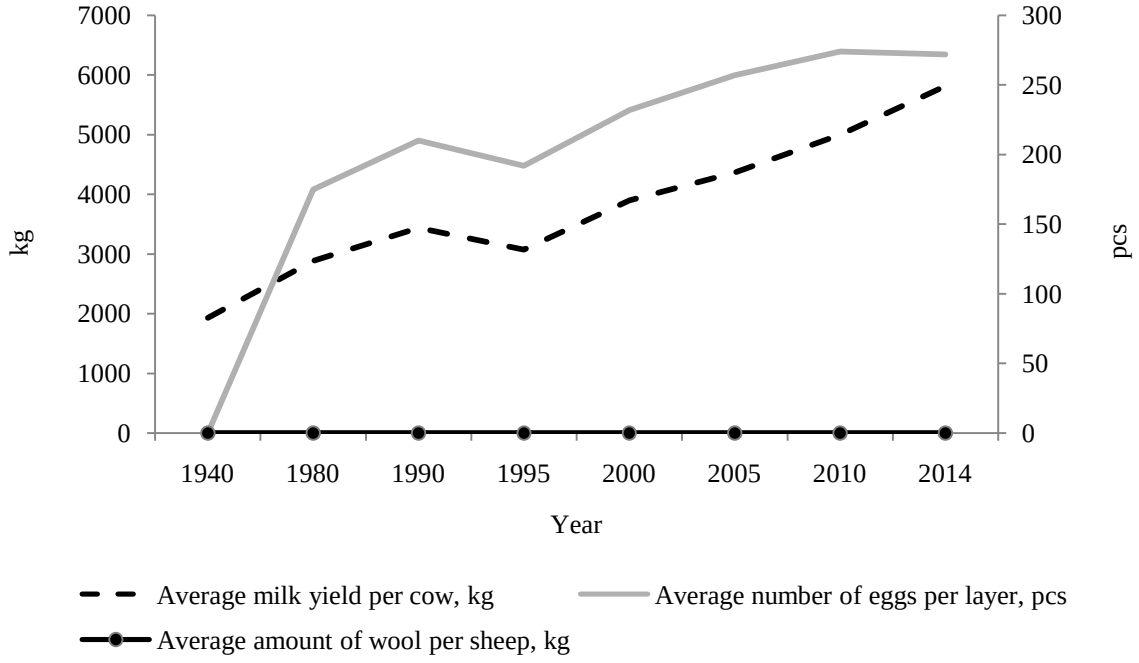

Figure 3.Changes in the productivity of livestock in Latvia in the period 1938-2014. (Source: authors' calculations based on CSB data, 2015)

Overall, the analysis of the agricultural indicators allows assuming that based on thepositive changes in agricultureand in view of one of the key challenges of the 21st century – the growing population and the increase in the demand for food –, such positive trends will continue in the future.

As the number of farms decreased, changes took place in their distribution by economic size. The greatest change in the number was reported for small farms whose standard output was less than EUR 14.9 thou. In 2013 compared with 2005, the number of farms in this farm group decreased by 44%. However, completely opposite changes were observed for the group of large farms with a standard output of more than EUR 100 thou. per year – in 2013 their number was 1 439, which was 5 times more than in 2005.

The data of Table 3 shows a very positive trend towards efficient agricultural production, which is based on progress in farm concentration and specialisation. An increasing share of the utilized agricultural area (UAA) is managed by commercial and specialised farms with a standard output of more than EUR 100 thou., which is ensured by a steady increase in the number of such farms.

Table 3.Distribution of agricultural holdings and their UAA (thou. ha) by economic size (standard output, thou. EUR) in Latviain 2005 and 2013

Standardoutput (SO), thou. EUR	2005		2013		Change, %	
	Number	UAAthou. ha	Number	UAAthou. ha	Number	UAA
Less than 14.9	131237	1204.7	73603	683	-44	-43
15.0–99.9	1521	289.6	6754	471.4	344	63
More than 100	247	210.9	1439	723.3	483	129
Total	133005	1705.2	81796	1877.7	-38	10

Source: authors' calculations based on [17]

The analysis of such a situation allows finding that the current trends in the agriculture of Latvia highlight two very diverse farming development directions:

- on the one hand, agricultural intensification is taking place, as agricultural production is being concentrated on farms of increasing size, and their productivity is rising, which contribute to the production of higher value-added agricultural products. This ensures that the industry's competitiveness enhances, incomes rise and economic growth in the nationally economy is positively affected;
- on the other hand, 90% of the total farms are still small (with a standard output of less than EUR 14.9 thou. per year) and inefficient from the economic perspective; yet, their existence and operation is important in the context of regional development. The segment of such farms is engaged in organic (about 5% of this type farms) and non-traditional farming as well as promotes rural tourism in Latvia, thereby contributing to the sustainable development of rural territories, the preservation of natural assets in rural areas and the creation of new jobs for rural residents.

Organic farming also features agricultural production concentration. In 2014, approximately 11% of the UAA was managed employing organic farming techniques, which was 3.6% more than in the previous year. Of this area, 179 082 ha were certified as organic farmland, more than 10 266 ha were in transition to organic production and the period of transition to organic was started for an area of 14 095 ha. The number of enterprises certified as organic was steady over the last five years; at the end of 2014, the number of such farms was 3477, and their average size increased from 46 ha in 2010 to 59 ha in 2014 [11]. After the United Nations Climate Change Conference was held in Paris at the end of 2015, Latvia joined France's initiative "4‰", the purpose of which was to increase the content of organic matter in soil and contribute to the accumulation of carbon in the soil through agricultural practices that are appropriate for local conditions from the economic, environmental and social aspects [9]. In this respect, an increase in the area farmed organically is a good opportunity to achieve the objective.

3 The current situation in Latvia in the field of GHG emissions from agriculture

Climate change brings challenges and changes that are important for agricultural production both in Latvia and in the entire world. After regaining its independence, Latvia has been actively involved in reducing global climate change. The Parliament of the Republic of Latvia ratified the UN Framework Convention on Climate Change in 1995 and the Kyoto Protocol in 2002, which Latvia's participation in the reduction of climate change is based on. According to the Kyoto Protocol, Latvia individually or in

joint efforts with other countries had to reduce GHG emissions by 8% in the period 2008-2012 from the level of GHG emissions in 1990. This target has been successfully reached by Latvia. However, since 2006, along with an increase in economic activity, GHG emissions from Latvia's agricultural sector have tended to increase; besides, the agricultural sector is the second largest source of GHG emissions, accounting for 21.5% of the total GHG emissions in the country (Figure 4). Such changes in GHG emissions from agriculture in Latvia indicate that without additional measures Latvia cannot reach its GHG emission targets set internationally.

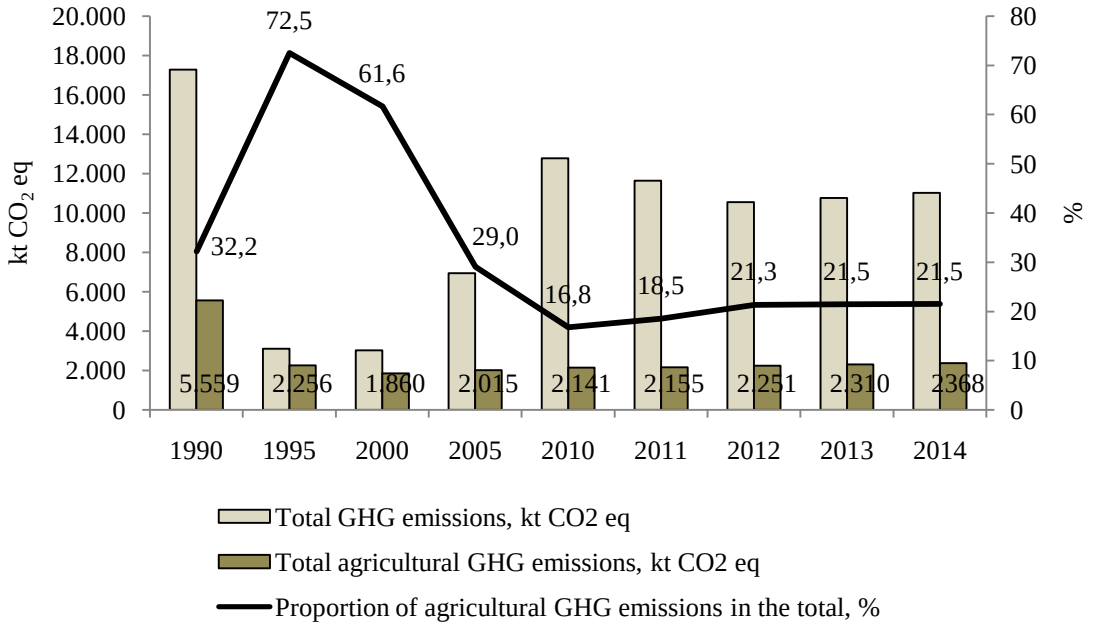

Figure 4. Changes in the total and agricultural GHG emissions in Latvia in 1990-2014 (kt CO_{2eq}) (Source: authors' construction based on [18])

To identify appropriate GHG emission-reducing measures to be introduced in Latvia's agriculture, it is important to determine the key sources of GHG emissions from agriculture in Latvia. According to Latvia's National Inventory Report (hereinafter the NIR), the main sources of GHG emissions from the agricultural sector are as follows: 1) UAA tillage and nitrous oxide (N_2O) emissions from soil; 2) ruminant digestive tracts, as methane (CH4) is produced in the fermentation process; 3) manure management, which produces methane (CH4) and nitrous oxide (N2O) (Table 4).

Table 4.Percentage distribution of GHG emissions by source in Latvia in 1990-2014

Source of GHG emissions	1990	1995	2000	2005	2010	2011	2012	2013	2014
Internal fermentation (CH_4)	41.1	44.0	38.9	36.7	35.0	35.0	34.5	34.8	34.9
Manure management (CH_4)	7.4	7.3	6.1	6.2	6.2	6.1	5.9	5.9	5.7
Manure management (N_2O)	5.5	5.9	5.5	5.3	4.9	4.8	4.7	4.8	4.8
Agricultural soils (N_2O)	39.3	42.8	49.2	51.7	53.7	53.5	54.1	53.7	53.6
Liming (CO_2)	6.7	0.1	0.3	0.1	0.1	0.4	0.5	0.6	0.8
Use of carbamide (CO_2)	7.7	0.7	0.1	0.1	0.2	0.2	0.3	0.2	0.2

Source: authors' calculations based on [18]

In Latvia, the key source of GHG emissions is direct N_2O emissions from soil – in 2014, it comprised 53.6% of the total agricultural emissions. The key sources of N_2O emissions are as follows: ameliorated organic soils; synthetic N fertilisers (nitrogen), organic N fertiliser (for example, manure, compost, sewage sludge), N excreted by animals in pastures or pens, N accumulated in crop residues and integrated into soil in the field (green manure, crop residues etc.). The distribution of the sources and changes in the distribution over the last 25 years are presented in Figure 5.

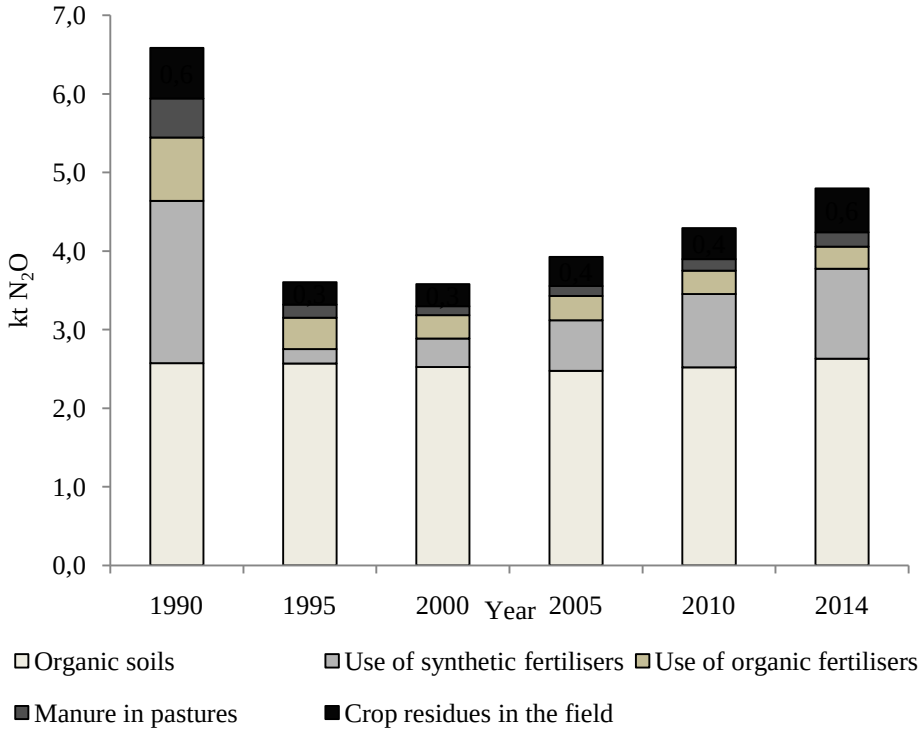

Figure 5. Distribution of direct N_2O emissions from agricultural soils in Latvia in 1990-2014 (kt N_2O) (Source: authors' construction based on [18])

According to Latvia's NIR data, in 2014 direct N_2O emissions from organic soils accounted for 55% and direct N_2O emissions from N fertilisers comprised 24% of the total N_2O emissions. The direct N_2O emissions from N fertilisers rose by 8% in the period 2005-2014. The use of N is essential in the production of crops. Agricultural production trends in Latvia allow forecasting that the use of N fertilisers is going to increase in the future too, which unfortunately creates negative external effects, i.e. N_2O emissions.

A detailed analysis of the crop industry reveals that the use of the UAA is intensified particularly for the purpose of grain production. In the period 2009-2014, the use of N fertilisers for grain production increased the fastest, reaching 57.9 thou. t per year (Table 5). In the same period, the area of grain, the production of which consumes N fertilisers, increased from 394.3 thou. ha to 511.7 thou. ha.

Table 5. Distribution of the amount of N fertilisers consumed in Latvia by crop in 2009-2014 (thou. t, calculated in terms of 100% crop nutrients)

Crop	2009	2010	2011	2012	2013	2014	2009/2014, %
Grains	37.9	41.5	41.7	46.6	49.1	57.9	+53
Potato	0.9	0.7	0.9	0.8	0.8	0.8	-
Industrial crops (rapeseed)	8.2	12.4	12.4	12.7	15.1	10.5	+28
Open field vegetables	0.4	0.3	0.4	0.3	0.3	0.3	-
Forage crops	4.5	3.9	4.0	4.5	4.0	3.1	-32
Total	51.9	58.8	59.4	64.9	69.3	72.6	+40

Source: authors' calculations based on CSB data

An analysis of the current situation regarding GHG emissions from agriculture allows concluding that in examining the potential for the reduction of GHG emissions from agriculture in Latvia, the key focus has to be placed on the GHG emission-reducing measures that decrease: 1) direct N_2O emissions from the use of N fertilisers; 2) direct N_2O emissions from organic soils; 3) CH_4 produced in the internal fermentation process. Further authors have discussed one of these options –reducing direct N_2O emissions from the use of N fertilisers – trough different GHG emission-reducing measures, like precision fertiliser application which is binding for intensive cereal farms; fertilisation planning and introduction of organic farming which are binding for small farms.

4 Discussion

Nitrogen (N), to a great extent, is the determinant factor for crop yields; at the same time, the imprudent and excessive application of it significantly harms the environment. In many countries scientists have made a great number of research investigations into the effective use of nitrogen. In the scientific literature [20; 21; 22] there can be found various examples of best practices for N management, like choosing of the highest-yielding variety appropriate to maximize the use of the available nutrients; maintaining a green cover as much as is practicable to retain N; making regular soil analyses for pH, P, K and Mg and possibly trace elements; using lime to maintain the appropriate pH for optimum nutrient supply; calculating fertilizer requirements using a recommendation system; avoiding unnecessary autumn and early spring applications of N; applying fertilizers and manures evenly, and well away from watercourses, with a properly calibrated spreader. However, taking into account the current development trends of Latvian agricultural farms in this paper authors have discussed on few of these listed measures.

Nowadays, technologies allow combining precision agricultural technologies and the application of fertilisers. The application effectiveness of plant nutrients can be increased if using a GPS-controlled precision fertiliser application system. Precision fertiliser application is a set of concerted activities that involve the use of the newest technologies (the GPS, the GIS, sensors, software, applications, specially equipped fertiliser spreaders, etc.) in planning fertiliser application rates and in fertiliser spreading. The key advantages are associated with: increase in crop output is provided through variable fertiliser application rates; financial savings, as field areas with sufficient crop nutrients are not over-fertilised; environment-friendly practices, as the fertiliser crops are not able to absorb does not produce N_2O emissions that are released into the environment. If introducing this measure, fertiliser savings can reach 15-80% [10; 19].However, main target group for the introduction of this measure is crop farms with an UAA of more than 200 ha as measure is cost intensive.

Another aspect of effective use of nitrogen is application of the appropriate type and amount fertilizer that will give to agriculture farmer a more reasonable chance to obtain the desired crop yield. For cereal production under the conventional farming system, the production of synthetic pesticides and fertilisers, nitrogen in particular, and, at a smaller extent, phosphorous and potassium accounts for, on average, 37% of the total energy consumed. If using a large amount of synthetic nitrogen fertilisers in cereal production, about half of the total energy consumed (directly and indirectly) relates to the nitrogen fertilisers. For comparison, organic farming in which the sources of nitrogen involve manure, legumes and other natural sources of nitrogen, the consumption of energy, according to scientists, is lower two times [15]. For this reason, an urgent problem in the conventional farming system is the effective use of nitrogen. According to research studies conducted in Latvia, winter wheat yields considerably rose at the nitrogen (N) application rates of up to 150 kg ha^{-1}, while a rate of more than 150 kg ha^{-1} ensured the yields ranging from 4.67 to 5.20 t ha^{-1}, as well as high quality grain. The highest gross profit at EUR 626.11 ha^{-1} was made at a nitrogen application rate of 187 kg ha^{-1}, which resulted in the highest cereal yield [14].Current agricultural practice in Latvia shows that those farmers who don't implement fertilisation planning usually are guided by maximum permissible amount of nitrogen, which may be used for crops. However, it has been scientifically proved that in some cases current fertilizer recommendations, which are based on the grower's yield expectation, can lead to significant errors in N management practice. For example, current Finnish N-fertilizer recommendations are uneconomically high for poorly responsive fields, where N input can be reduced by 20–75 kg ha^{-1} without economic loss to agriculture. Such improved practices could reduce N balances by 10–40 kg ha^{-1} $year^{-1}$. In contrast, the current recommendations may be uneconomically low for highly responsive fields, thus leading to economic losses for the growers [22].Target group for the introduction of the measureis small and medium farms.

Another topical issue in Latvia is development of organic farms, which forms about 5% from small farms. According to scientific findings [13] very important issue energy consumption through the use of fertilisers accounted for anywhere from 25-68% of total energy use depending on the type of crop and growing conditions. Energy consumption and GHG emissions per hectare were lower for organic farms than conventional ones, particularly in dairy farming. The consumption of energy per Mg of milk produced by and GHG emissions from organic farms accounted for 80% and 90%, respectively, of the rates forconventional farms. In organic farming if measured per Mg of produce, the input of energy was 5-40% lower, while GHG emissions were 7-17% greater than those in conventional farming. The performance results indicate that organic dairy farming is more environment friendly and resource efficient than crop farming [6]. The performance results are influenced by grazing intensity, grazing livestock density and grass regrowth frequency. However, there are large differences among crops. Emissions from a few crops grown organically are lower than those from the crops grown conventionally (sugar beet, peas and beans), whereas the emissions from other crops are higher (leeks, carrots, wheat). Overall, the GHG emissions are higher for legumes and other crops that require nutrients in greater quantities [6]. According to research results, there are less nutrient residuesfrom organic farming systems, which reduce the risk of water and air pollution. The most important factors contributing to the reduction is the lower livestock density per hectare and the prohibited use of synthetic fertilisers. Economically the opportunity cost (the cost to produce nitrogen on-farm) of nitrogen on organic farms can amount to from seven to sixteen times the cost of mineral N-fertilisers. Avoiding non-productive nitrogen losses is of special economic interest for organic farmers. As far as nutrient deficiencies are concerned, medium term effects of non-balanced inputs and outputs are likely to take the form of a reduction in economic performance rather than environmental detriment [6]. Reducing the dependence of agricultural systems on non-renewable energy resources involves two

aspects: renewable energy sources have to be used instead of fossil energy resources and the negative effects of energy consumption on greenhouse gas emissions have to be decreased. Farming is unique not only because it produces GHG emissions by consuming energy but also because it absorbs theemissions produced, thus reducing the environmental effect. Carbon emitted from soil in the form of carbon dioxide is absorbed by plants, forming the biomass of the plants and organic matter in the soil. Organic farms have greater potential to absorb carbon in the biomass and soil than conventional farms, especially those organic farms whose fields are covered with green crops, that have established pastures, permanent green hedges and buffer areas and that use manure, composts and crop residues to maintain their soil fertility [15].Overall, organic farming consumes 30-50% less energy to produce agricultural products than conventional one. Although organic farming is, on average, more efficient in terms of energy consumption, it, however, indirectly more frequently needs more other resources, for example, more human work by approximately a third. Technological progress increases the use of fertilisers and other chemicals in agriculture, and their application techniques involve greater precision. The production of agricultural products can often be inconsistentwith organic farming practices, and to reduce emissions of gases causing the greenhouse effect, an increasing area of agricultural land is exploited to grow bioenergy crops by environment-friendly techniques.Organic production might be a way how to reasonably balance energy efficiency with economic and environmental factors at all the stages from production to consumption, which, in the result, will determine the social and financial viability of it based on energy-saving practices [15].

5 Conclusions

1. Over the last decade Latvian agriculture has experienced considerable growth and the following structural changes:
   - an increasing role in crop farming is played by intensive crops that are produced for export (wheat and rapeseed), while the proportion of produce grown for the domestic market declines;
   - changes in the number of livestock are highly dependent on livestock category: positive trends can be observed in the increasing number of beef cattle, sheeps and poultry; but negative – in decreasing number of dairy cattle, pigs, goat and horses;
   - the yields of key crops – cereals, potato and vegetables – and key livestock products – milk, eggs –constantly rose, which indicates that agriculture got more efficient and intensive;
   - on the one hand, agricultural intensification is taking place, as agricultural production is being concentrated on farms of increasing size, and their productivity is rising, which contribute to the production of higher value-added agricultural products; on the other hand, 90% of the total farms are still small and inefficient from the economic perspective, but they are regionally important as they are engaged in organic (about 5% of this type farms) and non-traditional farming as well as promotes rural tourism in Latvia.
2. Along with an increase in economic activity, GHG emissions from Latvia's agricultural sector have tended to increase and currently agricultural sector is the second largest source of GHG emissions, accounting for 21.5% of the total GHG emissions in the country. Such changes indicate that without additional measures Latvia cannot reach its GHG emission targets set internationally. In examining the potential for the reduction of GHG emissions from agriculture in Latvia, the key focus has to be placed on the GHG emission-reducing measures that decrease: direct N_2O emissions from the use of N fertilisers; direct N_2O emissions from organic soils; direct CH_4emissions produced in the internal fermentation process.
3. Reduction of direct N_2O emissions from the use of N fertiliserscan be acheived through best practices for N management. Taking into account the current development trends of Latvian

agricultural farms authors reveal that special focus should be paid on such N_2O emission-reducing measures as precision fertiliser application which is binding for intensive cereal farms; and implementation of fertilisation planning which is binding for small farms; as well as development of organic farming.

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CONSUMER BEHAVIOR AND PERCEPTION ON THE RENEWABLE ENERGY INSTALMENTS. CASE STUDY: WIND ENERGY IN ROMANIA AND THE NETHERLANDS

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Abstract: As the renewable energy development is facing challenges on a global level from the technological, political and social point of view, being a necessary element for a sustainable future, a new issue for green energy producers has emerged, namely the consumer behavior and the acceptance degree of renewable energy instalments. In the wind energy sector, this issue is becoming more visible as wind energy instalments are becoming a permanent part of the natural landscape for humans, in small countries with a broad expansion of wind turbines, such as the Netherlands being a current problem of the producers in the sector.

By using the Delphi method, the current paper analyses consumer behavior and perception on wind energy instalments in the Netherlands and Romania. The paper reveals the importance of the visual elements of wind parks in landscapes, as well as the benefits offered by wind energy producers, factors causing a better acceptance of the new technological elements in the human habitat.

The relevance of the present study consists in a current perspective on the issue of consumer behavior of renewable energy, namely wind energy, that represents a current subject in the political and economic debates in several countries throughout the European Union and globally.

Keywords: wind energy, consumer behavior, perception, wind turbines

1 Introduction

The implementation of new renewable energy facilities as wind instalments is a priority objective for the European Union that fixed significant targets for reducing the greenhouse gas emissions by 80% before 2050 below 1990 level [1] but also for other countries that have to deal with the transition from conventional energy sources to new energy structures where the renewable energy will play a more and more important role.

Renewable energy development is facing challenges on a global level from the technological, political and social point of view, being a necessary element for a sustainable future, a new issue for green energy producers has emerged, namely the consumer behavior and the acceptance degree of renewable energy instalments.

The research area of wind energy and wind energy instalments is a research area of large interest in the last decade.

The aim of this paper is to identify and examine the consumer behavior and perception closed to wind energy instalments. To create successful wind energy parks must be understood the consumer perception and behavior on wind energy instalments.

In the wind energy sector, this issue is becoming more visible as wind energy instalments are becoming a permanent part of the natural landscape for humans, in small countries with a broad

expansion of wind turbines, such as the Netherlands being a current problem of the producers in the sector.

Many peoples are willing to promote good environment intentions but in the real life this is not direct implemented as an environmental friendly consuming or behavior. The discrepancy between intentions and current activity is known as the "attitude behavior gap" [2,3].

It is important to find the real consumer behavior in order to have a better understanding on the energy strategy, on the environmental protection strategy and on the future life conditions. In addition green energy is associated with dynamic and modern lifestyle of customers [4].

2 Consumer behavior in the renewable energy field

Consumer behavior is a subject that faced many analysis in many fields of interests. A main approach to analyze the consumer behavior is based on the theory of planned behavior [5,6].These theory has it s roots in the theory of reasoned action [7] that integrate psychological and sociological elements to predict and influence the consumer behavior. These theories explain and recognize the influence of norms and attitudes on behavior of persons.

The structure of planned consumer behavior reflect three main elements as attitude, subjective norm and the perception behavior control. The attitude toward behavior is measured by the degree to which the consumer has a favorable or unfavorable evaluation of it's behavior [8]. When the attitude toward the behavior of a consumer is favorable he will perform a specific behavior. The subjective norm represent a perceived social pressure, as an opinion of other persons, to realize or not the specific behavior. The perceived behavioral control is the individual perception regarding a specific behavior. The perceived behavior is used by Bamberg [9] by analyzing the environmental friendly behavior.

There are few research studies regarding consumer behavior in the renewable energy field and these are focused on the customers willing to pay for renewable energy [10]. Also, these researches determined that peoples which consume energy from renewable sources are more concerned about environment and environment protection than other persons [11]. Unfortunately the NREL Study indicate that the consumers that are willing to pay more for renewable energy is reduced in the last years [12].

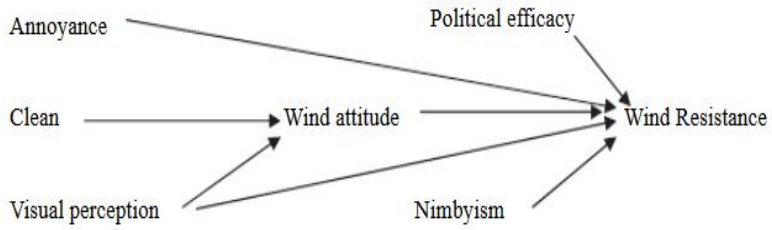

Figure 1. Wolsink model causal factors for wind turbines resistance (Devine-Wright, 2005)

Devine-Wright mentions in his study [13], on the other hand, the causal factors of Wolsink model for the resistance towards wind turbines placement, the NIMBY (not in my back yard) phenomena, that is becoming more frequent as wind turbines are expanding closer to residential areas, thus being another issue of the current consumer behavior towards renewable energy producers (as shown in Figure 1).

These factors relate especially to the visual perception of wind turbines, such as colors, height, placement and distance from specific residential areas, but also regarding annoyance such as landscape damage, noise, shadow flickering, but that can be balanced through the benefit element of clean energy, that is favorable for the environment and health of people.

The research regarding the theory of planned behavioral was applied for energy efficient products that enable permit the estimation of the consumer behavior [14].

The main studies regarding consumer behavior close to the environmental protection are analyzing the key factors that influence the consumer proenvironmental behavior [15]. Furthermore the theory of planned behavior support studies on the pro-environmental behavior in connection with the age of the consumers [16]. Based on the study coordinated by Kikuki-Uehana [17] in Japan the environmental perception and the trust in environmental information are factors that influence the proenvironmental behavior. A good and real environmental information can change the people behavior [18] by promoting the environmental sustainability. Closed to this subject, another major research topic in this field is dedicated to the influence of environmental perception on behavior of consumers and is analysed in different studies [19,20].

Therefore, our research attempts to understand the consumer attitude and behavior toward wind energy instalments in Romania and Netherlands. This will help policy makers but also regional leaders to develop sustainable communications and development strategies specific to the local groups.

3 Methodology

In order to gain a practical perspective of consumer perceptions and behavior towards wind parks instalments in the two selected regions, we have used questionnaires and interviews, that followed the Delphi procedure with two phases. The first step of the procedure was to define the subject to be inquired, then the preparations of the questionnaires, selection and acceptance of the participants, the first round of interviews and questionnaires, informing participants about the results of the first phase and finally the second round of interviews and informing the participants on the results. The final data analysis was included in a Delphi report, that was used for the current paper.

For the study a sample of 30 citizens from Romania and 20 citizens from the Netherlands accepted to take part into the current questioning.

The respondents, who accepted to take part on our study were classified mainly based on age and on the fact that they owned or not their own property, two factors that influence the reaction towards wind energy and wind turbines. The Romanian citizens, that responded to the inquiry were mainly between the ages 20-40: 23% were between 20 and 30 years old, while 33% had an age of 31-40 years. 20% of the Romanian participants were 40-50 years old, while 17% were 60-70 years old. The rest of the respondents had an age of 70-85 years old, respectively: 1 person of 70 years and 1 person of 81 years. Half of the Dutch respondents had an age between 20-30 years old (50%), 10% had an age of 30-40 years, 25% were between 50-60 years old, 5% of the participants were 16 years old, another 5% were between 60-70 years old and the rest between 40-50 years old.

Only 13% of the Romanian participants did not own their house or apartment, thus renting, while the others owned their own apartment or house. Half of the Dutch participants on the other hand did not own their own apartment or house, but rented. 1 person was staying with their parents, but was a student, while 45% owned their own apartment. This aspect was included in the analysis, because age

and the sense of property might impact the acceptance of wind turbines in natural or residential landscapes based on openness towards new technologies and the need for green energy, but also based on the own property value that could be affected by the presence of wind parks.

The interviews and questionnaires referred to multiple questions regarding: influence of visual, environmental and impact on property value of the wind turbines in Romania and the Netherlands, existence or absence of protests against these technological elements in natural landscapes, orientation of respondents towards having a participation or investment in the renewable energy field.

Therefore, the two hypothesis of the study were:

H1: The respondents, that own their own property believe there is a lower tendency towards accepting the presence of wind turbines close to residential areas comparing to the citizens that rent or do not own their own property due to the fact that wind turbines can decrease property value.

H2: The majority of the Dutch and Romanian responding citizens are willing to invest in wind turbines on their own property for producing renewable energy for the future.

The questioning time span occurred between 1st October 2014- 30th July 2016.

4 Findings and results analysis

The first inquired aspect was the influence on reaction towards wind turbine presence close to residential areas. When the respondents were asked if they believe this aspect would have a high impact on reaction towards wind turbines, 63% of the Romanian citizens and 85% of the Dutch citizens said it would have a high impact as shown in Figure 1, especially in the sense of lowering acceptance of such wind turbines close to residential areas due to the fact they decrease property value because of noise, visual damage of landscape, etc. 80% of the Dutch respondents not owning their own apartment or house said this aspect would have a high impact on the reaction towards wind turbines close to residential areas, while the rest mentioned an average impact. 89% of the Dutch citizens owning their property also mentioned it would have a high impact and also the student living with parents, while the 11% also owning their own property mentioned a high impact.

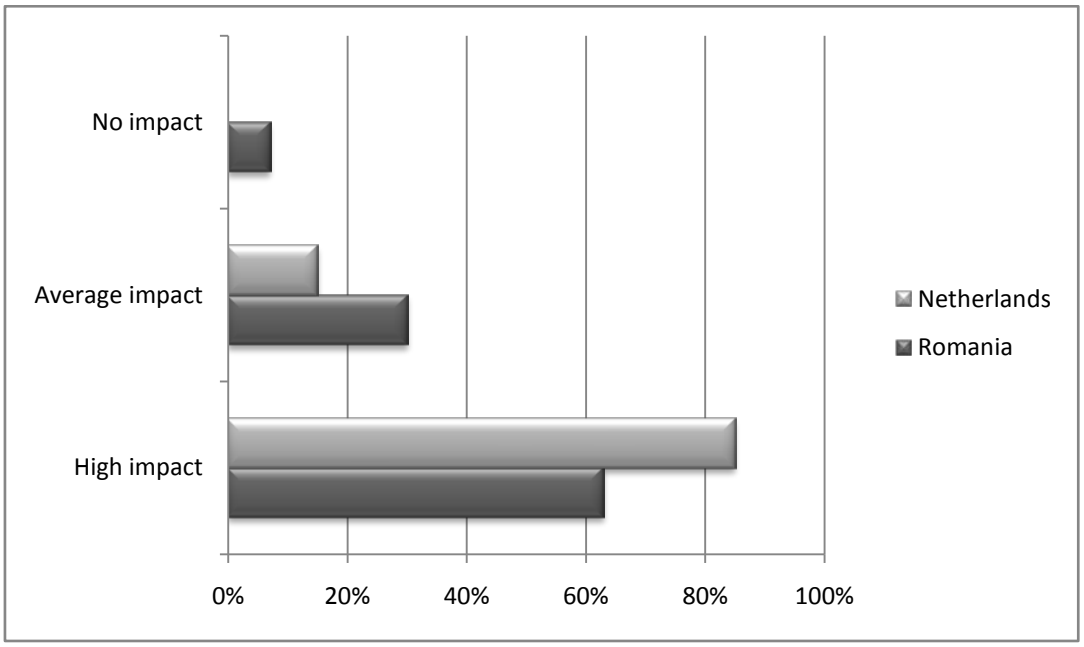

Figure 2. Perception of Dutch and Romanian respondents regarding impact on property value on reaction towards wind turbines, such as value decrease of property reducing the acceptance of wind turbines close to residential areas (Source: Authors' own research)

As mentioned in the methodology, only 4 of the Romanian citizens did not own their own apartment, and half of these mentioned a high impact while the other ones mentioned an average impact. 65% of the Romanian respondents owning their own place mentioned a high impact, while 7% no impact and the rest an average impact. The next question referred to the impact of wind turbines on consumer perception regarding environmental damages produced through installation, expansion and maintenance of wind parks, such as cutting forests, trees, damaging fauna, etc. Each third of the Romanian respondents answered as follows: high impact (33%), average impact (34%) and no impact (33%). The majority of the Dutch citizens answered average impact (60%), while 30% believe there would be a high impact and the rest no impact. Shadow flickering was another debated aspect regarding the reaction towards wind installations and was classified mainly with an average impact on the acceptance of citizens by the majority of Romanian respondents (50%) and Dutch respondents (65%).

Regarding the visual elements of wind turbines, such as color of wind turbines, height and visibility of wind turbines 45% of the Dutch respondents and 37% of the Romanian respondents mentioned a high impact, while 57% of the Romanian respondents and 50% of the Dutch respondents mentioned an average impact. The rest of the respondents mentioned a low impact or no impact.

The visual element was an important factor, that was mentioned by the majority of the respondents, when debating about a higher acceptance of wind turbines in a landscape or residential area. Citizens mentioned lighter colors, such as white, grey, blue would be preferred, as well as turbines placed at a distance where they are not so visible from their own residential surface.

The second part of the research focused on respondents knowledge on protests against wind turbines, focus on renewable energy and impact of financial benefits on the acceptance of wind turbines.

When asked if they agree to the statement that ''in their region there were protest meetings with citizens against the placement of wind turbines'', 60% of the Romanian respondents answered ''No'', while the rest answered they do not know, while 55% of the Dutch citizens said ''Yes'' and 20% said No. The Dutch citizen offering a positive response were mainly living in Gelderland and Friesland. The rest of the Dutch citizens mentioned they do not know if there were such protests in their region.

The next statement referred to the existence of protests on social media, such as Facebook, Twitter, against wind turbines and renewable energy technology. It was denied by 55% of the Romanian respondents, while 33% of them do not know and 14% mentioned there were such protests. The Dutch confirmed these protests in a proportion of 55% and 35% said they do not know. Only 25% of the Dutch respondents mentioned there are no such protests.

The presence of protests of NGOs (non governmental organizations) in the renewable energy field was also questioned. Similarly, with the first inquired statement of the second part of the research, 60% of the Romanians denied there are such protests, while 40% of them said they do not know. In case of the Dutch participants 40% said there are no such protests, 25% said there are an 35% do not know of such protests.

The issue of media (such as articles, press releases, etc.) against wind turbines was not confirmed by the majority of Romanian citizens (53%), while the rest did not know what to answer. Half of the Dutch respondents mentioned there are such media releases, while 35% said they do no know. The rest of the Dutch participants did not know what to answer.

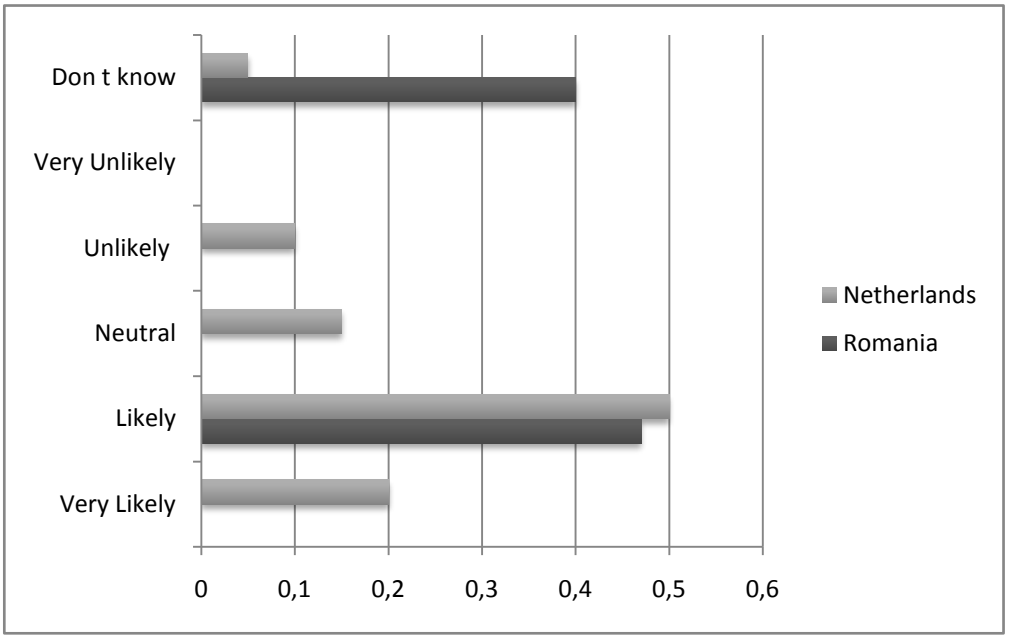

Figure 3. Perception of Dutch and Romanian respondents regarding the statement ''Wind energy projects provide important income for land owners'' (Source: Authors' own research)

Another aspect was that if respondents believed the wind energy projects provide important sources of income for land owners. The majority of the Romanian respondents believed it is ''Likely'' (47%), while a similar percentage (40%) mentioned they did not know anything about this situation, as

shown in Figure 2. On the other side, 50% of the Dutch respondents mentioned it is ''Likely'', 20% mentioned it is ''Very Likely'' and only 10% said it is ''Unlikely''. The Dutch citizens, who responded positively mentioned in the Netherlands it is likely or very likely citizens living close to wind turbines obtain an annual fix income, shares or compensation financial benefits for the disturbance wind turbines cause in the region. The Romanian citizens however mentioned they are not sure of exactly what benefits land owners get in Romania for the acceptance of such wind turbines in their residential areas.

The last two questions referred to the acceptance of wind turbines in their own residential area if respondents were offered shares within the wind energy company and orientation towards wind energy investment.

In the case of the first of the two questions both majority of Romanian (57%) and Dutch (65%) citizens mentioned a positive answer, namely they would accept wind turbines in their own areas in return for shares within the wind energy company. 30% of the Romanian citizens did not know if they would accept, while only 10% of the Dutch mentioned the same.

The Dutch citizens were more interested in the investment of wind turbines on their own property to produce renewable energy (60%) as compared to the Romanian citizens (30%), who were in a much lower proportion open to such an investment. The Romanian respondents mentioned financial reasons as being the main obstacle for the focus on such an investment. Another 30% of the Romanian citizens mentioned they would not have interest for such an investment, while the rest do not know. Only 30% of the Dutch respondents would not be interested for such an investment.

5 Conclusion

In conclusion, the first hypothesis, that we established in the methodology was not confirmed by the practical inquiry, respectively both respondents owning or not their own property believed there is a lower tendency towards accepting the presence of wind turbines close to residential areas due to the fact property value might decrease. This face was emphasized in similar proportions for respondents owning their own apartment or house or renting in comparison to the initial hypothesis, where we assumed the people renting their place would not think this aspect would have such a high impact on citizens reaction towards wind turbines. The second hypotheses, namely the majority of the responding citizens are willing to invest in wind turbines on their own property for producing renewable energy for the future, was confirmed in the case of the Dutch citizens. The majority of the Dutch citizens (60%) would be willing for such an investment, while only 30% of the Romanian respondents would be willing for such an investment. As mentioned before, these percentages were also explained by financial potential, that is lower in the case of Romanian respondents according to them.

The consumer behavior is slowly moving towards the direction of accepting the need of renewable energy considering the major environmental and economic changes, that impose new requirements on all levels considering, sustainability and sustainable technology for environmental preserving. Although there is a global effort towards rapidly implementing modern installations to sustain green energy, the modern technologies have started to interfere with the everyday living environment of humans causing negative reactions often against this disturbance to the natural environment, such as in the case of the Netherlands, that does not dispose of a vast surface such as in the case of Romania, but has a developed network of wind energy installations over the majority of the surface.

While in this study the majority of the Romanian and Dutch respondents showed interest in the renewable energy field, namely the wind energy, many of them consider the financial factor, such as for example the cost of an investment on wind turbines on their own property or gaining financial benefits from the renewable energy producer installing wind turbines on their own property, essential factors, that could lead to a higher or lower focus on the development of such a sustainable energy system.

In the case of the Dutch respondents, the vast majority were well informed about the situation of wind energy development of their country and mentioned this is also due to the fact that wind turbines are present in various regions, their presence being unavoidable, while in Romania citizens mentioned they had some information there are wind turbines in the country however these do not interfere with residential areas in many regions and are situated in further areas than their own residential surface.

As a future objective of the present study, we intend to expand this research in Romania, the Netherlands, as well as in Germany for the upcoming years, in order to analyze the future development of consumer behavior and perception on the wind energy field, depending on the size of wind parks and their proximity to residential areas or natural landscapes.

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COMPARISON OF LIFE CYCLE ASSESSMENT TOOLS: SIMAPRO AND OPENLCA

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Abstract: Nowadays, software tools are inevitable for performing life cycle assessment and computing the environmental impacts from products and processes. Among numerous modern software tools, SimaPro and openLCA are the most used and the leading ones. This research investigates the differences between the SimaPro and openLCA results in case where products are analysed with the same life cycle inventory database and life cycle impact assessment method. Result ratio was introduced in order to compare the differences between the life cycle assessment results obtained by the two software tools. The comparison was conducted on illustrative example and result ratio showed that in many cases results are identical, but in some cases the results reveal notable differences. SimaPro and openLCA users often use only one of these tools, without comparing the results obtained with other software tools. This research showed that the results of analyses obtained by SimaPro and openLCA are same or very similar within the majority of impact categories if the same assessment method is applied. However, some impact category results had significant differences and software users should be aware of this issue.

Keywords*:* SimaPro, openLCA, life cycle assessment, software

1 Introduction

Life cycle assessment (LCA) is a comprehensive tool for evaluation of environmental impacts in all product and process life cycle stages [1]. While there are many LCA software tools, some of the well-known and most used software tools for LCA are: SimaPro [2], GaBi [3], Umberto [4], openLCA [5], and COMPASS [6]. According to review made by Speck et al. [7] when it comes to extent which LCA software is being used for research, SimaPro and GaBi stand out from the rest. Speck et al. [7] review was conducted on three LCA journals: Packaging Technology and Science, Journal of Industrial Ecology, and International Journal of Life Cycle Assessment, published from 2010 to 2013 and covering 164 articles (Figure 1). List of over 50 LCA software tools can be found on web page of the European Commission's Joint Research Centre [8], while the short review of over 20 LCA tools is provided by Lehtinen et al. [9]. The comparative assessment of SimaPro and GaBi was carried out by Hermman and Moltesen [10]. They compared the software performances on a random sample of 100 unit processes from a life cycle inventory (LCI) database. The results were identical in many cases

between SimaPro and GaBi, but in other cases the results revealed some differences. The implementation of the life cycle impact assessment (LCIA) methodologies also showed notable differences.

While the research conducted by Hermman and Moltesen [10] compared SimaPro and Gabi this paper compares openLCA and SimaPro on the same basis, i.e. based on the same LCI dataset and LCIA method. Result ratio was introduced in order to compare the differences between the LCA results of these two software tools. The overview of openLCA and SimaPro LCA tools is provided in table 1.

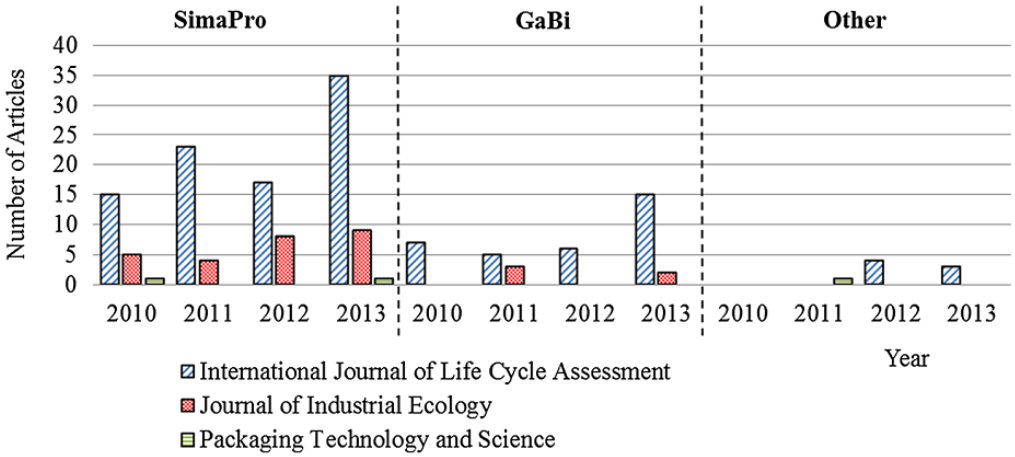

Figure 1. Use of LCA tools in Journal articles [7]

Table 1. Overview of openLCA and SimaPro LCA software tools

LCA tool	openLCA	SimaPro
Developer	GreenDeltaTC GmbH	PRé Consultants B.V.
Current version	1.4.2*	8.2.3
Release date:	August 10th, 2015 *	March 31, 2016
Licence	Open source software, made publicly available under the Mozilla Public Licence, MPL 2.0.	Business (Direct, Analyst, Developer, Share&Collect) Educational (Faculty, Classroom, PhD) Single and multi user client
Free licence	Yes	No**
Operating system	Windows, Mac, or Linux operating system (32 or 64bit)	Windows (7, 8/8.1, 10), Windows Server (2008, 2008 R2, 2012, 2012 R2)
Supported LCI database	ESU World Food, DataSmart, PSILCA, GaBi, Ecoinvent, ELCD, Social Hotspots, ProBas, Agribalyse, USDA, Ökobaudat, LC-Inventories.ch, NEEDS, bioenergiedat	Ecoinvent, Agri-footprint, US LCI, ELCD, EU and Danish Input Output, Industry data v.2 and Swiss Input Output.
Provided LCIA methods	*openLCA LCIA methods 1.5.5*: CML (baseline and non baseline), Cumulative Energy Demand, Eco-indicator 99 (E, H, and I), Ecological Scarcity 2006, ILCD 2011 (endpoint and midpoint), LCIA method according to EN 15804, ReCiPe Endpoint (E, H, and I), ReCiPe Midpoint (E, H, and I), Selected LCI Results, TRACI 2.1, USEtox. *Ecoinvent LCIA methods 3.2*: CML (2001 and 2001 w/o LT), Cumulative Energy Demand, Cumulative Exergy Demand, Eco-indicator 99 (E, H, and I),	*European methods*: CML-IA, Ecological Scarcity 2013, EDIP 2003, EPD 2013, EPS 2000, IMPACT 2002+, ReCiPe Endpoint (E, H, and I), ReCiPe Midpoint (E, H, and I), ILCD 2011 Midpoint+ *North American*: BEES, TRACI 2.1 *Single Issue*: Cumulative Energy Demand, Cumulative Exergy Demand, Ecosystem Damage Potential, Greenhouse Gas Protocol, IPCC 2013, Selected LCI Results, USEtox. *Water Footprint*: Berger et al 2014, WAVE (Water

	Ecological Footprint, Ecological Scarcity (1997, 2006, 2013), Ecosystem Damage Potential, EDIP, EDIP2003, EDIP w/o LT, EDIP2003 w/o LT, EPS 2000, IMPACT 2002+ (endpoint and midpoint), IPCC (2001, 2007, 2007 no LT, 2013, 2013 no LT), ReCiPe Endpoint (E, H, and I), ReCiPe Midpoint (E, H, and I), Selected LCI Results, Selected LCI Results, additional, TRACI, USEtox, USEtox w/o LT.	Scarcity), Boulay et al 2011 (Human Health, and Water Scarcity Water Scarcity), Ecological Scarcity 2006 (Water Scarcity), Hoekstra et al 2012 (Water Scarcity), Motoshita et al 2011 (human health), Pfister et al 2009 (eco-indicator 99 and Water Scarcity), Pfister et al 2010 (ReCiPe). *Superseded*: CML 1992, Eco-indicator 95, Eco-indicator 99 (E, H, and I), Ecopoints 97, EDIP/UMIP 97, EDIP 2003, EPD 2008, IPCC 2001 GWP, IPCC 2007, Ecological Footprint.
Language	Bulgarian, Chinese, English, French, German, Italian, Spanish	Chinese (Simplified), Chinese (Traditional), Danish, Dutch English (UK), English (US), French, German, Italian, Japanese, Portuguese, Portuguese (Brasil), Spanish, Swedish
Web page	http://www.openlca.org	https://simapro.com/

* openLCA 1.5.0 beta1 version is available (Release date: March 3rd, 2016).

** SimaPro 8.2.3 Demo version with limited features and 100 LCI database processes is available for free.

2 Materials and methods

Comparison of openLCA and SimaPro was carried out based on the life cycle inventory of 1 kg aluminium sheet production from the ELCD database 3.2 [11]. Aluminium sheet production process (Aluminium sheet, primary prod., prod. mix, aluminium semi-finished sheet product, RER S) relates to the production in Europe and it includes the environmental burden and credit associated with the recycling of aluminium scrap over the whole life cycle using the substitution methodology. The substitution methodology considers that recycled aluminium substitutes primary aluminium with average recycling rate of 79%. Produced aluminium sheets have typical thickness between 0.2 and 4 mm. Aluminium sheets are produced from aluminium ingots which are hot rolled at temperature around 400–500°C and then cold rolled.

Result ratio O/S was introduced in order to compare the differences between the LCA results of these two software tools. The more the ratio O/S deviates from 1 the larger the difference between the output values from openLCA and SimaPro are. The following LCIA methods have been selected for analysis of aluminium sheet production process:

- CML [1] at the characterization and normalization level,
- ReCiPe [12] at the characterization and normalization level,
- TRACI 2.1 [13] at the characterization and normalization level, and
- Cumulative Energy Demand [14] at the characterization level.

3 Results

Comparison of characterized and normalized results for CML baseline, ReCiPe midpoint (E), TRACI 2.1 obtained by openLCA and SimaPro LCA tools is provided in Tables 2–4, while the comparison of Cumulative Energy Demand characterized results is shown in Table 5.

Table 2. Comparison of characterized and normalized results for aluminium sheet process using the CML baseline LCIA method with Europe EU25+3, 2000 normalization set

	Characterization results				Normalization results		
Impact category	Units	openLCA	SimaPro	O/S ratio	openLCA	SimaPro	O/S ratio
Acidification potential	kg SO2 eq.	1.43E-02	1.43E-02	1.00	2.41E+08	2.41E+08	1.00
Climate change - GWP100	kg CO2 eq.	3.20E+00	3.22E+00	0.99	1.67E+13	1.68E+13	0.99
Depletion of abiotic resources - elements, ultimate reserves	kg antimony eq.	8.39E-07	1.88E-07	4.46	5.07E+00	1.13E+00	4.49
Depletion of abiotic resources - fossil fuels	MJ	3.41E+01	-	-	1.20E+15	-	-
Eutrophication	kg PO4--- eq.	7.76E-04	7.76E-04	1.00	1.44E+07	1.44E+07	1.00
Freshwater aquatic ecotoxicity	kg 1,4-dichlorobenzene eq.	1.10E-02	5.30E-03	2.08	2.31E+09	1.11E+09	2.08
Human toxicity	kg 1,4-dichlorobenzene eq.	1.86E+00	1.75E+00	1.06	9.31E+11	8.74E+11	1.07
Marine aquatic ecotoxicity	kg 1,4-dichlorobenzene eq.	5.72E+03	5.67E+03	1.01	2.54E+17	2.52E+17	1.01
Ozone layer depletion	kg CFC-11 eq.	3.56E-07	3.56E-07	1.00	3.64E+00	3.64E+00	1.00
Photochemical oxidation	kg ethylene eq.	7.63E-04	6.32E-04	1.21	1.32E+06	1.09E+06	1.21
Impact category	Units	openLCA	SimaPro	O/S ratio	openLCA	SimaPro	O/S ratio
Terrestrial ecotoxicity	kg 1,4-dichlorobenzene eq.	8.01E-03	9.15E-05	87.54	9.30E+08	1.06E+07	87.78

Table 3. Comparison of characterized and normalized results for aluminium sheet process using the ReCiPe midpoint (E) LCIA method with Europe ReCiPe E normalization set

	Characterization results				Normalization results		
Impact category	Units	openLCA	SimaPro	O/S ratio	openLCA	SimaPro	O/S ratio
Agricultural land occupation	m2*a	0.00E+00	-	-	0.00E+00	-	-
Climate Change	kg CO2 eq	3.23E+00	3.23E+00	1.00	3.30E-04	3.34E-04	0.99
Fossil depletion	kg oil eq	8.13E-01	7.55E-01	1.08	5.20E-04	4.85E-04	1.07
Freshwater ecotoxicity	kg 1,4-DB eq	8.17E-04	1.46E-04	5.60	6.99E-05	1.26E-05	5.55
Freshwater eutrophication	kg P eq	6.50E-06	6.50E-06	1.00	1.57E-05	1.57E-05	1.00
Human toxicity	kg 1,4-DB eq	2.45E+00	1.93E+00	1.27	5.50E-04	4.39E-04	1.25
Ionising radiation	kg U235 eq	4.32E-01	4.25E-01	1.02	6.89E-05	6.79E-05	1.01
Marine ecotoxicity	kg 1,4-DB eq	1.19E+00	1.03E+00	1.16	4.70E-04	4.35E-04	1.08
Marine eutrophication	kg N eq	2.05E-04	2.05E-04	1.00	2.03E-05	2.03E-05	1.00
Metal depletion	kg Fe eq	9.23E-03	1.02E-01	0.09	1.29E-05	1.43E-04	0.09
Natural land transformation	m2	0.00E+00	-	-	0.00E+00	-	-
Ozone depletion	kg CFC-11 eq	3.56E-07	3.56E-07	1.00	1.62E-05	1.62E-05	1.00
Particulate matter formation	kg PM10 eq	5.38E-03	5.38E-03	1.00	3.60E-04	3.61E-04	1.00
Photochemical oxidant formation	kg NMVOC	6.28E-03	6.29E-03	1.00	1.10E-04	1.18E-04	0.93
Terrestrial acidification	kg SO2 eq	1.33E-02	1.33E-02	1.00	3.50E-04	3.47E-04	1.01
Terrestrial ecotoxicity	kg 1,4-DB eq	6.67E-04	6.36E-04	1.05	4.77E-05	4.56E-05	1.05
Urban land occupation	m2*a	0.00E+00	-	-	0.00E+00	-	-
Water depletion	m3	7.68E-03	6.49E-03	1.18	0.00E+00	-	-

Table 4. Comparison of characterized and normalized results for aluminium sheet process using the TRACI 2.1 LCIA method with US 2008 normalization set

	Characterization results				Normalization results		
Impact category	Units	openLCA	SimaPro	O/S ratio	openLCA	SimaPro	O/S ratio
Acidification	kg SO2 eq	1.36E-02	1.36E-02	1.00	1.50E-04	1.50E-04	1.00
Ecotoxicity	CTUe	4.67E-02	2.62E-01	0.18	4.22E-06	2.37E-05	0.18
Eutrophication	kg N eq	2.74E-04	3.08E-04	0.89	1.25E-05	1.43E-05	0.87
Global Warming	kg CO2 eq	3.22E+00	3.22E+00	1.00	1.30E-04	1.33E-04	0.98
Human Health - carcinogenic	CTUh	1.98E-08	2.27E-08	0.87	3.90E-04	4.48E-04	0.87
Human Health - non-carcinogenic	CTUh	5.98E-12	1.63E-07	> 0.01	5.76E-09	1.55E-04	> 0.01
Ozone Depletion	kg CFC-11 eq	3.88E-07	3.88E-07	1.00	2.43E-06	2.41E-06	1.01
Photochemical ozone formation	kg O3 eq	7.93E-02	1.18E-01	0.67	5.66E-05	8.45E-05	0.67
Resource depletion - fossil fuels	MJ surplus	3.62E+00	3.59E+00	1.01	2.10E-04	2.08E-04	1.01
Respiratory effects	kg PM2.5 eq	9.55E-04	1.28E-03	0.75	3.98E-05	5.26E-05	0.76

Table 5. Comparison of characterized for aluminium sheet process using the Cumulative Energy Demand LCIA method

Impact category	Units	openLCA	SimaPro	O/S ratio
Non-renewable resources - fossil	MJ	3.70E+01	3.41E+01	1.09
Non-renewable resources - nuclear	MJ	1.24E+01	1.24E+01	1.00
Non-renewable resources - primary forest	MJ	0.00E+00	-	-
Renewable resources - biomass	MJ	2.82E-04	2.60E-04	1.08
Renewable resources - geothermal	MJ	2.66E-02	-	-
Renewable resources - solar	MJ	2.75E-01	-	-
Renewable resources - wind	MJ	1.33E-01	-	-
Renewable resources - wind, solar, geothermal	MJ	4.34E-01	4.34E-01	1.00
Renewable resources - water	MJ	9.99E+00	9.99E+00	1.00

4 Discussion

Observations from Table 2 show that most of the CML baseline impact categories have very similar results with O/S ratio close to 1 (in 7 out of the 11 impact categories compared). The impact category "Freshwater aquatic ecotoxicity" deviates by 2.08 in characterizations and normalization results, while the impact category "depletion of abiotic resources – elements, ultimate reserves" deviates by 4.46 in characterizations and 4.49 in normalization results. The major differences are found in "Terrestrial ecotoxicity" impact category and the O/S ratio is 87.54 for characterization and 87.78 in normalization results.

In the case of the ReCiPe midpoint (E) LCIA method (Table 3) the O/S ratio is close to 1 for the majority of the impact categories. The largest differences in the LCIA results were observed in "Freshwater ecotoxicity" and "Metal depletion" impact categories. The "Freshwater ecotoxicity" impact category has the O/S ratio of 5.60 for characterization and 5.55 for normalization results, while the "Metal depletion" impact category has the O/S ratio of 0.09 for characterization and 0.09 for normalization results.

TRACI 2.1 results (Table 4) show significant differences in four out of the ten impact categories investigated. "Respiratory effects" impact category has the O/S ratio of 0.75 for characterization and 0.76 for normalization results, for "Photochemical ozone formation" it is 0.67 for characterization and normalization results. Large differences were observed in the results obtained within the "Ecotoxicity" and "Human Health - non-carcinogenic" impact categories. "Ecotoxicity" impact category has the O/S ratio of 0.18 for characterization and normalization results, while "Human Health - non-carcinogenic" has the O/S ratio smaller than 0.01 for characterization and normalization results.

Comparison of Cumulative Energy Demand LCIA method (Table 5) show very similar characterization results with O/S ratio between 1.00 and 1.09. Impact category "Non-renewable resources – fossil" and "Renewable resources - biomass" have O/S ratio 1.09 and 1.08, while in other impact categories the O/S ratio equals to one.

In general, all of the observed LCIA methods (CML baseline, ReCiPe midpoint (E), TRACI 2.1, and Cumulative Energy Demand) had similar output results for openLCA and SimaPro. However, differences are present in some impact categories results and this should not be disregarded by LCA software users.

5 Conclusions

LCA practitioners often use only one of the LCA tools, without comparing the results with the ones obtained by other software tools. On the other hand, this research confirms the previous conclusions from Speck et al. [7] and Hermman and Moltesen [10], that different LCA tools can provide different output results. The general finding of this paper is that although SimaPro and openLCA yield very similar results within the majority of impact categories, in some impact categories significant differences may appear. This leads to a conclusion that the users should be aware of this issue because large differences between the impact category results could potentially influence the conclusions drawn from an LCA study. One of the potential solutions for overcoming this issue is to form a standardized test for validation of commercial LCA software tools consistency.

Future research should investigate larger sample of processes, comparison of results obtained from other LCI databases and should include the determination and analysis of factors which caused the differences in the LCIA results. Furthermore, results from other LCIA methods should be compared also in order to obtain more comprehensive research.

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ENVIRONMENTAL MANAGEMENT - A PLATFORM FOR SUSTAINABLE DEVELOPMENT

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Abstract: During the 19th and even 20th century, humanity firmly believed that the value of technical progress cannot be specifically discussed, because this process was conducted in accordance with the current understanding of the situation and the relationship of man and society to nature. This attritional is frequently afflicted in ecological crisis, whose conditions are growing, and established policies have no proposal that can offer a solution. Today's civilization was developed in the paradigm of continuous material growth and encourage unscrupulous consumption of natural resources. The consequences are well known. Mankind is entering the third millennium with global environmental problems and solution is in investing to new technologies that work alongside with sustainable development. Right way to do so is through legal regulative and national strategy, where environmental management is a link that connect all fields.

Key words: Ecological crisis, Environmental management, Legal Regulative

1 Introduction

During the 19th and even 20th century, humanity firmly believed that the value of technical progress cannot be specifically discussed, because this process was conducted in accordance with the current understanding of the situation and the relationship of man and society to nature.The change from small-scale production to industrial production is based on the convergence of many economical, technical and political factors. Even so, three of them are fundamental: technical progress, the use of fossil fuels and organization.

The industrial revolution and the development of technical means, systems of machines and forms of organization of work processes, factories, began the process of rapid development of technology that continues today. Innovations that have occurred during the industrial revolution changed the type and price of energy resources, a way of making yarn and fabric production and processing of textiles, metals, and the price range of industrial raw materials. At the same time the open process of progression in the acquisition of new knowledge variables. Greater or less importance is attached to one of the elements of technological development: communication, power source and mechanism, resources, information technology.All this leads to uncontrollable expanding on the cost for something that is not unlimited – natural resources. In modern times almost all countries, at least medium and well developed, have some sort of regulative about sustainable development and natural resources protection, some have that as national strategy and agenda, but it is still far away from being enough. Priority in industrial development and new technologies have been cost effectiveness for a long time. Now, focus is shifting towards sustainable development.

A development priority of the European Union is to undertake structural changes in industry and strengthen its competitiveness. Manufacturing industry is the most important section of the

EU economy, it drives its growth and propels its technological and innovation development. Through its new industrial policy, the EU endeavors' in particular to stimulate the development of technologies that are environmental green and can be positive for sustainable development. One of the key elements is education and how well educated management can make system that is environmental oriented in any economy or industrial subject.

2 Environmental Management Systems

Environmental management systems follow a systematic approach of planning, implementing, evaluating and improving. An environmental management system is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency. This system provides a framework that helps a company achieve its environmental goals through consistent control of its operations.

Much of what a company needs for an environmental management system may already be in place. In this system framework includes many elements that are common to managing many organizational processes, such as quality, health and safety, finance or human resources. Many organizations have some environmental management processes in place already, though they may have been designed for other purposes. Integrating environmental management with other key processes can improve performance across multiple functional areas. Environmental Policy – before beginning to build an environmental management system, a company should make sure to define its environmental policy and goals, and communicate these with the entire organization. Launching environmental management operations requires commitment from both senior managers and employees at all levels. It is important that everyone understands why the organization needs an effective environmental management system, what their role is and how this system will help control environmental impacts in a cost-effective manner. Solidifying these objectives into a policy document gives companies a framework for measuring progress and signals a clear commitment to environmental management.

An environmental management operation can provide many benefits from both an environmental and a business standpoint. Because this specific system, is tailored to each company's specific goals and processes, it provides a structure for optimizing company performance across multiple dimensions. Specifically, an environmental management can help achieve the following: Cost savings through reduced resource consumption, increased operational efficiency, improved environmental performance, compliance with legal and regulatory requirements, deeper customer trust, enhanced employee skills and satisfaction, positive community and public relations.

3 Ecological Crisis and Sustainable Development

Ideas of consumer society is to produced cheaper and more, regardless of the applied technology, or adverse effects that they have on the environment and leading to greater pollution. This approach imposes the development of environmental awareness in the light of the concept of environmental protection, which are objectives of rational use of natural resources, sites and the introduction of protective measures, which ultimately only seemingly more expensive and limiting the production of, or leads to a reduction of profits.

Ecological balance represents the balance between the animate and inanimate nature. The disturbance of this balance leads to ecological crisis. It is rapidly expanding. On the one hand, industrialization to improve the living standards of a large number of people on Earth, but on the other hand, has a negative impact on the quality of the environment and human health. The man has finally realized that the issue of further survival strategy different attitude towards the environment. In essence, the environmental crisis is an inseparable part of the large manmade events. First of all, a profound crisis of a way of production, consumption patterns and economic growth, while loss of basic human values. Such life has upset the balance between man and nature, and it can only improve the fundamental socio-cultural alternatives to the production method and consumption.

Sustainable development is something that every industry is shifting to. One cannot be a global factor in industry if his technology and innovations are not towards sustainable economic and natural policy. One of the goals of the European Union industrial policy is permanent enforcement of competitiveness, protection of industrial and intellectual property, and reduction of costs incurred through compliance with high ecology, energy, and social standards. The backbone of competitive EU industry is development of new technologies and innovations, which is why the EU allocates huge funds for stimulation of research and creation of environment which fosters innovativeness.

Since ecological crisis is not a new problem, solution is not simple – otherwise we would already solve this global problem. Process is long with many elements, starting with massive education of people in every country, through very high standards in industry, over very strict legal regulative. It is clear that only as a national agenda this can be enforced, it is not possible to protect environment only on local level. European Union takes this very seriously and so far it is going in good direction. Many complicated issues arising when it comes to legal regulative of each union member, which leads to problems in other European countries.

4 Legal Aspects of Environmental Management

The mandate of the legal task force established under the European Union project was to evaluate the present status of legal environmental instruments at national, sub-regional and regional levels with a view to exploring ways to strengthen regional co-operation in the environmental management sector. Regional co-operative mechanisms and activities for environment protection need to be strengthened in order to reverse current trends. Until recently, mechanisms for regional co-operation in the area were

neither extensive nor, well developed. Existing environmental co-operation has developed mainly through the work of international and regional organisations. Since Lisbon (2007) in Europe, in the environmental field like in many other fields, legislation and current regulations in Member states are transcriptions of community texts into national law. The three principal types of text are:

Regulations: they are directly applicable and compulsory in all Member states of the European Union without it being necessary to adopt means of execution within national legislation.

Directives: they link Member states regarding the result to obtain and the deadline to respect, at the same time as permitting national proceedings the choice of how and the means. Directives should be incorporated into the different national judicial orders, conforming to the planned procedures in each Member state.

Decisions: they are compulsory for the designated recipients. Consequently, decisions do not require national legislation for their execution. A decision can address one, several or all the Member states, companies or individuals.

Another approach naturally fell into place for the regulation of environmental impacts: impact prevention. Before the impact even exists, the intention is to reduce, even eradicate it completely. To put this approach into practice requires improving the production chain or the product during its usage phase by using best environmental performing technologies. It is an integrated preventive environmental strategy for procedures, products and services. It aims to improve efficiency and to reduce sanitary and environmental risks. Pollution prevention operations or reduction of toxic products usage are examples of achievements. Prevention can also consist of banning the use of certain substances known to be sources of particular impacts.High quality of institutional environment represents one of the necessary conditions for competitiveness and sustainable development of industry. To have such institutional environment, it is necessary to have strong, detailed and well development legal regulative. For such task European Union have Commission to undertake this complex regulative network.

The European Commission aims to ensure coherence between industrial, environmental, climate and energy policy to create an optimal business environment for sustainable growth, job creation and innovation. To support this, the Commission has established an ambitious agenda to transform EU economy into circular one, where the value of products and materials is maintained for as long as possible, bringing major economic benefits. The Commission also supports European industry in the move to a low-carbon economy and improves the energy efficiency of products through Eco-design legislation. As such goal is very complex and complicated,European Union is constantly working within their legal teams how to ensure that every member and candidate state have laws and legal regulative on a same or very close level.

Ultimately environmental management must be compound not only with professionals and experts coming from fields like economy and technology, also such team must have legal workers and jurists who are experts in environmental protection and sustainable development. It si simple why, a

number of significant standards are available for practical operations of industries and institutions, like international environmental management standard known as ISO 14000 series.

5 Conclusion

Sustainable development has many different meanings and therefore provokes many different responses. In broad terms, the concept of sustainable development is an attempt to combine growing concerns about a range of environmental issues with socio-economic issues. Sustainable development has the potential to address fundamental challenges for humanity, now and into the future. However, to do this, it needs more clarity of meaning, concentrating on sustainable livelihoods and well-being rather than well-having, and long term environmental sustainability, which requires a strong basis in principles that link the social and environmental to human equity. Environmental management must be link that connect between national strategy, legal regulative, industry and technology, economy growth, usage of natural resource and sustainable development. Some nations already coming well ahead in this subject, some are lacking, but nevertheless it is the only possible platform for future development. Investing in new technology have no point if one does not invest in management who is capable to deliver excellence in managing complexity of profit grows, implement new technology and protect environment.

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ECOPRENEURSHIP AND GREEN PRODUCT INITIATIVES (GPI): AN AGENDA FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract: Ecopreneurship (Green Entrepreneurship) has been identified as a critical engine to counteract environmental hitches facing modern societies. This posture stems from the neo-Malthusian environmentalism ideology that assumes that conducting economic activities in a sustainable way will help to revert and reconfigure most of the injuries done to eco-system. Standing on this supposition, this paper examines how environmentally attentive entrepreneurs and their innovative ideas can contribute significantly to the process of achieving sustainable development. It explains the exclusive roles of Ecopreneur and Green Product Initiatives in the rising trend of green economy in current global market. The paper document the numerous benefits associated with eco-entrepreneurship and how these benefits can translates to anticipated self-development, creativity, decision making and risk taking among modern-day entrepreneurs. It also explains the micro and macro levels of eco-entrepreneurship and green product initiatives as agenda for sustainable development goals. To do this, the paper adopts Schumpeter's theory of entrepreneurship and Ecological modernization theory as development framework to underline the important of ecopreneurship and green product initiatives in mitigating the challenges of environmental degradation particularly those caused by economic activity. The paper is exploratory with the use of secondary data sourced from current and relevant academic publications and reports. Findings from the paper serve as indicators and pointers to government, researchers, academicians and other stakeholders to promote, engage and invest in ecopreneurship and green product initiatives as the lens to locate the path to a more sustainable future.

***Keywords**:* Ecopreneur, Innovation, Green Products, Agenda, Nigeria

YOUTH ENVIRONMENTAL ENTREPRENEURSHIP AS A FACTOR OF SUSTAINABLE ECONOMIC GROWTH

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Abstract: The sphere of activity, where converge the interests of society and young people as a social group, is entrepreneurship. Efforts of the state and the public performs tasks as the creation of a regulatory framework on entrepreneurship, the creation of information and financial infrastructure for entrepreneurs, various consulting and legal support of youth projects, assistance in finding investors, the creation and development of business incubators in educational institutions. The paper dwells on the management experience in youth entrepreneurship in the sphere of innovations and ecology in Russian and Belorussia, and gives an overview of the youth ecological initiatives. The paper identifies problems caused by the lack of the mechanism of the formation of "tender" on environmental projects for young entrepreneurs. The implementation of this activity largely determines the favorable attitude of the young people, aiming to establish their own business, taking into account the environmental needs of society.

Keywords: business incubators, demand and market needs, environmental entrepreneurship, framework on environmental entrepreneurship, new economic paradigm, tender for innovation, youth entrepreneurship.

1 Introduction

Europe chooses a new economic paradigm of growth. Now mechanisms are formed, which can provide sustainable growth or protracted stagnation. The new generation entering the labor market in the next 10 years has a different value base, based on the need for changes as a form of life, now in contrast to the dominant older generations with their desire for stability and comfort. Entrepreneurship is the only area of activity where the interests of society and youth as a social group converge. However, the results of the global entrepreneurship monitor [1] shows the decrease in business activity. Investment in small business sector is growing slowly and mainly in the IT industries.

It is possible to change the trend in the small and medium business by bringing environmental entrepreneurship to the youth. In Russia, as well as in most european and CIS counties the system of support of youth entrepreneurship is established and developed, which includes the state structures of federal, regional and local level, as well as a number of different associations and independent associations.

2 Body

All of them are aimed at development of youth entrepreneurship and consolidating various mechanisms to support entrepreneurial activity of youth. In Russia most active in pursuing these objectives are the Federal Agency for youth Affairs, the Council of the Ministry of education and science of the Russian Federation on youth Affairs, the Commission on youth entrepreneurship, the Committee for the support and development of small and medium enterprises, the support and development of youth entrepreneurship in the State Duma of the Federal Assembly of the Russian Federation at the Council on entrepreneurship.

In addition to the bodies of state and municipal authorities, such public organizations as: all-Russian public organization "National Student Union", interregional Public Organization "Moscow Entrepreneurs Association", the Association of agencies for support of small and medium business "development", the Fund of assistance to development of youth entrepreneurship "My business", international socio-educational project "Academy", a nonprofit partnership "Club of youth entrepreneurship", Moscow club of young entrepreneurs, the national Foundation for the promotion of international youth organizations "JCI", Center of youth and enterprise initiatives "Generation-2025", Association of young entrepreneurs of Russia and many others are active in Moscow and other Russian regions.

A key role in the training of young entrepreneurs comes from leading educational institutions that implement programs of higher education on entrepreneurship, such as: WSB MSU M. V. Lomonosov Moscow state University, REU named after G. V. Plekhanov; RANEPA (Russian Presidential Academy of National Economy and Public Administration), Higher school of management SPBU, etc. The important function of disseminating the latest approaches in the development of entrepreneurship, ensuring of retraining of teachers for entrepreneurship education such organizations as: the Center for Entrepreneurship and the national Association of entrepreneurship education perform.

Each of these organizations has its own specific purpose and function in the development of entrepreneurship in Russia, but they all share the desire to create favorable conditions for the formation of the innovative environment and growth in business activity among young people.

However, despite this, one of a key issue remains the relevance of the proposed innovative products and services in the market. Estimate and demand creation, is partly a task of competent marketers and trend watchers **[2],** which are able not only to monitor the competitive environment, but also to develop a strategy of market entry, taking into account the maximum satisfaction of the target group. At the same time, services of marketing agencies are very costly part of any business plan and independent market analysis does not always give reliable results.

Thus, the existing system of support of youth entrepreneurship in Russia allows us to implement a number of important functions that are aimed at comprehensive support for both beginners and existing entrepreneurs, through a complex infrastructure and the creation of a wide range of consulting services, support state funds and private investors. Such indicative projects of Rosyouth as "You are an entrepreneur" as a result provide for creation of 2 million new businesses, and "Zvorykin project" according to the portal of the Association of young entrepreneurs, should provide not less than **100** profitable businesses from **10.000** innovative ideas **[2].**

The state and the public with joint efforts solve such tasks as creating a regulatory framework for entrepreneurship, creating information and financial infrastructure for start-up entrepreneurs, providing various kinds of consulting and legal support of youth projects, assistance in finding investors, creating and developing business incubators in educational institutions. The implementation of this activity

largely determines the favorable attitude of the youth, aiming at creating a business based on the demand of the society to solve environmental problems.

According to the data of the National report "Global entrepreneurship monitor" in **2015**, representatives of the youth, respondents aged **25 - 34** years old **(29.8 %)** most often declared the intention to create a business. The portion of the youngest age group (**18-24** years old) among those who intend to start their own business in the next three years is **21.3%.** In the same group there is the largest increase of entrepreneurial activity, the activity index was **7.9%** (compared to **4.3%** in **2012**) **[3].**

Russia and other countries of the Commonwealth of Independent States (CIS) countries development of the environmental entrepreneurship is rendered through specialized nonprofit organizations, supported by the government.

Interregional public organization Green Movement "ECA" was founded in 2010, volunteer divisions of the organization operate in more than 50 regions in Russia. "ECA"'s goal is to ensure establishment of «green» economy in Russia based on the principles of entrepreneurship and government support.

"ECA"'s activities are aimed at:

- forming a new culture of behavior in Russia, focused on the respect of the environment,
- creating a community capable of solving environmental,
- realization of environmental projects.

Since 2010 "ECA" has been successfully pursuing the following activities: Federal state program «More Oxygen!», «Unpackaging!», campaign «Live, Forrest!», «Birds in the City», «Green Ribbon», «Saturday Long Hours», eco festivals, regional best social poster competition «Save the Planet», regional competition «ECA Christmas Tree», etc. **[4]**

Issues related to the youth environmental entrepreneurship are acute issue in the Eastern Europe countries. Thus in the Republic of Belorussia the State committee for since and technology regularly holds the National Competition of innovation projects. The majority of the projects submitted to the competition are focused on ecology and rational environmental management, construction and power engineering, IT-technologies, health, socio-economic issues.

The breakdown according to the thematic focus shows the following figures:

- informatization, computerization and IT technologies - 19%
- chemical, pharmaceutical, microbiological technologies - 17%
- instrument engineering, radioelectronics and optics - 15%
- mechanical engineering and metal processing - 11%
- production, processing and storage of agricultural products - 11%
- construction and power engineering - 11%
- health - 9%
- socio-economic and state issues - 5%
- ecology and rational environmental management - 2%

Such a low percentage of environmental projects shows lack of formed social demand and the mechanism of the formation of "tender" on environmental projects for young entrepreneurs.

However, in the following list of organizations and their functions there is no essential function for any business - the function of the demand or ensuring the relevance of business initiatives and projects at the sectoral markets. The current system is designed so that a beginner entrepreneur will not only be able to meet the challenge of producing the product or service technically, legally, and organizationally, in compliance with the current environmental regulations, and will organize its

implementation. At the same time, the authors of innovative environmental business ideas have this lack of support. The attractiveness of innovative projects is determined by the term of return of investment and profit. This means that to attract investment the entrepreneur must have a clear market and commercial prospects.

The experience of the authors in working with student business project shows that creativity and ingenuity inherent to young people and attracts them like an activity. Nevertheless, very rarely an aspiring startuper clearly understands who and why may need it the idea, even focusing on the market of Internet users, which is developing rapidly. The Foundation for Internet Development Initiatives (FIDI) supports only those projects that have preliminary agreements with potential customers.

This problem, in our opinion, can be solved by introducing a system of *tenders from direct* customers to develop an environmental business project or an innovative product. The provision of such services may be arranged through the system of chambers of Commerce and industry of the Russian Federation, as well as organizations that support entrepreneurs in their professional activity, foe example Community of young entrepreneurs (CYE).

CYE is a national framework aimed at development of entrepreneurship. It provides infrastructure for the young entreprenuers to exchange their experience, create new ideas and projects, establish business relations, find business partners. The Community renders assistance and support to the its members, helps find investors fot their environmental projects.

Young entrepreneurs - members of the CYE - receive support of the successful entrepreneurs, take part in various activities aimed at business development and demand and market survey of environmental issues facing the state and local entrepreneurship community.

Such a "pool" of direct customers can be compiled through the centralized filing of applications for the development of specific solutions, both from private consumers and large companies, which are ready to describe the problem and present it in the form of a case.

The creation of such a system of *tenders for environmental innovation*, on one hand will allow young entrepreneurs in developing their business models to go from the very specific needs of the potential client, to avoid errors connected with inaccurate assessment of the needs of potential customers and the capacity of market niches.

3 Conclusion

Thus, the proposed mechanism of *the tender for the environmental innovation* will allow:

- *young entrepreneurs* to direct their efforts on solving practical social problems with a guarantee of demand for their business projects in the real sector, find investor, to quickly grow the business and meet the needs of the domestic economy to environmental innovation;
- *the company-client* that is conducting modernization or expansion through the formation of "tenders", to obtain an environment-freindly solution in the form of a product/service from a young entrepreneur whose business idea will be the most effective for the client.
- *the business community* to consolidate the youth audience in order to create conditions for generation of environmental entrepreneurship and sustainable development of national economies of European countries.

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WASTE AS A SOURCE RESOURCES

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***Abstract*:** Industrial and technological developments have led to the situation that humans get more than they basically need through the products they use. Thus, the production develops in this direction, more and more products are to be consumed having daily more new products. Some products barred from year to year and cannot be used.
The question is - what to do with products that are not necessary to anybody? Lawyers warn that the obligations from the law follow, not only for environmental protection but also for the management and disposal of waste. One solution is, of course, the use of waste as a resource for new products that are, at the same time, cost-effective, but also as a source of income for both employers and workers, and the entire economy.
Accordingly, the area in the development of a country is important, not just to the side of environmental protection and sustainable development, but also the economic point of view. Thus, the EU countries have a stable level of use of resources, because some natural resources replace the waste to be used in further production, thus preserving its natural.

***Keywords*:** Recycling, resources, environmental protection, new products...

1 Introduction

Production represented a process that is accomplished by man works on materials from nature in order to obtain a new use-value and quality necessary for the satisfaction of human needs: individual, mutual, social or reproduction. Products receive its new features. When natural objects (materials) have characteristics of products, production would be unnecessary, because these features would directly secure the settlement of human needs.

Thus, the production changes the original forms of the material in new production items as interaction of three elements of production: labor, tools and materials. Each of them works and participates in the creation of a new product. In this way, all the elements are involved in creating a new product, i.e. in the production process. Manpower and resources to work do not change and do not lose its original shape, but they are spent, and the material loses its natural shape and never returns to its original one. Therefore, natural materials (resources) with daily wear are becoming limited and it is necessary to use them cost-effectively.

Thus, production develops in this direction, there is more the production for more consuming with daily new products. Some products barred from year to year and cannot be used.

2 Limited natural resources

At today's level of economic and technological development there is no resource in nature, which can be unlimited and uncontrolled spending. Material resources that are used in nature are limited. "Awareness of the fact that environmental resources are limited and have its price has not, therefore, widespread, or the conviction that environmental protection does not necessarily restrict competition, but that it may also increase. In times of recession and unemployment has pursued economic growth, which does not take account of the pollution of the environment and the exploitation of resources, no account is taken of environmental protection because that cares damn expensive."[1] In addition to spending, material resources, and the nature of the act. Evaluation and preservation of natural resources are one of the factors for the development of the country.

The process of exploitation of natural resources takes place in adverse conditions, with restrictions on the use of natural, which increases the cost of the material components within each product taken individually. This way, the development of their own production and economic development based on the use of interchangeable materials and raw materials and synthetic substances or other, such as the waste that can be recycled and re-used in the production.[2]

3 Legislation in Serbia

The modern way of life and work, have led to changing habits and needs of man. Analyses show that the purchasing power of the population in Serbia is still low, but it is still more bought what is imposed rather than what is really necessary. Consumers behaving this way, and the daily production of the manufacturer, directly increase the amount of waste. The responsibility was given to producers, but also consumers. Lawyers point out that the obligations following from the law, not only for environmental protection but also for the management and disposal of waste.

The legislator clearly in their legislation defines social responsibility of all participants in the economy and that "manufacturers of products used in the production technology and develops in a manner that ensures the rational use of resources, materials and energy, encouraging reuse and recycling of products and packaging at the end of the life cycle and promote environmentally sustainable management of natural resources"[3]. It is important to point out that: "The waste is stored in places that are technically equipped for temporary storage of waste at the site of the manufacturer or owner of the waste collection centers, transfer stations and other locations in accordance with the law."[4]

This law sets a target to increase the volume of recycling all types of waste, at national and local level, and to prevent the creation of illegal dumps.

[1] Maja Lj. Arsić Trajković, Miroslav S. Trajković, Maja Z. Mladenović, „O strategiji održivog razvoja EU", Referat sa Međunarodne konferencije „Kako do kvalitetnijeg života", održane na Fakultetu za primenjeni menadžment, ekonomiju i finansije u Beogradu, 12. maja 2016.

[2] Prof. dr Slobodan M. Ivović, „Roba i tehnološki razvoj", Univerzitet BK, Beograd, 2005.

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[4] Ibid.

4 EU Legislation

Waste Framework Directive is linked to the EU legislation. It states the hierarchy of waste management: from prevention, preparation for reuse, recycling, recovery and disposal.

The aim of the directive is to prevent waste production as much as possible, use the waste as a resource and reduce the amount of waste deposited in landfills. This Directive together with the other EU directives on waste (about disposal, waste transport means-cars, e-waste, batteries, packaging, etc.), Includes specific objectives, such as: by 2020, turning waste into a resource, then each member country the EU needs to recycle half of its municipal waste and must be recycled and restore 70% of building materials which are not and do not belong to hazardous materials from demolition waste (by weight), and so on.

Since Serbia is in the vicinity of the EU, must also comply with the legislation on waste and environmental protection because the Directive applies to the Member States, but also for the candidates.

5 Waste management

Waste management is a concept that has emerged as a reaction to the economic and ecological crisis of 2008 and for the maximum utilization of usable material resources. Waste management policy includes measures for prevention, reduction and environmental waste management. Implementation of measures to reduce the amount of waste and to control waste streams up the hierarchy of the various wastes, the ability to reuse and recycling, and therefore saves the environment and human health. Poor waste management and uncontrolled waste disposal may endanger the different ecosystems and lead to climate change.

Waste management represents expenditure. Creating the infrastructure for collecting, sorting and recycling is also costly for our requirements, but may represent an investment where it can achieve revenue and provide "green" jobs.

From the economic point of view, the loss of the waste, both for producers and for society as a whole. In this way, the waste that is not used is a potential loss or missed opportunity for gain. Waste has a global aspect of the effect because what is produced in one place causes a waste elsewhere.

Waste management policy provides a way to influence the reduction of waste through the development of a functioning waste management system that aims to use waste as a valuable resource material. Thus, linking economic growth and the use of waste as a resource and its effects opens the possibility of lasting sustainable growth.

6 Waste as resource

The amount of waste that is produced is related to the way of life of people. Increasingly, the products to be consumed with daily new products. Some products barred from year to year and cannot be used. The question - "What to do with products that are not necessary to anybody?" There is also a large amount of municipal waste, food, solid waste in the form of packaging, etc. Packaging is the

fastest growing category of solid waste. More than 30% of municipal solid waste is packaging, and 40% plastic. The process of decomposition of plastic in nature is very long, and has a negative impact on ecosystems.

The purpose of collecting e-waste is to prevent dangerous substances that end up in the wrong place. Both in Sweden and the manufacturer or importer is obliged to collect the same ie. responsible for the collection and disposal. Importers and manufacturers should provide sites for the disposal of e-waste (appliances used in households) in all municipalities. Municipalities are responsible and obliged to provide recycling centers.

"The Netherlands and Denmark recycle almost 90% of construction waste, while in Serbia do not recycle construction waste which leads to unrestricted use of materials such as gravel and stone, a waste disposal permanently destroys the space."[5]

One solution, of course, the use of waste as a resource for new products that are, at the same time, cost-effective, but also as a source of income for both employers and workers. This use of waste as a resource is also known as zero waste.

7 The application of a zero waste economy

Zero Waste is a goal and a way, the whole approach that changes the flow of materials through society. Also represents a management approach that monitors the material to the beginning (for the production and sale), and finally (re-use, finishing, processing) and their capacity, connectivity. Everything that someone represents worthlessness and throws up for the other may represent a resource. For example: organic waste is the raw material for commercial compost operations, where food, leaves, garden waste into compost that feeds the soil in agriculture (in the fields) or in parks for green areas.

What is Zero Waste? Is it technology, policy or program?[6] In fact, it's a management strategy that discarded materials from production and consumption, on the site where it is separated and recycled back into the production process. The waste is reused as a material increase recycling and reduce the costs of storage, preservation and maintenance. Accordingly, based on a model that weighs less use of resources and avoiding the creation of waste: Take-benefit-back device re-used.

8 The well-being

The state of Serbia is the one whose task is to promote and establish a system of zero waste. Various incentives, should enable the working population to take the initiative through entrepreneurship to deal with the recycling industry.

"For entrepreneurial development requires a plan and coordination of all stakeholders, and support national and local authorities. Entrepreneurship its function most efficiently achieved in the development of small and medium-sized enterprises. Already in recent years to develop awareness of

[5] http://uzickarepublikapress.rs/ekologija/

[6] „From Waste Management to Resource Recovery", Jessica Edgerly, Toxics Action Center, Dori Borrelli, Vermont Law School, 141 Main St. Suite 6 Montpelier.

entrepreneurship and entrepreneurs to make a significant contribution to the transition of the social and economic system and significant are the basis for the renewal and growth of our economy."[7] The benefit would be mutual. Employers would earn revenue, workers earnings, state income tax, and environment protection.

Zero Waste strategy reduces the need for landfills, which have a negative impact on the environment and human health. In this way, preserve resources and reduce energy consumption in production. Thus, the EU countries have a stable level of use of resources, because some natural resources replace the waste to be used in further production and thus, preserve their natural.

"In addition to changes in ways of thinking about the importance of sustainable development, a new concept by the standards of the European Union requires the creation of new business models. This transition provides an opportunity to modernize the industry, increase energy efficiency, increase the efficiency of use of material resources, achieve new industrial growth and job creation. According to estimates by the Chamber of Commerce of Serbia in this way Serbia can get 10 thousand "green" jobs. Therefore, it is now SMEs present examples of good practice"[8]

Accordingly, the area in the development of a country is important, not just to the side of environmental protection and sustainable development, but also the economic point of view.

9 Conclusion

In the end, whether it will become a waste, or waste resources, depends on how we manage it.

Progress on waste requires the engagement of all parties: producers, consumers, legislators, local governments to state institutions. Consumers even when they want to recycle their household waste, can only do that if there is infrastructure and systems for collecting their waste classified. Also, conversely, recycling centers will recycle waste if separate their household waste. Of course, under the assumption that everything is so recycling is not possible without the recycling industry. It should naturally come out of the vicious circle.

Serbia needs incentives zero waste and use waste as a resource. "The Government of the Federal Republic of Germany through the grant provides assistance to Serbia in the field of waste management and waste water management at national and local level and will be invested three million euros for projects in 2016 and 2017-that-that year."[9] Chances are started, followed by work.

The authors want to contribute and develop awareness of the importance of using waste as a resource. Potential benefit is great:

- the remains of a production process is used as a material of another process;
- economics of material where nothing is thrown away and not lose or zero waste;

[7] Tijana B. Prokopović, Maja Lj. Arsić-Trajković, Miroslav S. Trajković, „Put do uspešnog preduzetnika je u inovacijama", Referat sa 6-te Međunarodne konferencije "Economics and Managment – Based on New Technologies (EMoNT)", u Vrnjačkoj Banji, 15-18 jun 2016.

[8] Privredna komora Srbije, www.pks.rs/

[9] Privredna komora Srbije, www.pks.rs/

- ecological gains and
- continuing importance from the standpoint of sustainable development.

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LEGAL FRAMEWORK FOR ENVIRONMENTAL PROTECTION IN THE REPUBLIC OF SERBIA

(in Serbian language)

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Abstract: Environmental sector is becoming increasingly visible and important area in the Republic of Serbia. Considering that the Republic of Serbia is in the EU accession process, central instrument for Environmental Management are laws. Harmonisation of legal acts is an extensive and complexed process, for every country wanting to access the EU, considering that you need certain amount of time for implementing the most complexed and most demanding parts of acquis. Republic of Serbia has considerably improved in transposition of acquis recently and began with the process of adopting big number of system and sector legal acts. Those legal acts in this area represent unavoidable factor for all other partitipants and subjects. All this is because legal obligations in this area represent an essential factor for any future activity. Comparing complexity and number of acts in this area, that are equaly binding, for both state authorities, and economic entities, we have a short display of environmental regulations, and presentation of current laws, and this paper processes commentary of the current legislation of the environment in the Republic of Serbia, with concluding remarks.

Keywords: environmental protection, Republic of Serbia, law regulations, legal responsibility, company, state authorities

UVOD

Zaštita životne sredine u skladu sa opredeljenjima međunarodne zajednice, zauzima značajno mesto u vrhu svetskih prioriteta. Koordinirana aktivnost na zaštiti vazduha, voda, mora, zemljišta, šuma, opasnih materija, jonizujućeg i nejonizijućeg zračenja, svih vrsta otpada, klime, ozona i dr., se podrazumeva na globalnom, regionalnom, subregionalnom, bilateralnom i nacionalnom planu.

Politiku zaštite životne sredine u svim državama sveta, utvrđuju i vode vlade država, bez obzira na društveno-politički sistem i stepen razvijenosti. Tako su vlade odgovorne za stanje životne sredine na svojoj teritoriji, što obezbeđuju odgovarajućim organima uprave i stručnim telima.

Postavljanje efikasnog sistema upravljanja životnom sredinom zahteva usaglašena načela, razgraničene nadležnosti i savremene i efikasne društveno-upravne mere. Te mere moraju imati svoje uporište, najpre u nacionalnim propisima svake države.

Kada je u pitanju Republika Srbija, poslovi zaštite životne sredine organizaciono pripadaju, deo su ministartstva poljoprivrede i zaštite životne sredine [1]. Međutim, polazeći od značaja, složenosti, specifičnosti i multidisciplinarnosti pitanja životne sredine, neophodno je formiranje samostalnog ministarstva za ovu oblast. Postojeća organizacija vršenja navedenih poslova, imajući u vidu da je Republika Srbija započela proces pridruživanja i pristupanja EU, otvara mogućnost zastoja, nekontinuiteta u usvojenim i planiranim aktivnostima u ovoj oblasti na nacionalnom nivou. Ovo iz razloga, što je započet postupak usvajanja pravnih tekovina EU (acquis-a), u nacionalno zakonodavstvo. Započeti proces je neophodno nastaviti, tako što će se obezbediti koordinirano praćenje stanja životne sredine i predlaganje Vladi preduzimimanja određenih mera u ovoj oblasti, a što se postiže

odgovarajućom zakonodavnom regulativom. S tim u vezi Vladu Republike Srbije u narednom periodu očekuje realizacija preuzetih obaveza iz oblasti zaštite životne sredine.

1 USTAV I REGULISANJE PRAVA ŽIVOTNE SREDINE

Odredbe o pravima vezanim za pravo životne sredine reguliše Ustav Republike Srbije [2]. Zdrava životna sredina u poglavlju Ustava u kome su grupisana ljudska i manjinska prava, sadrži tri norme važne za garantovanje i ostvarivanje prava na zdravu životnu sredinu. Prva norma je opšta garancija prema kojoj „svako ima pravo na zdravu životnu sredinu", uz koju se jemči još jedno pravo – pravo na „blagovremeno i potpuno obaveštavanjne o stanju životne sredine" [3]. Druga i treća ustavna norma odnosi se na obaveze i odgovornosti institucija i pojedinaca u vezi sa zaštitom zivotne sredine, tako da propisuje da je svako fizičko i pravno lice odgovorno za zaštitu životne sredine, a eksplicitno i posebno naglašava odgovornost RS i Autonomne pokrajine: „Svako, a posebno Republika Srbija i Autonomna pokrajina, odgovoran je za zaštitu životne sredine" [4].

Ustav tako rezerviše pravo Republici da svojim propisima, obezbeđuje: „održivi razvoj; sistem zaštite i unapređenja životne sredine; zaštitu i unapređenje biljnog i životinjsokog sveta; proizvodnju, promet i prevoz oružja, otrovnih, zapaljivih, eksplozivnih, radioaktivnih i drugih opasnih materija" [5].

Autonomnoj pokrajini utvrđuje da ima pravo nadležnosti , odnosno da u granicama i okvirima koje odredi zakon „reguliše pitanje od pokrajinskog značaja (...) u oblasti zaštite životne sredine" [6].

Nadležnost spušta i na lokalne zajednice, jer utvrđuje da se „u skladu sa zakonom (...) staraju o zaštiti životne sredine, zaštiti od elementarnih i drugih nepogoda", kao i o „zaštiti, unapređenju i korišćenju poljoprivrednog zemljišta" [7].

2 RAZVOJ PROPISA U OBLASTI ZAŠTITE ŽIVOTNE SREDINE U REPUBLICI SRBIJI

Početak i naznaka razvoja legislative u oblasti životne sredine u našoj državi, karakteriše oskudna pravna regulativa. Naime, ova oblast, kao celina, dugo vremena nije bila posmatrana kao posebna pravna disciplina, u smislu međusobne povezanosti, što je imalo za posledicu da su njeni pojedini segmenti bili proučavani u okviru različitih grana prava, ustavnog, građanskog, krivičnog, upravnog.

Počeci ove regulative se vezuju za period od 1991. do 2004. godine koji karakteriše izdvajanje zaštite životne sredine kao zasebne pravne celine. Donošenjem i stupanjem na snagu Zakona o zaštiti životne sredine [8], te 1991. godine po prvi put, u Srbiji pokušava da se urediti sistem zaštite i unapređenja životne sredine. Međutim, donošenje Zakona o zaštiti životne sredine, nažalost, nije uspeo da reguliše postojeće probleme u ovoj oblasti, jer ga nije pratio odgovarajući broj zakonskih i podzakonskih akata koji bi detaljnije regulisali ovu materiju. Pitanja koja se odnose na različite oblasti, kao na primer kvalitet vazduha, kvalitet vode, zaštita od buke, zaštita prirode, upravljanje hemikalijama, upravljanje otpadom i ostale, podrazumevaju posebnu, pojedinačnu regulativu za svaku od tih oblasti. Navedenim Zakonom, ove oblasti nisu, niti su mogle biti na adekvatan način regulisane.

Period od 2004. do 2009. godine se odnosi na uvođenje u ovu oblast, četiri veoma važna zakona, koji predstavljaju i nazivaju se sistemskim zakonima: Zakon o zaštiti životne sredine, Zakon o integrisanom sprečavanju i kontroli zagađivanja životne sredine, Zakon o strateškoj proceni uticaja na životnu sredinu i Zakon o proceni uticaja na životnu sredinu [8].

Period od 2009. godine, vezuje se za podnošenje prijave Srbije za pristupanje EU, kojoj je prethodilo usvajanje većeg broja sektorskih zakona [9]. Iako je njihovo donošenje imalo pozitivne promene, još uvek ih karakteriše izostanak ozbiljnijeg rešavanja nagomilanih problema u oblasti zaštite životne sredine.

3 PREGLED POJEDINIH ZAKONA IZ OBLASTI ZAŠTITE ŽIVOTNE SREDINE U REPUBLICI SRBIJI

U materiji zaštite životne sredine, opšta pitanja koja se odnose na životnu sredinu, regulisana su sistemskim zakonima [10], a pravila o upotrebi i zaštiti pojedinih dobara, regulisana su sektorskim zakonima [9].

3.1. U okviru kraćeg prikaza pojedinih zakona, **Zakon o zaštiti životne sredine**, je od velikog značaja za regulisanje ove oblasti. Samim tim i navodi na određene konstatacije u vezi sa njegovom primenom. Kao krovni zakon, uređuje pitanja koja se odnose na principe zaštite životne sredine; upravljanje i zaštitu prirodnih resursa; mere i uslove, programe i planove za zaštitu životne sredine; industrijske udese; mere remedijacije; sisteme za izdavanje ekoloških dozvola i odobrenja; mere zaštite od opasnih materija (proizvodnja, transport i rukovanje); monitoring u oblasti zaštite životne sredine (sistemi i informisanje); pravila koja predstavljaju implementaciju SEVESO II Direktive [11]; kazne za prekršaje i privredne prestupe (koje su povećane novim izmenama i dopunama); pristup informacijama i učešće u javnosti u donošenju odluka; ekonomske instrumente za zaštitu životne sredine; odgovornost za zagađenje životne sredine; nadzor. Inače ovako propisan sistem zaštite životne sredine, obezbeđuju različiti subjekti (organi uprave, privredni subjekti, naučne i stručne organizacije, građani i njihova udruženja), sa različitim ulogama. Odredbe ovog zakona su veoma opširne, između ostalog definišu opšte principe zaštite životne sredine, a takođe i zakonski okvir. Tako između ostalog, utvrđuje pravila za različita pitanja koja su toliko indirektna, kao na ona koja se odnose na zaštitu prirode, do upravljanja hemikalijama, te je jako teško da se uspostavi jedinstven režim, jer ne predstavljaju pravne odredbe u smislu definisanja prava i obaveza.

U vezi sa navedenom problematikom, navodi se kao jedan od primera poređenje sa Zakonom o strateškoj proceni uticaja na životnu sredinu [10]. Naime, navedeni zakon uspostavlja pet načela strateške procene, od kojih su tri (načelo održivog razvoja, načelo integralnosti i načelo predostrožnosti) navedena kao načela i u Zakonu o zaštiti životne sredine, gde su drugačije formulisana. Zakon o strateškoj proceni uticaja na životnu sredinu je *lex specialis*, a Zakon o zaštiti životne sredine je opšti zakon i ima prednost u odnosu na njega i tu naizgled nema sukoba. Ipak, postavlja se pitanje da li je korisno da krovni zakon definiše ta opšta načela, koja su definisana i drugim zakonima kojima se uređuje određena oblast zaštite životne sredine. Kao važan podatak navodi se i činjenica da ovaj zakon u prethodnom periodu, tačnije od 2004. godine do danas, imao više izmena i dopuna, što nije uputno za jedan sistemski zakon koji uređuje ovako važnu oblast [10] .

3.2. Zakon o integrisanom sprečavanju i kontroli zagađivanja životne sredine, kada je u pitanju njegova primena, otvara određena pitanja. Od stupanja na snagu ovog zakona, takođe od 2004. godine do danas, za čitavu teritoriju Republike Srbije, izdat je zanemarujući broj integrisanih dozvola [12]. Kao sistemski zakon, svojim odredbama uređuju uslove i postupak izdavanja integrisane dozvole za postrojenja i aktivnosti koji mogu imati negativne uticaje na zdravlje ljudi, životnu sredinu ili materijalna dobra, vrste i aktivnosti postrojenja i druga pitanja od značaja za sprečavanje i kontrolu zagađivanja životne sredine. Bez obzira na propisane (rigorozne) uslove, koji novim izmenama i

dopunama [10] nisu promenjeni, pitanje je da li privredni subjekti u postojećim okolnostima, mogu da ih ispune. Dalje, kao podatak navodi se i da je postupak izdavanja inegrisane dozvole veoma složen i dugotrajan (rok izdavanja dozvole traje najmanje 6 meseci). Zakon o opštem upravnom postupku, koji predstavlja osnovni-opšti propis na osnovu koga postupaju organi državne uprave i lokalne samouprave, propisuje rok za rešavanje upravnih predmeta po podnetom zahtevu, koji je u trajanjuod 30 do 60 dana. Postavlja se pitanje usaglašenosti primene zakonski propisanih rokova, prema vazećim propisima.

3.3 Zakon o proceni uticaja na životnu sredinu, iz grupe sistemskih zakona, uređuje pitanja koja se odnose na postupak procene uticaja za projekte koji mogu imati značajne uticaje na životnu sredinu (projekti iz oblasti industrije, rudarstva, energetike, saobraćaja, turizma, poljoprivrede, šumarstva, vodoprivrede, upravljanja otpadom i komunalnim delatnostima, kao i projekti koji se planiraju na zaštićenom prirodnom dobru i u zaštićenoj okolini nepokretnog kulturnog dobra), zatim sadržaj studije o proceni uticaja na životnu sredinu, učešće zainteresovanih organa i organizacija i javnosti, prekogranično obaveštavanje za projekte koji mogu imati značajne uticaje na životnu sredinu druge države i druga pitanja od značaja za procenu uticaja na životnu sredinu. Za primenu ovog zakona od velike važnosti je Uredba o utvrđivanju Liste projekata za koje je obavezna procena uticaja na životnu sredinu i Lista projekata za koje se može zahtevati procena uticaja na životnu sredinu [13]. Kada je u pitanju primena Uredbe Liste projekata za koje se **može** zahtevati procena uticaja, u praksi je veoma teško izvršiti procenu, od strane nadležnog organa, koja je to delatnost, odnosno projekat koji će se svrstati ili ne u ovu kategoriju. Ovo iz razloga što odluku o tome nadležni organi donose isključivo na osnovu podnetog zahteva sa priloženom propisanom dokumentacijom, bez izlaska na teren, čime se dovodi u pitanje pravilnost (mogući personalni uticaj) donete odluke. Pored ove problematike, u vezi sa zakonski propisanim rokovima, postupak odlučivanja i donošenja odluke o potrebi izrade studije o proceni uticaja na životnu sredinu je takođe dugačak i u suprotnosti sa ZUP-om.

3.4. U cilju efikasnog upravljanja kvalitetom vazduha, donošenjem **Zakonom o zaštiti vazduha** [9], započet je proces uspostavljanja jedinstvenog sistema praćenja i kontrole nivoa zagađenja vazduha i održavanja baze podataka o kvalitetu vazduha. Odredbama ovog zakona precizno su utvrđene nadležnosti u uspostavljanju državne i lokalnih mreža, upravljanje kvalitetom vazduha i određivanja mera, način organizovanja i kontrola sprovođenja zaštite i poboljšanja kvaliteta vazduha, uslovi pod kojima se može vršiti monitoring, kao i obaveza nadležnih organa da sve relevantne podatke o kvalitetu vazduha, propisane u podzakonskim aktima, dostave Agenciji za zaštitu životne sredine i stave na uvid javnosti. Iako Zakon reguliše gotovo sve segmente vezane za kvalitet vazduha, dosadašnjom primenom u praksi uočavaju se izvesni nedostaci koje se sastoje u nedorečenosti ili manjkavosti njegovih pojedinih odredaba. Tako na primer, propisana je obaveza privrednih subjekata koji u obavljanju svoje delatnosti utiču, ili mogu uticati na kvalitet vazduha, da obezbede tehničke mere za sprečavanje ili smanjenje emisije u vazduh, planiraju troškove zaštite vazduha od zagađivanja u okviru investicionih i proizvodnih troškova i prate uticaj svoje delatnosti na kvalitet vazduha. S tim u vezi propisana je i dužnost operatera stacionarnog izvora zagađenja, kod koga se u procesu obavljanja delatnosti mogu emitovati gasovi neprijatnih mirisa da primenjuje mere koje će dovesti do redukcije mirisa iako je koncentracija emitovanih materija u otpadnom gasu ispod granične vrednosti emisije. Pri tome ni jedna odredba zakona ne utvrđuje koje su to tehničke mere koje sprečavaju ili smanjuju emisije u vazduh, kao i mere koje dovode do navedene redukcije, pogotovo imajući u vidu da ni podzakonski akti, na primer ugostiteljske objekte i druge vrste delatnosti koje se bave termičkom obradom hrane, ne tretira kao zagađivače životne sredine. Nepostojanje zakonskih ovlašćenja za nadležne inspektore u primeni ovih odredaba zakona, naročito u velikim, urbanim sredinama, gradovima, dovodi u praksi do nemogućnosti preduzimanja, u ovakvim situacijama, neophodnih mera.

3.5. U okviru sektorskih zakona, od kojih su gotovo svi doneti maja meseca 2009. godine, **Zakon o upravljanju otpadom** [9], zaslužuje određeni komentar. Njegovim odredbama se utvrđuju savremeni principi klasifikacije otpada, planiranje upravljanja otpadom, nadležnosti u upravljanju otpadom, organizacije upravljanja otpadom, upravljanja posebnim tokovima otpada, dozvole za upravljanje otpadom, uključujući dozvole za mobilna postrojenja, prekogranična kretanja otpada, izveštavanja o otpadu i baze podataka, finansiranja upravljanja otpadom, kao i nadzor, odnosno inspekcijski nadzor nad primenama odredaba istog i kaznene odredbe. Od momenta primene ovog zakona, do sada, iako su sveže izmene i dopune iz 2016. godine, uočavaju se izvesna preklapanja sa drugim propisom, odnosno sa Zakonom o komunalnim delatnostima [14], koja se odnose na inspekcijski nadzor. Konkretno gradu Beogradu i opštininskim organima se Zakonom o upravljanju otpadom, poveravaju inspektorima za zaštitu životne sredine poslovi vršenja inspekcijskog nadzora nad aktivnostima koje se odnose na inertni i neopasni otpad (komunalni otpad). Isto tako odredbe Zakona o komunalnim delatnostima utvrđuje kao izvornu nadležnost komunalnih inspektora vršenje inspekcijskog nadzora u oblasti komunalnog otpada. Pitanje primene ovih zakona, odnosno vršenja poslova inspekcijskog nadzora inspektora za zaštitu životne sredine i komunalnih inspektora čiji je predmet inspekcijske kontrole isti, ostaje otvoreno.

3.6. Zakon o zaštiti od buke u životnoj sredini [9] je svojim odredbama trebalo da bude adekvatan primer nastavljanja procesa decentralizacije nadležnosti u oblasti zaštite životne sredine, odnosno prenošenje nadležnosti na nivo Autonomne pokrajine i lokalne samouprave, kako u donošenju dozvola, tako i u inspekcijskom nadzoru. Njegove odredbe uređuje subjekte koji učestvuju u zaštiti od buke u životnoj sredini, mere i uslove zaštite od buke u životnoj sredini, merenje buke, takođe u životnoj sredini, pristup informacijama, zatim nadzor i kaznene odredbe. Međutim, njegovom dosadašnjom primenom naročito na nivou lokalne samouprave, može se zaključiti da nije opravdao ovu adekvatnost. Nedostaci se tiču manjkovosti odredaba u zakonu o utvrđivanju, odnosno uređenju uslova i mera koje se odnose na zvučnu zaštitu, zaštitu od buke u objektima koje obavljaju delatnost u stambenim i stambeno-poslovnim objektima. S tim u vezi, zakon nije dao ovlašćenja jedinici lokalne samouprave da može propisati bliže uslove za upotrebu izvora buke koju koriste određene vrste delatnosti, što je neophodno naročito u većim gradovima, gde je prisutno usložnjavanje urbanog prostora. U delu koji se odnosi na uslove i mere koje operateri treba da preduzimaju prilikom obavljanja registrovane delatnosti, nisu utvrđene, niti je dato ovlašćenje lokalnoj samoupravi da tu oblast svojim propisima uredi. Tako je prisutno ugrožavanje životne sredine i zdravlja ljudi, jer su u pitanju aktivnosti privrednih subjekta koje se odobravaju bez učešća organa nadležnih za poslove zaštite životne sredine. Naime, radi se o obavljanju delatnosti u objektima za koje prethodno nisu definisani ni ispunjeni uslovi zaštite životne sredine (tehničkom dokumentacijom i prijemom objekta ili adaptacijom i prenamenom, najčešće bez odgovarajućih odobrenja).

3.7.Zakon o zaštiti od nejonizujućeg zračenja [9] predstavlja dobar primer dosadašnjeg napredovanja Srbije u transpoziciji legislative EU. Donošene ovog zakona je bilo neophodno, jer je stanje u oblasti zaštite od nejonizujućih zračenja u našoj državi nezadovoljavajuće. Mnogi izvori nejonizujućih zračenja u životnoj sredini koristili su se u velikoj meri nekontrolisano. Nisu uređene mere zaštite zdravlja ljudi i zaštite životne sredine od štetnog dejstva nejonizujućih zračenja u korišćenju izvora nejonizujućih zračenja. Ne postoji baza podataka o vrsti, karakteristikama i broju izvora nejonizujućih zračenja koji se koriste u životnoj i radnoj sredini. Sistematsko ispitivanje nivoa nejonizujućeg zračenja u životnoj sredini nije uspostavljeno. Sva ova pitanja, kao i uslove i mere zaštite zdravlja ljudi i zaštite životne sredine koji se odnose na štetno dejstvo nejonizujućeg zračenja i to u korišćenju izvora nejonizujućih zračenja, se uređuju ovim zakonom, kao i druge obavezne odredbe. Primena ovog zakona je najzastupljenija u delu nalaganja ispitivanja nivoa nejonizujućeg zračenja u

lokalnoj zoni baznih stanica na mestima od interesa i podnošenja zahteva nadležnom organu o potrebi procene uticaja zatečenog stanja.

4 KOMENTAR

U segmentu harmonizacije propisa, Republika Srbija je postigla veliki napredak, jer je u proteklom periodu donela set navedenih zakona, čime je započela reformu propisa. Međutim, bez obzira na ovako postignut napredak, osnovne karakteristike dosadašnjeg zakonodavnog stanja u oblasti zaštite životne sredine bi mogle da se svedu na karakteristike koje se ogledaju u sledećem:

Implementacija zakonodavne regulative EU u srpsko zakonodavstvo nije dovoljna, odnosno adekvatna. Ključni faktori nedovoljne ili izvitoperene implementacije, leže u slabim administrativnim kapacitetima državne administracije, nespremnosti države da usvojeni zakoni budu i primenjeni, stanju ekonomije i povlašćenom, odnosno nejednakom položaju onih koji su trebali da se usklade sa njihovim odredbama [15].

Dalje, prisutna je međusobna neusklađenost zakona, jer još uvek dominira sektorsko planiranje sa vrlo malim horizontalnim integrisanjem. U vezi sa tim, sektorske strategije nisu dovoljno usaglašene u odnosu na zaštitu životne sredine, a naročito imajući u vidu da nije formirano resorno ministarstvo, te nije obezbeđena potrebna koordinaciji svih aktivnosti u ovoj oblasti. Na primer, nedovoljna koordinacija između zakona iz oblasti životne sredine i drugih zakona koji definišu druge nadležnosti institucija na nacionalnom nivou izaziva neuravnoteženosti i preklapanja, koja se naročito manifestuju u Zakonu o lokalnoj samoupravi [16] i Zakonu o utvrđivanju nadležnosti Autonomne pokrajine Vojvodine [17]. Pored toga, prisutna je i slaba međuministarska koordinacija i saradnja. U prilog ove konstatacije govori Zakon o zaštiti životne sredine, koji iako je sistemski propis, ni jednom odredbom ne određuje bliže vezu tog ministarstva sa drugim sektorima, što otežava adekvatna programska delovanja. U pogledu primene propisa, prisutno je nedovoljno efikasno sprovođenje istih. Naime, jedna od osnovnih odlika resora životne sredine u Srbiji je da je regulisan velikim brojem propisa i da je previše kompleksan sistem. Ovi propisi su veoma teški za razumevanje, jer bez obzira na multidisciplinarnost koja je u njima zastupljena, sadrže i veliki broj kontradiktornosti i nepotrebnih stvari, tako da su ponekad više, dokumenta politike sa ambicioznim odredbama, a ne zakonskim okvirom sa normama o pravima i obavezama [18].

Kao veoma važan podatak je činjenica da se izrada nacrta podzakonskih akata vrši posle usvajanja zakona, dok su postojeća podzakonska akta i dalje na snazi. Tako je prisutna neusklađenost propisa, jer prilikom primene novousvojenih zakona i postojećih („starih") podzakonskih akata, nastaju „problematični slučajevi" (upravni predmeti) koje nije moguće pravno regulisati.

Posebno se naglašava segment učešća javnosti u oblasti zaštite životne sredine, koji zaslužuje sledeći kometar. Donošenjem Zakona o potvrđivanju Konvencije o dostupnosti informacija, učešću javnosti u donošenju odluka i prava na pravnu zaštitu u pitanjima životne sredine [19], u pravni sistem Republike Srbije je „ušla" Arhuska Konvencija. Učešće javnosti u procesu usaglašavanja nacionalnih propisa sa propisima EU, nije dovoljno zastupljeno. Budući, da su okviri zaštite prava na životnu sredinu u Srbiji uređeni većim brojem zakona i podzakonskih akata, treba naglasiti da se postupak dobijanja ekoloških informacija i učešće javnosti u donošenju ekoloških odluka, deli na osnovu dve grupe zakona: one zakone koji normiraju poseban postupak učešća javnosti i one koji ne normiraju poseban postupak učešća javnosti.

U grupu propisa koji normiraju poseban postupak učešća javnosti [20] svojim odredbama su inkorporirali međunarodne standarde o informisanju i učešću javnosti u postupcima od značaja za

životnu sredinu [21], kao i značajnoj zaštiti ovih prava pred državnim organima - upravnim i sudskim. Ovim nizom zakona, učešće javnosti je na odgovarajući način uneto u pravni okvir koji se može primenjivati, mada je potrebno pojačati njihovo praćenje. Međutim, drugu grupu čini izvestan broj zakona [22], koji uopšte ne reguliše materiju učešća javnosti u postupcima od značaja za životnu sredinu. Ovi zakoni ne mogu biti dovoljni za odgovor na pitanje koja je uloga i mogućnost javnosti, odnosno zainteresovane javnosti, da u materiji koju ti zakoni regulišu, subjekat uzme učešće kao stranka u postupku. Samim tim uloga zainteresovane javnosti u procesu usaglašavanja nacionalnih propisa sa propisima EU nije ostvarena [23].

5 ZAKLJUČNA RAZMATRANJA

Postojeći pravni okvir zaštite zivotne sredine, pokazuje da je ova materija jedna od najobimnijih i najsloženijih u Republici Srbiji. Ova konstatacija potvrđuje da je harmonizacija propisa obiman i složen proces, za svaku državu koja pretenduje na članstvo u EU, imajući u vidu da je za implementaciju najkompleksnijih i finansijski najzahtevnijih delova acquis-a potrebno određeno vreme [24]. U ovom segmentu Republika Srbija je postigla veliki napredak, koji se ogleda u reformi propisa u oblasti životne sredine. Ove promene ukazuju na napore koje država ulaže na stvaranju institucija koje su sposobne za implementaciju obaveza koje proističu iz međunarodnih, nacionalnih i obaveza EU [25]. Činjenica da zakoni predstavljaju osnov za regulisanje oblasti životne sredine, je nesporna, međutim, nije najvažnija, jer se postavlja pitanje efikasnosti njihovog sprovođenja i primene.

U kontekstu navedenih zaključaka, neophodno je istaći da mnogi privredni subjekti, odnosno odgovorna lica u njima, još uvek nisu u dovoljnoj meri upoznati sa važećom zakonodavnom regulativom u oblasti životne sredine. Delatnost privrednih organizacija u Srbiji, odredbama ovih zakona i podzakonskih akata, je stavljena pod visoki stepen odgovornosti u oblasti zaštite životne sredine. Time je stvoren poslovni ambijent koji zaštitu životne sredine mora uključiti u osnovne vrednosti kojima se teži, kao što je to već odavno visoko pozicionirano u praksi većine kompanija u svetu [23].

Zato privredne organizacije i državni organi u Republici Srbiji imaju obavezu da hitno izvrše neophodne organizacione promene i pripreme, a sve u cilju sprovođenja odredaba ovih zakona u svakodnevnu praksu. Na taj način moguće je da se u kratkom roku započne sveobuhvatni i osmišljen proces zaštite životne sredine u Republici Srbiji.

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THE ROLE OF COSTS AND ASSESSMENT OF THEIR ECONOMIC EFFICIENCY WHEN IMPLEMENTING ENERGY SAVING TECHNOLOGIES IN BLOCKS OF FLATS MANAGEMENT

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Abstract: Development of domestic economy in general, subjects and municipalities in particular, in the context of limited financial subsidies depends on their economic condition, technological equipment, organization of activities aimed at saving energy resources.

Branch of housing and utilities currently is one of the main consumers of energy resources of Russia. The housing and utility sector accounts for about 35% of total energy consumption in the country.

Energy saving measures can reduce payments for consumed energy resourcesin a short time in the long term. The contracts for the provision of services on energy saving and increasing energy efficiency, which found its definition in the law and called energy service contribute to this.

ECONOMIC EFFECTS OF COLLECTION AND PRIMARY RECYCLING OF PACKAGING WASTE FROM HYGIENE AND CLEANING PRODUCTS IN SERBIA

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Abstract: Hygiene and cleaning products and their packaging are highly likely to threaten the environment, especially water and soil. The degree of environmental threat from hygiene and cleaning products and their packaging primarily depends on: the type of product; product ingredients and their toxicity; product use; amount of product used for washing and cleaning; manner of production; expiration date; etc. In addition to these factors, the degree of environmental pollution is also affected by the packaging and the manner of their disposal. Therefore, collection and primary recycling of packaging waste from hygiene and cleaning products occupy an important place in an integral system for managing this type of waste. It is a fact that management of such waste helps reduce negative economic and environmental impact on one hand and helps bring direct and indirect benefits from collection and primary recycling of the packaging waste. In order to obtain more comprehensive data on the economic effects of managing this type of waste, this paper presents a methodology for calculating the relevant values associated with the waste. The paper also provides data on the amount, type, and market value of packaging waste from hygiene and cleaning products. Using the data on economic and environmental impact of the packaging waste from hygiene and cleaning products, as well as the data on economic benefits from this type of waste, it is possible to analyse the profitability of its collection and primary recycling in Serbia.

***Keywords*:** hygiene and cleaning products, packaging waste, waste collection, primary recycling, economic effects, environmental impact, packaging waste value and economic effects

1 Introduction

Economically, packaging waste from hygiene and cleaning products can have both negative and positive effects. Namely, such waste initially requires certain economic means to be managed properly, including the costs of collection, transport, storage, and treatment. In modern economies, this waste is treated as a potential resource, i.e. secondary raw material with a specific value that is constantly increasing. Analysis of the values of this type of waste involves establishing its real and hidden value.

The real value of packaging waste from hygiene and cleaning products is the one expressed as the product of the amount of a specific type of this waste and the average price of materials used to make the packaging. The hidden value of this waste is expressed as the sum of the costs of improper waste management, i.e. its improper disposal, costs of medical treatments of ill workers and civilians, and costs due to absenteeism of ill and injured workers (financial compensation, reduced production, etc.).

A comparison of these values with the degree of negative economic effects caused by improper management of this type of packaging waste can reveal whether this waste causes positive or negative economic effects. If the obtained real and hidden values exceed the costs of improper packaging waste management, taxes, and remediation and mitigation of the damage due to waste generation, it means that the effects are positive; otherwise, the effects are negative.

2 Methodology

2.1 Methods of analysis of solid waste from hygiene and cleaning products

Analysis of solid waste from hygiene and cleaning products can be performed using a variety of methods. For the research of such waste at the recycling centre of the Public Utility Company "Mediana" in Niš, Serbia, we used the following methods:

- direct analysis, or sample and sort method,
- indirect analysis of the composition if solid waste by means of analysing market products, and
- indirect analysis of the products of solid waste treatment.

Direct analysis of solid waste from hygiene and cleaning products involves the following steps:

- collecting samples for analysis that are smaller than the total amount of generated municipal solid waste of a particular hygiene and cleaning product,
- inspection and analysis of solid waste samples, and
- determination of waste resources and their substances.

Indirect analysis of the composition of municipal solid waste through analysis of market products, which is applied to analysis of the composition of packaging waste from hygiene and cleaning products, involves the gathering of:

- information about the hygiene and cleaning products manufacture,
- information about the fate of hygiene and cleaning products during use and consumption,
- information about the hygiene and cleaning products from the manufacturers, corporations, professional organizations (e.g. A.I.S.E. – International Association for Soaps, Detergents and Maintenance Products), and government agencies (e.g. Serbian Environmental Protection agency)
- information about import, export, and supplies of every category of the analysed sample of solid waste from hygiene and cleaning products, and
- information about the average life span of a specific product.

Indirect analysis of the products of packaging waste treatment is based on the information about the resulting products after the treatment (recycling, disposal, incineration, etc.) of collected samples of this waste. The advantage of using this method lies in the fact that the *outputs* of hygiene and cleaning products waste treatment are less heterogeneous than its *inputs* [Source: Vujić, G. and Brunner, P., Sustainable Waste Management, 2009].

The use of the aforementioned methods for hygiene and cleaning products solid waste analysis is shown in Figure 1.

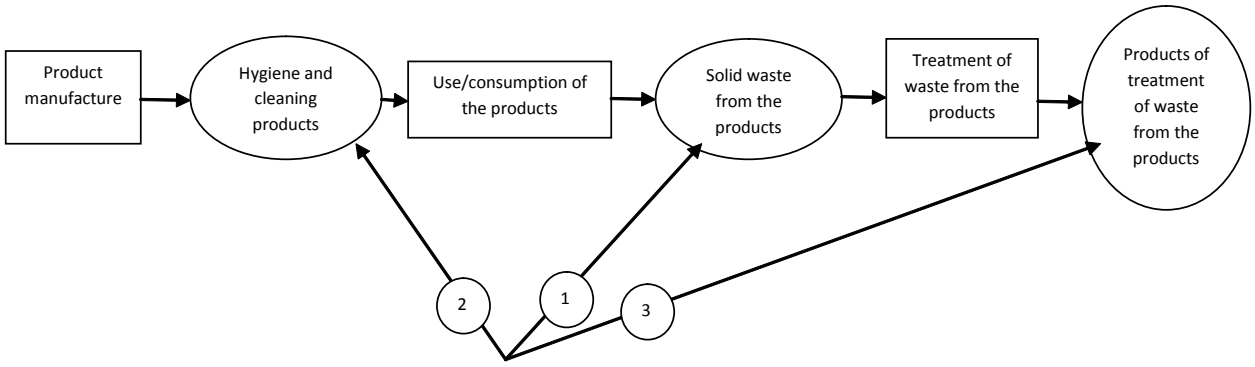

Figure 1. Methods of analysis of solid waste from hygiene and cleaning products: 1) Direct analysis, 2) Analysis of hygiene and cleaning products, 3) Analysis of products of hygiene and cleaning products waste treatment

2.2 Method of decursive calculation of economic effects

Calculation of economic effects of collection and primary recycling of solid waste from hygiene and cleaning products using the decursive method is made a posteriori, after the manufacturing process, trade, and use of the products, and the registered economic and environmental impact caused by improper management of this waste.

Comparison of the data on packaging waste values with the degree of negative economic impact resulting from improper management of this waste can yield the following relations:

• if the value of the packaging waste from hygiene and cleaning products is higher than the negative economic effects of improper waste management, the economic effects of collection and primary recycling are *positive*;

• if the value of the packaging waste from hygiene and cleaning products is lower than the negative economic effects of improper waste management, the economic effects of collection and primary recycling are *negative*.

2.3 Method of analysing economic and environmental justifiability of collecting hygiene and cleaning products packaging

Packaging waste from hygiene and cleaning products (plastic bags and bottles, bottle caps, cardboard and plastic boxes, etc.) should not be scattered around the environment but deposited at predetermined locations in compliance with local or national legislation (Figure 2).

Figure 2 International symbol for a location where hygiene and cleaning products packaging waste is properly deposited

When hygiene and cleaning products are spent, their packaging most commonly ends up in the bin with other waste, whether it is dry or wet municipal waste. However, raising the citizens' awareness that they should stop throwing such packaging away into the environment, i.e. improperly disposing of it, and instead collect it and deposit it in an organized and proper fashion can have a significant positive environmental and economic impact. Positive environmental impact includes elimination of illegal dumping sites and increased ambient landscape aesthetics, e.g. with the removed plastic bags, bottles, and cardboard, glass, and aluminium containers of hygiene and cleaning products. In addition, positive economic effects are also likely.

We should note that there were many families in Serbia that used to make a living by collecting and selling secondary raw materials. Nowadays, the only economic benefits of packaging waste collection are reaped by associations that deal exclusively with hygiene and cleaning products packaging waste collection. Thus, in Serbia there are associations dealing with organized collection of plastic caps, such as: "Čep za hendikep" (*Eng.* A Cap for the Handicapped) from Zrenjanin, "Čepom do osmeha" (A Cap for a Smile) from Novi Sad, "Pomoć ugroženima" (Help for Those in Need) from Niš, and others. Their exclusive collection of plastic caps from plastic hygiene and cleaning product containers creates a significant positive environmental and economic impact.

Environmental impact of cap collection is reflected in a cleaner environment and reduced amount of plastic caps. For illustration, one tonne of plastic caps contains over five million pieces weighing 20 grams. Furthermore, these associations are able to collect sufficient amounts to be processed at the recycling centre.

The economic impact is reflected in specific financial results achieved through cap sales to recycling centres at prices ranging from €150 to €200. The associations usually spend their earnings on orthopaedic aids (e.g. wheelchairs).

3 Data analysis

Composition of solid waste from hygiene and cleaning products is determined by means of analysis of the composition of packaging material after primary recycling. The analysed amount of packaging waste was collected from 600 households over one month. The following values for the analysed waste were obtained:

- type of packaging according to the material,
- packaging mass, and
- packaging volume.

Table 1 shows the data on the mass and volume of packaging waste from hygiene and cleaning products according to the type of packaging material.

Table 1. Mass and volume of packaging according to the type of material in hygiene and cleaning products waste collected from 600 households [Source: Project *Model of Environmental Impact Assessment for Hygienic and Cleaning Products Waste*, 2015]

Number	**PACKAGING MATERIAL**	*MASS*		**VOLUME**	
		[kg]	**%**	**[dm^3]**	**%**
1.	Plastic	158.71	46	1,687.42	48
2.	Glass	118.72	34	1,107.69	32
3.	Aluminium	42.16	12	397.58	11
4.	Paper and cardboard	28.93	8	301.57	9
	TOTAL	348.52	100	3,494.26	100

The analysis considered total mass and volume of the packaging from hygiene and cleaning products, as well as the amount of their content. The amount of packaging waste depends on the packaging material. The results showed that plastic packaging has the biggest mass percentage of the four categories with 46%. It is followed by glass packaging with 34%, aluminium packaging with 12%, and paper and cardboard packaging with only 8% of the total packaging waste mass. The analysed waste did not contain any packaging made of wood.

Analysis of the volume of hygienic and cleaning products packaging waste, which had been classified according to the packaging material, showed that plastic packaging has the biggest volume percentage of the four categories with 48%. It is followed by glass packaging with 33%, aluminium packaging with 11%, and paper and cardboard packaging with only 9% of the total packaging waste volume.

4 Value of packaging waste from hygiene and cleaning products

In the secondary raw materials market, packaging waste from hygiene and cleaning products has its value, expressed as its price. The price of packaging waste from hygiene and cleaning products is expressed in monetary units (dinars or euros), per unit mass (kg, t, etc.) or unit volume (dm^3 or m^3). The total price of packaging waste from hygiene and cleaning products (C_{ohs}) expressed in suitable units of measure (din/kg, din/dm^3, €/t, €/m^3, etc.) is calculated with the formula:

$$C_{ohs} = C_p + C_s + C_m + C_{pk} + C_d + C_o \quad (1)$$

where:

C_p – price of plastics from hygiene and cleaning products waste;

C_s – price of glass from hygiene and cleaning products waste;

C_m – price of metals from hygiene and cleaning products waste;

C_{pk} – price of paper and cardboard from hygiene and cleaning products waste;

C_d – price of wood from hygiene and cleaning products waste;

C_o – price of other materials from hygiene and cleaning products waste.

4.1 Price of plastics from hygiene and cleaning products waste

The price of plastics from hygiene and cleaning products waste ($\sum C_p$) is determined according to the type of plastic. It is calculated as the sum of the products of prices and amounts of plastic subtypes, according to the formula:

$$\sum C_p = (C\times Q)_{pet} + (C\times Q)_{hdpe} + (C\times Q)_{pvc} + (C\times Q)_{ldpe} + (C\times Q)_{pp} + (C\times Q)_{ps} + (C\times Q)_{ost} \quad (2)$$

where:

C_{pet} and Q_{pet} – price and amount of polyethylene terephthalate plastic,

C_{hdpe} and Q_{hdpe}– price and amount of high-density polyethylene plastic,

C_{pvc} and Q_{pvc}– price and amount of polyvinyl chloride plastic,

C_{ldpe} and Q_{ldpe}– price and amount of low-density polyethylene plastic,

C_{pp} and Q_{pp} – price and amount of polypropylene plastic,

C_{ps} and Q_{ps} – price and amount of polystyrene plastic, and

C_{ost} and Q_{ost}– price and amount of other types of plastic.

4.2 Price of glass from hygiene and cleaning products waste

The price of glass from hygiene and cleaning products waste ($\sum CQ_{ST}$) is determined according to the type of glass. It is calculated as the sum of the products of prices and amounts of glass subtypes, according to the formula:

$$\sum CQ_{ST} = (C\times Q)_B + (C\times Q)_Z + (C\times Q)_S \quad (3)$$

where:

C_B and Q_B – price and amount of colourless glass packaging,

C_Z and Q_Z – price and amount of green glass packaging,

C_S and Q_S – price and amount of amber glass packaging.

4.3 Price of aluminium packaging

The price of aluminium packaging ($\sum CQ_{AL}$) is determined according to the type of aluminium. It is calculated as the sum of the products of prices and amounts of aluminium subtypes, according to the formula:

$$\sum(CQ)_{AL} = (C \times Q)_m + (C \times Q)_t \quad (4)$$

where:

C_m and Q_m – price and amount of soft aluminium packaging,

C_t and Q_t – price and amount of hard aluminium packaging.

4.4 Price of paper and cardboard packaging

The price of paper and cardboard packaging ($\sum CQ_{PIK}$) is determined according to the type of material. It is calculated as the sum of the products of prices and amounts of either paper or cardboard, according to the formula:

$$\sum(CQ)_{PIK} = (C \times Q)_p + (C \times Q)_k \quad (5)$$

where:

C_p and Q_p – price and amount of paper packaging,

C_k and Q_k – price and amount of cardboard packaging.

5 Calculation of the value of hygiene and cleaning products waste

The prices of packaging waste were obtained from the companies that buy or sell secondary raw materials. The price of packaging waste from hygiene and cleaning products heavily depends on whether the waste was previously sorted, whether it was treated (ground, granulated, baled, etc.), and whether it contains any impurities. If it was sorted and treated, it is more expensive than the unsorted and untreated waste. The waste containing certain impurities is far less expensive than 'pure' waste.

Table 2. Price of packaging waste according to material in Serbia [Source: SanSI Marketing System – Price report, July 2014]

Packaging	Price in din/kg
Aluminium, soft and hard	**100-120**
HDPE	**25-115**
LDPE	**28-95**
Mixed paper and cardboard	**3-8**
PET	**19-45**
PP	**25-115**
PS	**55-125**
PVC	**30-65**
Glass	**05-2**

The value of packaging waste from hygiene and cleaning products can be calculated based on the data on the amount collected and deposited daily, monthly, and annually, and by including the percentage of constituent materials, as well as the price of the waste in the secondary raw materials market.

If it is assumed that the total amount of generated packaging waste from hygiene and cleaning products has the same composition as our analysed sample, we can determine its value. The calculated daily, monthly, and annual value of packaging waste from hygiene and cleaning products in the Nišava County and in Serbia is shown in Table 3.

Table 3. Value of packaging waste from hygiene and cleaning products in the Nišava County and in Serbia in 2015 [Source: Project *Model of Environmental Impact Assessment for Hygienic and Cleaning Products Waste*, 2015]

SCOPE	**NUMBER OF HOUSEHOLDS**	**PRICE [din]**		
		DAY	MONTH	YEAR
Our own research	600	497.82	14,934.50	179,213.98
Nišava County	127,300	105,620.09	3,168,602.72	38,023,232.63
Serbia	2,487,886	2,064,184.95	61,925,548.67	743,106,584

The daily, monthly, and annual values of waste from hygiene and cleaning products in Serbia reduced to the total population number indicate the values of this waste per capita in the same intervals. Namely, the value of waste from hygiene and cleaning products amounts to 103.7 dinars per capita annually. By using the percentage of the mass of specific packaging waste materials and their prices, we

can calculate the values for plastic, glass, aluminium, and paper and cardboard packaging waste (Table 4, Figure 3).

Table 4. Value of packaging waste from hygiene and cleaning products according to material [Source: Project *Model of Environmental Impact Assessment for Hygienic and Cleaning Products Waste*, 2015]

NUMBER	**PACKAGING MATERIAL**	*VALUE* **[din]**
1.	Plastic	496,681,504
2.	Glass	8,881,752
3.	Aluminium	229,880,640
4.	Paper and cardboard	7,662,688
	TOTAL	743,106,584

Economic value of packaging waste from hygiene and cleaning products is reflected in the market value of such waste. Economic benefit can be viewed as the *final value of a material in the secondary raw materials market*, while it can also be viewed through waste management stages, considering that waste management reduces the costs incurred by the negative environmental and health impact of the waste.

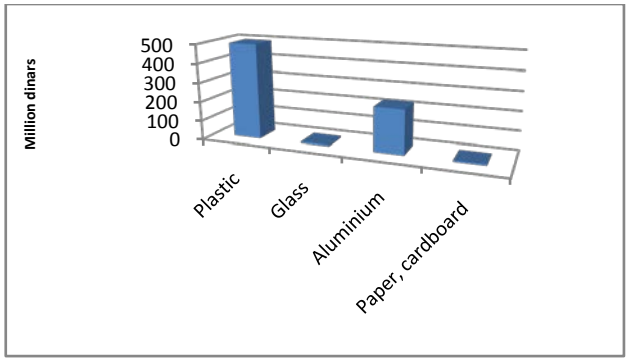

Figure 3. Annual value of packaging waste from hygiene and cleaning products according to material

In fact, if there were no adequate waste management for waste from hygiene and cleaning products, cities would turn into dumpsites and diseases, injuries, and fatalities would abound, which would eventually lead to an economic collapse. Recovery of a degraded environment is a long and economically demanding process, as is medical treatment of humans. Therefore, the economic significance of waste management for waste from hygiene and cleaning products is relevant for the general public interest. In addition, the economic benefit can initially be invisible. For instance, deposited waste from hygiene and cleaning products occupies a lot of space. In the event of proper waste management, it would be deposited over a much smaller area, which, in turn, would allow other profitable activities to be conducted in the remaining area. The classification of economic values of packaging waste from hygiene and cleaning products is shown in Figure 4.

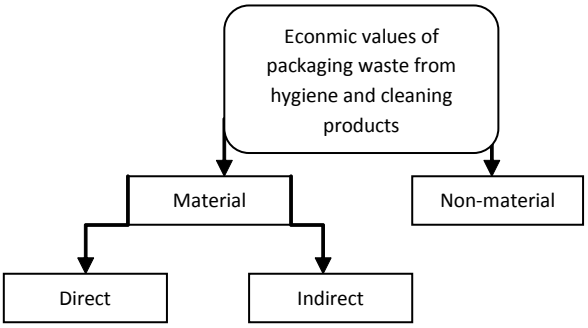

Figure 4. Classification of economic values of packaging waste from hygiene and cleaning products

6 Number of employees in waste management in Serbia

The number of employees hired for waste removal from 2003 to 2007 is given in Table 5 and Figure 5.

Table 5 Number of employees for waste removal in Serbia from 2003 to 2007 [Source: Statistical Yearbook of Serbia, 2003-2007]

Year	No. of employees	Index
2003	11,388	100.00
2004	11,669	102.47
2005	12,153	106.71
2006	12,388	108.78
2007	12,596	110.60

The data reveal that the number of employees in waste removal increased by year, by 10.6% in total, from 11,388 employees in 2003 to 12,596 in 2007.

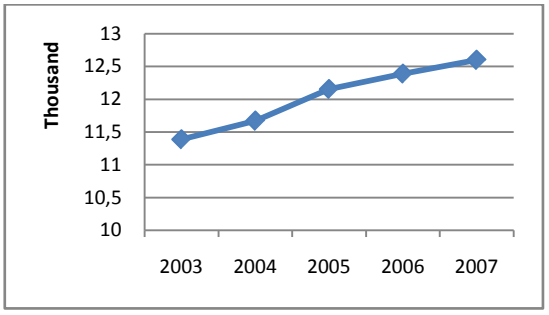

Figure 5. Flow of the number of employees in waste removal in Serbia from 2003 to 2007

In 2009, the job category of waste removal changed its name to *waste collection, treatment, and disposal*. The number of employees in waste collection, treatment, and removal from 2009 to 2013 is given in Table 6 and Figure 6.

Table 6. Number of employees in waste collection, treatment, and removal in Serbia from 2009 to 2013 [Source: Statistical Yearbook of Serbia, 2009-2013]

Year	No. of employees	Index
2009	14,505	100.00
2010	14,285	98.48
2011	14,370	99.07
2012	14,615	100.76
2013	15,786	108.83

The data reveal that the number of employees in waste collection, treatment, and removal in the shown five-year period increased by 8.83%, from 14,505 in 2009 to 15,786 in 2013.

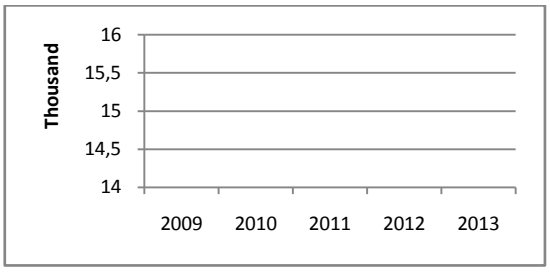

Figure 6. Flow of the number of employees in waste collection, treatment, and removal in Serbia from 2009 to 2013

7 Costs of workforce for waste management in Serbia

Costs of the workforce in waste management in Serbia are expressed in gross or net salaries. The following formula calculates the costs of workforce expressed in gross salary (TRS_{bz}):

$$TRS_{bz} = Z \cdot PBZ \quad (6)$$

where:

Z – number of employees and

PBZ – average gross salary.

The following formula calculates the costs of workforce expressed in net salary (TRS_{nz}):

$$TRS_{nz} = Z \cdot PNZ \quad (7)$$

where:

Z – number of employees and

PNZ – average net salary.

The data on the number of employees, gross and net salaries, and workforce costs for waste management in Serbia from 2009 to 2013 are shown in Table 7 and Figure 7.

Table 7 Number of employees, gross and net salaries, and workforce costs for waste management in Serbia from 2009 to 2013 in thousand dinars [Source: Statistical Yearbook of Serbia, 2009-2013]

Year	**No. of employees**	**Average gross income per employee**	**Average net income per employee**	**Gross workforce costs**	**Net workforce costs**
2009	14,505	40,642	29,126	589,512.21	422,472.63
2010	14,285	42,882	30,813	612,569.37	440,163.705
2011	14,370	46,988	33,906	675,217.56	487,229.22
2012	14,615	50,806	36,601	742,529.69	534,923.615
2013	15,786	52,825	38,178	833,895.45	602,677.908
Total	73,561			3,453,724.28	2,487,467.078

The data reveal that the workforce costs for waste management within this period increased significantly, with the gross costs as much as 41.4% higher, from 589,512.21 dinars in 2009 to 833,895.45 dinars in 2013. A similar increase occurred with the net workforce costs for waste management, which increased by as much as 42.6%, from 422,472.63 dinars in 2009 to 602,677.908 dinars in 2013.

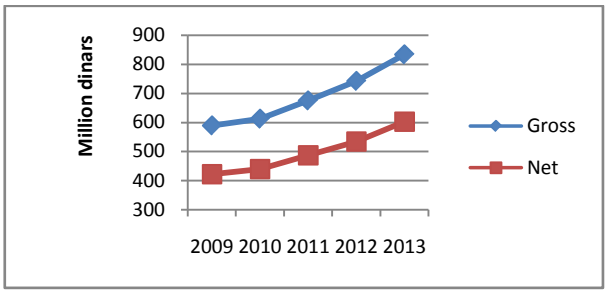

Figure 7. Flow of gross and net workforce costs for waste management in Serbia from 2009 to 2013 [Source: Statistical Yearbook of Serbia, 2009-2013]

8 Conclusion

Improper treatment of waste from hygiene and cleaning products can cause significant negative environmental and health impact, with the added economic effects.

Positive economic effects of hygiene and cleaning products waste management occur when the economic effects do not exceed economic benefits and investment in the management of such waste.

Negative economic effects of hygiene and cleaning products waste management occur when the economic effects of improper waste management exceed economic benefits and investment in assets and equipment for waste management. This difference can be 'balanced out' by reducing unwanted environmental impact or through so-called *indirect and non-material benefits from hygiene and cleaning products waste*, whose values are difficult to express in practice.

Investment in hygiene and cleaning products waste management increases the costs, but also raises the price of waste in the secondary raw materials market with each waste management stage. The presence of economic effects that are not instantly visible, but take time to manifest themselves, together with the indirect and non-material benefits, makes *investing in hygiene and cleaning products waste management economically and environmentally justified.*

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EFFECTIVE WASTE MANAGEMENT AS PART OF THE CONCEPT OF CIRCULAR ECONOMY

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Abstract: Production process needs natural material resources. The level of development depends of the level of technology becouse that material resources are not always sufficiently exploited. More effective waste management or better kind of exploatation, may bring environmental benefits. In the same time that meanseconomic benefits, too. Better management of these resources in the liberal competitiveness market may be an advantage that makes a difference. Economy, since the primitive capital accumulation and industrial revolution, growing on the principle: "take, make, consume, discard" and presenting the so called "linear model". The transition process from "linear" to "circular" economy is complex because it requires fulfilment of a series of assumptions: corresponding institutional framework, awareness, scientific approach and a new view of the economic reality and future. The EU has concluded that the concept of "linear economy" endangers competitiveness of the EU. Better material resource use is possible and this can significantly contribute to competitiveness of the EU economy. Transition from "linear" to the concept of "circular economy" is essential for realization of the program for successful exploitation of material resources in the framework of the Europe 2020 strategy. In this paper the author researches the effective waste management as part of the conceptof "circular" economy.

***Keywords*:** waste management, linear model, the concept of circular economy.

USAGE OF RENEWABLE ENERGY SOURCES IN THE FUNCTION OF SUSTAINABLE ECONOMIC DEVELOPMENT OF TRANSITION COUNTRIES

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Abstract: The achievement of sustainable development is an imperative for all economies, particularly if someone takes in account contemporary trends in the global energy market. This is particularly relevant for transition economies, given that most of them are facing numerous macroeconomic and structural imbalances. One of the most important is certainly a high dependency on energy imports, which cause significant fluctuations in the domestic energy market.

In order to adapt to the new situation and create conditions for greater stability of the energy markets, these economies are increasingly turning to the production of energy from renewable sources. In addition to many positive effects in the economic sphere, the use of these energy sources has a positive impact on the environment. In this sense, this paper investigates the key indicators of the situation in the energy sector in selected transition economies using the multi-criteria analysis, in order to evaluate the level of development of the sector in each of them. After that, it investigates the correlation between development of the energy sector and economic development and gives recommendations and guidelines for improvements in this area in Serbia in the future.

***Keywords*:** sustainable development, energy market, transition economies, renewable energy, multi-criteria analysis.

1 Introduction

Although each country is seeking to meet its short-term objectives - price stability, unemployment reduction, economic growth, since the 60s of the 20th century there has been recorded raising interest in achieving sustainable development in the long run. Numerous authors were and still are preoccupied with the issue of sustainable development, but all of them agree that it can be defined as the rational use of available resources and limited production. The advocates of sustainable development are faced with a dilemma that affects any program of political action and social change: the dilemma between the urge to take strong stands on fundamental concerns and the need to gain wide political acceptance and support. [1]

Renewable energy sources can play a crucial role in achieving sustainable development, particularly in transition countries. These economies are typically characterized by high energy consumption and high dependence on energy imports, which is a significant constraint for acceleration of their economic development. In this sense, the development of energy production from renewable sources allows them:

1) to reduce dependence on energy imports and, thus, to improve the situation in the balance of payments and achieve price stability (because these economies are faced with the problem of imported inflation);
2) to diversify the structure of energy suppliers and increase competition in this sector, which allows the prevention of monopoly and energy price reduction;

3) to improve access to energy for rural population (and, thus, to reduce poverty and improve the standard of living);
4) to decrease the environmental effects of energy production.

Although they are aware of the importance and benefits from using renewable energy sources, most transition economies have not made significant progress in this area. Except the slow development of technology in this area (due to lack of funds for investment in research and development and building capacities for the production of energy from renewable sources), the causes of such situation should be sought in the lack of consistent and coherent sustainable development strategy and its inefficient implementation. Some authors emphasize the importance of formulating the so-called "Transitional sustainability policy" [2], which enables the achievement of sustainable development, through the transition to sustainable use, consumption, production and distribution of energy. Such development policy will allow the integration of so far conflicting policies, like those relating to the energy use, resource use efficiency, waste management, transport systems, technological innovation, social entrepreneurship and ecology regulation. Formulating the policy, therefore, requires the use of a multidisciplinary approach to the problem, in order to overcome the problems and limitations during the policy formulation and implementation, as well as to ensure wide acceptance of the implementation by the society. In fact, it often happens that a number of institutions at different levels of government, involved in this policy implementation, have opposing interests, and, because of that, is very difficult to devise a policy that enables the achievement of a broad social consensus about the necessity of implementation of such policy and the realization of general public interest. Besides institutions, it should be taken in account the behavior, interests and the role of other agents engaged implementation process, like foreign investors, energy consumers and producers, non-governmental organizations, various professional associations and so on.

With this in mind, it is necessary to provide close cooperation and continuous information flow between mentioned stakeholders during the development and implementation of policies, in order to reach the optimal solution. The transition from the "consumer society" to "sustainable society" requires a radical change of behavior, attitudes, and values in society, so, instead the actual practice of analyzing the producers and consumers interests, defining the policies and strategies for sustainable development should consider the role and perception of the other agents in the society. Through communication with all of them, policymakers should, in early stage of policy formulation, identify those stakeholders who will provide the greatest resistance to changes, but also those that will be the main drivers of change, which will greatly affect the choice of policy measures and instruments and the effectiveness of its implementation.

The achievement of sustainable development should increase the population's awareness of the irrational and unconscionable resource consumption, treat in the same way the economic, environmental and social dimension and coordinate the social scale with individual preferences. In addition, sustainable development has to promote a partnership between the state and private sectors, as well as to correct market failures. The synergistic and pluralistic effects, as well as the effectiveness of economic institutions are a prerequisite for dominance of economic freedom, private property and the effective owner as a mass phenomenon, the development innovations and sustainable economic development in general. [3]

2 Energy production and consumption in countries in transition

The majority of former command economies have relatively slow renounced their heritage from a centrally planned period and one of these characteristics is certainly the high energy consumption. Figure 1 shows the trend of energy consumption per capita in selected transition economies.

From Figure 1 it can be seen a slight decline of energy consumption per capita in the most of observed transtion economies. These decline is higher in countries with highest energy consumption, like Slovenia and Slovakia. If we compare with initial period of transition, Slovenia and Albania are increasing the level of consumption, while the rest of the economies have retained approximately the same level of consumption, except Romania which recorded significant decrease in energy consumption. It is interesting to emphasize that Serbia recorded significant fluctuations in energy consumption until 2000, and after 2000 the level of consumption was relatively stable.

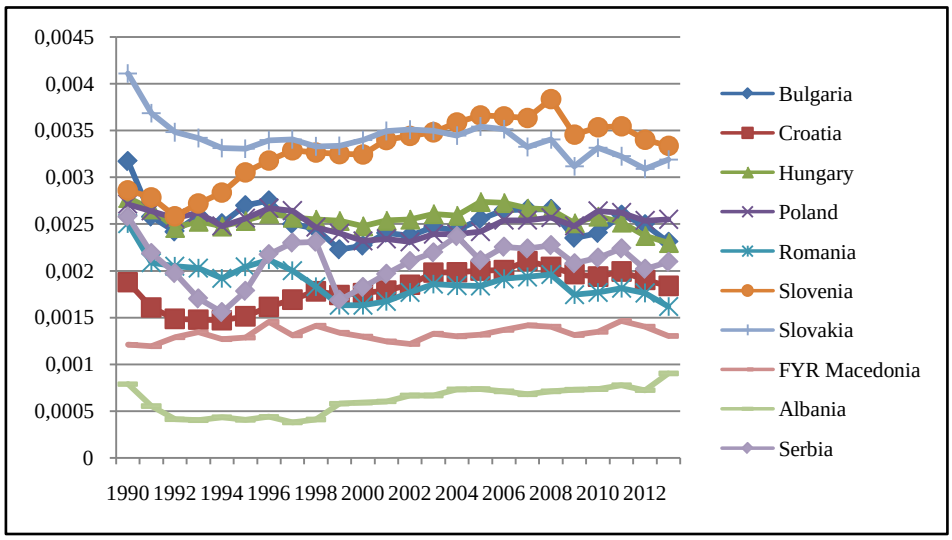

Figure 1. The trend of consumption per capita in the observed transition economies during the period 1990-2013 [4]

Considerably more noticeable changes have occurred in the field of energy production, which can be seen by analyzing the trend of primary energy production shown in Figure 2.

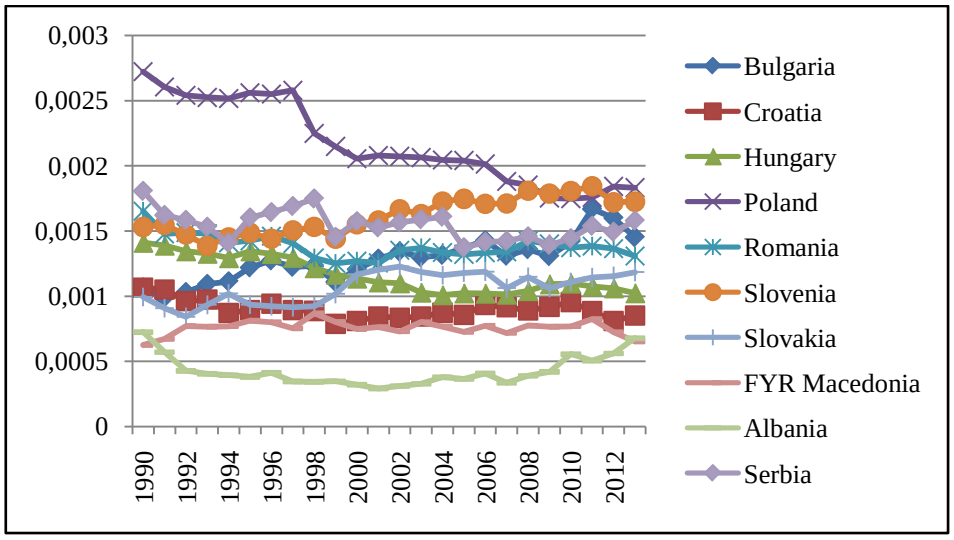

Figure 2. Trend of primary energy production per capita in the transition economies during the period 1990-2013 [4]

After some fluctuations until 2000, Slovenia and Bulgaria have recorded a significant increase of primary energy production. Poland, on the contrary, has recorded a continuous decline in primary energy production during the period. It should be noticed that there are significant fluctuations in primary energy production in Serbia, but the level of primary production per capita have not changed significantly from the start of transition. Other economies have not recorded significant changes in the level of primary energy production per capita.

In order to identify in which extent certain economy can produce energy to meet the needs of population and economy itself, it is necessary to examine the ratio between total energy consumption and primary energy production. In this regard, Figure 3 shows the share of primary energy production in total primary energy consumption.

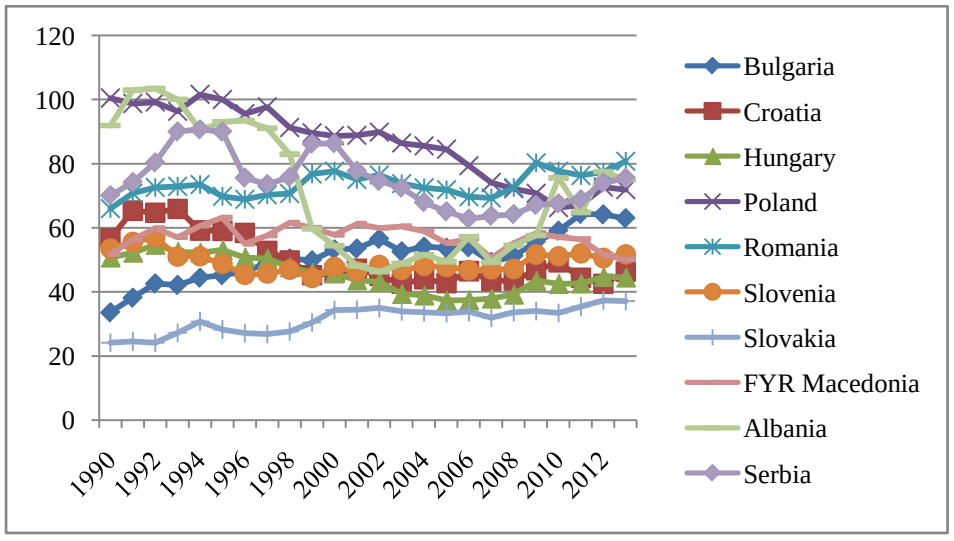

Figure 3. Share of primary energy production in total energy consumption during the period 1990-2013 [4]

The first thing that can be seen from Figure 3 is that the differences between observed the transiton countries decreased significantly during the transition period. Also, it can be noticed that the share of primary production in total consumption has been reduced in most transition economies, except Bulgaria and Slovakia.

3 Production and consumption of energy from renewable sources in transition countries

Utilization of renewable energy sources in transition countries is uneven and insufficient. Reasons are numerous, and most important are lack of investments needed for infrastructure and equipment, complicated regulations and lack of political will and understanding of authorities and society on importance of reorientation to renewable energy sources. [5] This is why, regardless on significant potential for development, share of energy production from renewable sources in total primary production is still low in most of transition countries, as it is shown in Figure 4.

From Figure 4, it can be seen that Albania recorded the highest share of production from renewable sources, with a slight decrease after 2005. This country has a very efficient use of its hydro potential and thereby it ensured a leading position during entire observed period in this area. Also, it is interesting to note that Croatia has recorded a significant increase in the share of renewable energy production in total primary energy production, especially after 2008, and in 2013 it reached almost the same level of this indicator as Albania. This is certainly a result of fulfilling EU requirements in this area during the process of EU accession. On the other hand, Poland had the lowest share of renewable energy production in total primary energy production during the entire transition period, which has not exceeded 12%. It indicates that Poland is still oriented on use traditional sources in the energy production, like during the centrally planned period.

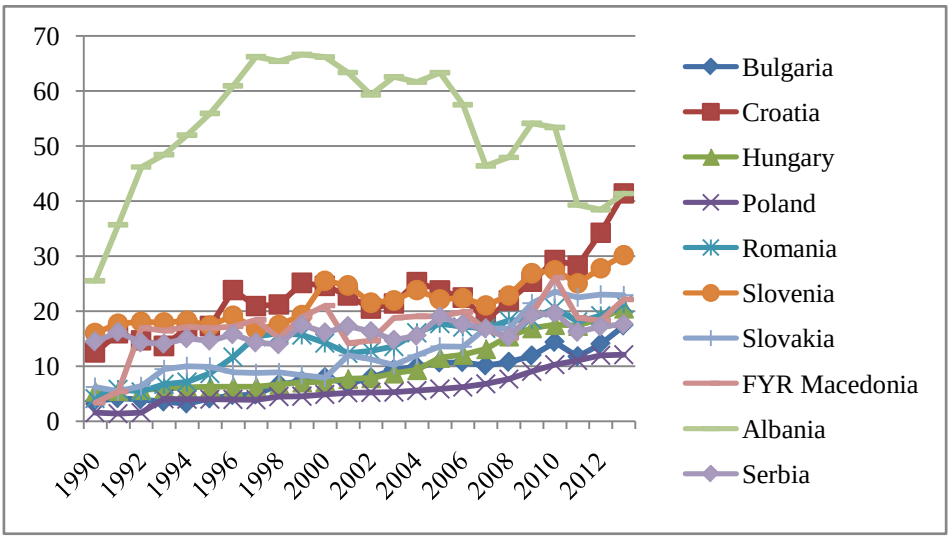

Figure 4. Share of primary production from renewable sources in the total primary production in the countries in transition in the period 1990-2013[4]

In order to take insight in the relative importance of specific renewable energy sources in selected countries, Figure 5 shows the share of energy production from the most commonly used renewable energy sources in total primary production in 2013.

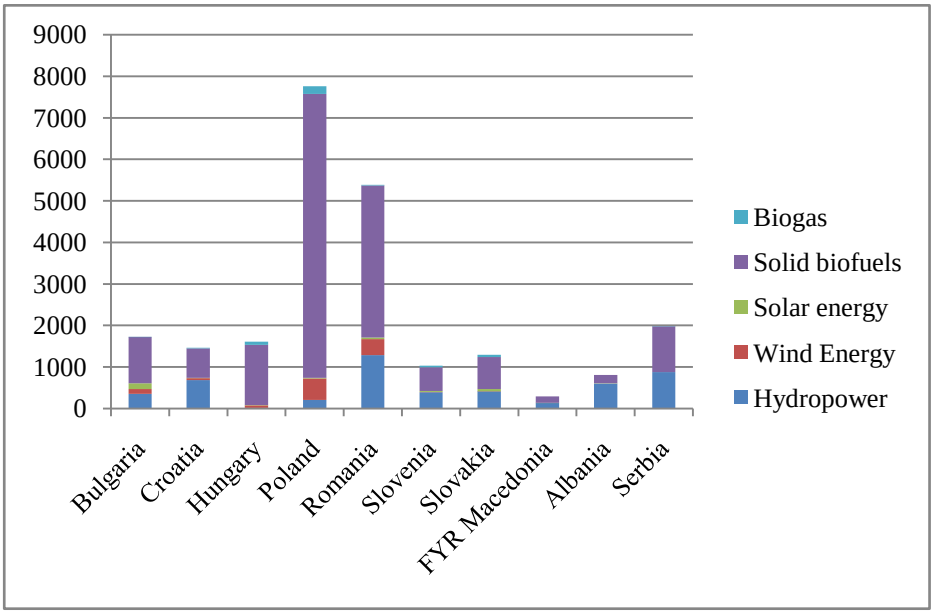

Figure 5. Structure of primary energy production from renewable sources in the observed transition economies in 2013[4]

Based on data presented in the Figure 5, it can be concluded that most transition economies using solid biofuels as the dominant renewable energy source (especially Poland, Romania and Hungary. In Albania over 70% of primary energy production from renewable sources was produced by hydropower, while the share of solid biofuels and hydropower were almost equally in Croatia, Macedonia and Serbia. All observed transition countries had the lowest share of energy production from solar energy, biogas and wind energy. Energy production from these sources is still in its infancy in the observed countries, and the reasons for this should be sought in significant investments and complicated administrative procedures for the opening of facilities in these sectors of energy production.

Analyzing the share of consumption of energy from renewable sources in the total energy consumption it can be concluded that the share of energy produced from these sources is still low. Figure 6 shows this trend of mentioned indicator during the transition period.

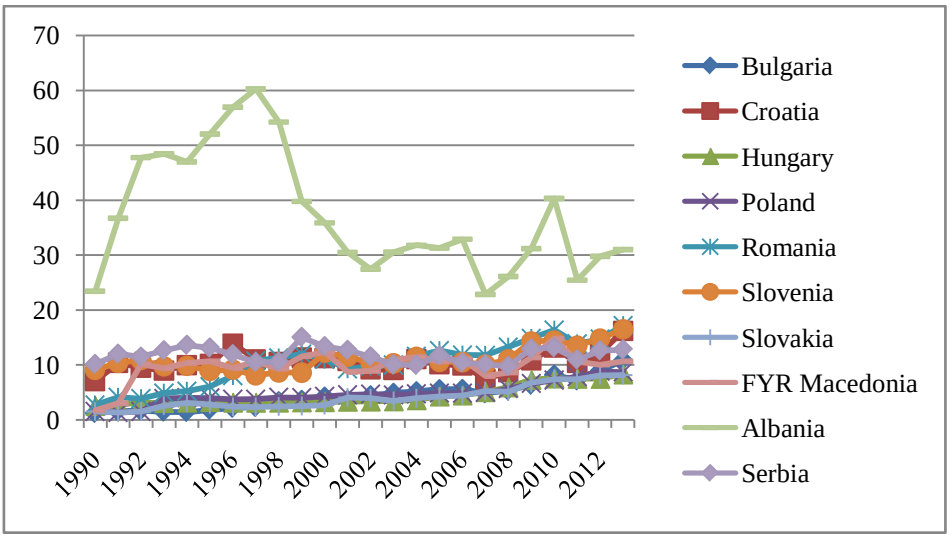

Figure 6. The share of energy consumption from renewable sources in the total energy consumption in the transition economies during the period 1990-2013 [4]

From the presented data in Figure 6 it can be concluded that Albania had the largest share of energy consumption from renewable energy sources in total energy consumption. Other transition countries has relative similar situation in this area. The lowest value of this indicator has been recorded in Bulgaria, Slovakia, Hungary and Poland during the entire observed period.

In order to evaluate ecological effects of energy production, Figure 7 presents data on CO2 emissions from electricity and heat production in total final energy consumption in the transition countries.

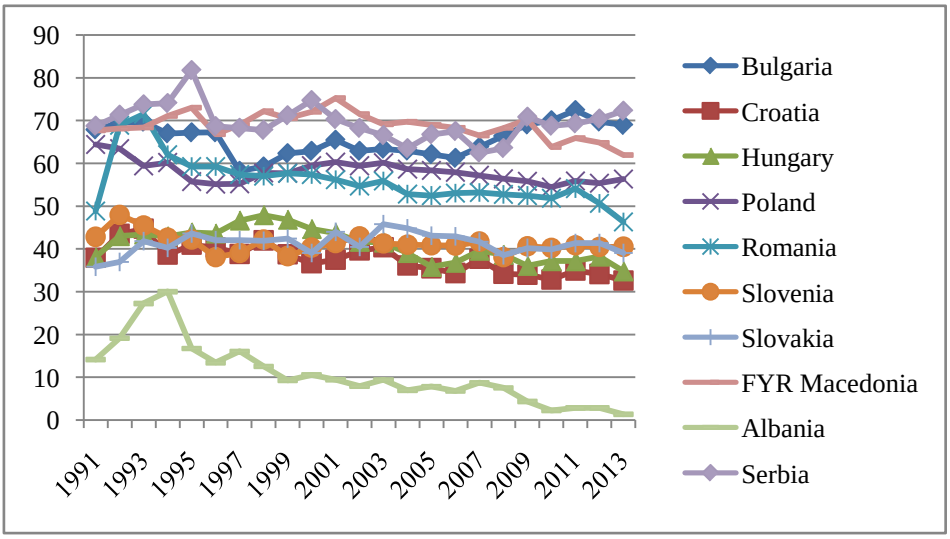

Figure 7. Share of CO2 emissions from the electricity and heat production in total CO2 emissions in the transition countries during the period 1991-2013. [6]

From Figure 7 it can be seen that a country that countries with the highest CO2 emissions from the electricity and heat production in total final energy consumption were Bulgaria, Macedonia and Serbia, recording the almost 80 percent of CO2 emission from the electricity and heat production in total final energy consumption during the entire observed period. On the other hand, Albania has the lowest level of this indicator, because of the intensive use of its hydropower potential, which contributes with 96% in total energy production. [7]

4 Ranking of observed transition countries by renewable energy sector development

In order to perform a comparative analysis of and to determine eventual changes in renewable energy sector development during the observed period, in this paper is has been applied multi-criteria analysis. The aim of multi-criteria analysis is ranking of numerous alternatives from best to worst, based on a large number of opposing criteria. One of the most commonly used methods of multi-criteria analysis is PROMETHEE GAIA method, developed by Brans, Vincke and Marshal during the late XX century [8,9].

4.1. PROMETHEE GAIA methodology

The PROMETHEE GAIA method is an adequate method for solving problems whose aim are multi-criteria ranking of final set of alternatives (in this case countries) based on a number of criteria that need to be maximized or minimized. For each alternative calculated its value is expressed in preferences [10]. Thereby, each alternative is evaluated based on the two preference flows. Positive preference flow φ + (P) indicates how much is given alternative better than other (according to all criteria). Accordingly, the higher this preference flow is, the alternative is better. The negative flow of preference φ - (P) indicates how much a given alternative is worse than the rest, and therefore if this flow is lower, the alternative is better. After that, the PROMETHEE method accounts net preference flow φ (P) as the difference between these two flows:

$$\varphi\ (P) = \varphi + (P) - \varphi - (P) \tag{1}$$

On the bias of such calculated net preference flow, final ranking of alternatives is performed, from the best one, with the highest net preference flow, to the worst one, with the lowest net preference flow. To calculate mentioned flows, PROMETHEE method requires the specification of appropriate parameters for each criteria [8,9]:

- Direction of preference, minimizing or maximizing;
- Weight coefficients, indicating the importance of certain criteria;
- Adequate preference function, that converts the difference between the two alternatives in the level of preference, which ranges from 0 to 1. In PROMETHEE methods following preference functions are available: Linear, Usual, U-shape, V-shape, Level and Gaussian;
- Preference threshold (p), which represents the minimum deviation that decision maker considers important for the decision making;

- Indifference threshold (q), which represents the maximum deviation that decision maker considered irrelevant in the decision making.

After defining parameters, PROMETHEE methodology is used, which consist of next steps [11]:

- First, deviation based on comparison of pair of alternative is calculated

$$d_j(a,b) = g_j(a) - g_j(a) \tag{2}$$

Where dj (*a, b*) represents the differences between the value of alternative a and b according to every criteria.

- After that, the chosen function of preferences is applied:

$$P_j(a,b) = F_j\left[d_j(a,b)\right] \tag{3}$$

Where Pj (*a, b*) represents preferences alternative *a* for each alternative *b* within every criteria, as a function of *dj (a, b).*

- Further, the general index of preferences is calculated:

$$\forall a,b \in A \;\; \pi(a,b) = \sum_{j=1}^{k} P_j(a,b)\, w_j \tag{4}$$

Where π (*a,b*) stands for weighted sum P (*a,b*) for each criteria, while *wj* stands for weighted *j* criteria coefficient.

- Then, the positive and negative course of preferences are calculated:

$$\varphi^{+}(a) = \frac{1}{n-1}\sum_{x \in A}\pi(a,x) \tag{5}$$

$$\varphi^{-}(a) = \frac{1}{n-1}\sum_{x \in A}\pi(a,x) \tag{6}$$

Where φ+ represents positive and φ- negative preferences values for each alternative.

- Finally positive and negative courses of preferences are used to calculate net flow of preferences and rank alternative:

$$\varphi(a) = \varphi^{+}(a) - \varphi^{-}(a) \tag{7}$$

Where φ(a) stands for net course for each alternative.

On the bias of φ (a) value the countries are ranked from best to worst, based on all observed criteria.

4.2 Ranking results

In order to compare the renewable energy sector development in 1991 and 2013 and to identify eventual differences, the observed countries have been ranked based on the following indicators (with adequate direction of preference): renewable energy production (% of total primary energy production) - max, renewable energy consumption (% of total final energy consumption) - max and CO2 emissions from electricity and heat production, total (% of total fuel combustion) - min. The data used for ranking is presented in Table 1.

Table 1. Data used for ranking [6]

Countries	Renewable energy production (% of total primary energy production)		Renewable energy consumption (% of total final energy consumption)		CO2 emissions from electricity and heat production, total (% of total fuel combustion)	
	1991	2013	1991	2013	1991	2013
Bulgaria	4.1354	17.3230	1.5762	37.1552	67.9032	68.9471
Croatia	15.9321	41.3547	10.4107	53.0238	37.9076	32.6046
Hungary	5.5272	20.4896	2.8880	54.7574	38.0712	34.7848
Poland	1.3604	12.0597	1.3429	27.3247	64.4056	56.3398
Romania	5.7990	21.2969	4.1016	18.5625	48.8579	46.3248
Slovenia	17.7165	30.1704	10.3785	47.9269	42.8235	40.5160
Slovak Republic	5.4710	22.8879	1.3455	61.2663	35.8290	39.0673
FRY Macedonia	5.4064	22.1405	3.0449	48.3894	67.6996	61.9277
Albania	35.6836	41.3630	36.7172	12.2846	14.1732	1.3736
Serbia	16.1870	17.5788	12.0001	23.6937	68.7392	72.2357
Mean	***11.3219***	***24.665***	***8.3806***	***38.4385***	***48.6410***	***45.4121***
Standard deviation	***10.3467***	***9.9387***	***10.7829***	***17.0322***	***18.2566***	***20.9417***

Before performing PROMETHEE methodology, the mean and standard deviation data should be analyzed, with aim to get some general conclusion about renewable energy sector development in chosen countries during the period 1991-2013. The average share of energy production from renewable sources in total primary energy production has been increased by 2.18 times, which indicates that all countries have made significant progress in the area of renewable energy production. On the other hand, standard deviation has been reduced by 0.41%, indicating that differences between countries have been slightly reduced. Average share of renewable energy consumption in total final energy consumption has been increased 4,59 times, indicating that there have been recorded significant improvement in this area. But, differences between countries have been increased, having in mind that standard deviation has been raised by 6,25%. Finally, share of CO_2 emissions from electricity and heat production in total fuel combustion has been reduced by only 3.23%, indicating that state in this area has been slightly improved during the period. Also, the differences between countries have been increased by 2.68.

Performing the PROMETHEE analysis, as it is mentioned, requires the selection of preference function. In this case, the V-shape function was used as the preference function (a function that is often used for quantitative data with a wide range of variation) and as the preference threshold (p) it was used the standard deviation. Based on such defined parameters, the application of multi-criteria analysis using the Decision Lab software has given follow rankings results for 1991:

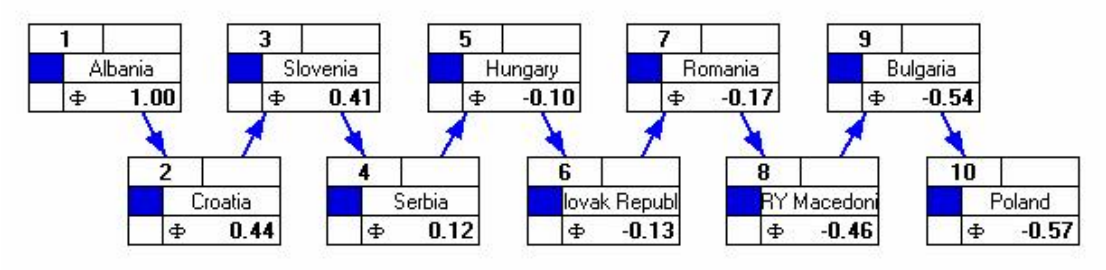

Figure 8. Ranking results for 1991

Based on the Figure 8 it could be concluded that Albania had the most developed renewable energy sector in 1991, followed by Croatia, Slovenia, Serbia, Hungary, Slovak Republic, Romania, FYR Macedonia, Bulgaria and Poland. Then, the same multi-criteria procedure has been applied on data for 2013 and ranking results are given in Figure 9.

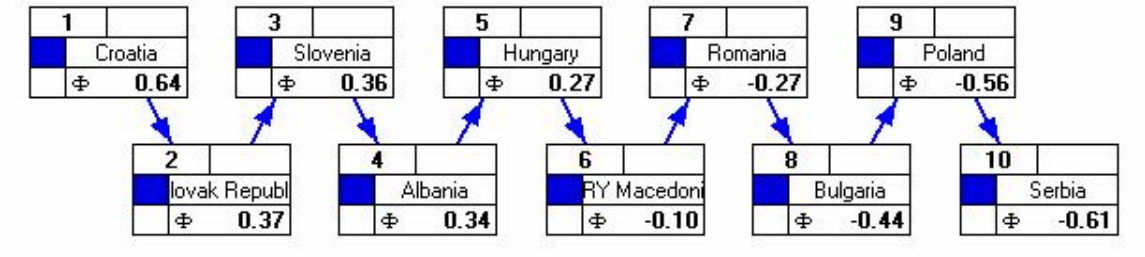

Figure 9. Ranking results for 2013

From the Figure 9 it could be concluded that Croatia had the most developed renewable energy sector in 2013, followed by Croatia, Slovak Republic, Slovenia, Albania, Hungary, FRY Macedonia, Romania, Bulgaria, Poland and Serbia. Serbia has the greatest ranking change compared to 1991, indicating the slowest progress in renewable energy sector development in the country.

5 Correlation analysis

In order to investigate if there is a connection between level of renewable energy sector development and economic development, correlation analysis was performed. The results of correlation analysis are presented in Table 2.

Table 2. Correlations matrix

		CO_2	SRECons	SREProduc	BDPOE
CO_2	Pearson Correlation	1	-0.565**	-0.530**	-0.704**
	Sig. (2-tailed)		0.000	0.000	0.000
	N	247	247	247	247
SRECons	Pearson Correlation	-0.565**	1	0.818**	0.487**
	Sig. (2-tailed)	0.000		0.000	0.000
	N	247	247	247	247
SREProduc	Pearson Correlation	-0.530**	0.818**	1	0.407**
	Sig. (2-tailed)	0.000	0.000		0.000
	N	247	247	247	247
BDPOE	Pearson Correlation	-0.704**	0.487**	0.407**	1
	Sig. (2-tailed)	0.000	0.000	0.000	
	N	247	247	247	247

**. Correlation is significant at the 0.01 level (2-tailed).

As the indicator of economic development GDP per unit of energy use (constant 2011 PPP $ per kg of oil equivalent) was used. It should be noticed that there is a high negative correlation coefficient between CO2 emissions and GDP unit of energy use (constant 2011 PPP $ per kg of oil equivalent) - 0.704 and slightly lower positive correlation coefficient between share of renewable energy consumption in total final energy consumption and GDP unit of energy use (constant 2011 PPP $ per kg of oil equivalent) - 0.487 and share of energy production from renewable sources in total primary energy production and GDP unit of energy use (constant 2011 PPP $ per kg of oil equivalent) - 0.407. Also, there is very high negative correlation between CO2 emissions and share of energy production from renewable sources in total primary energy production (-0.530). Having in mind all correlation coefficients, it can be concluded that there is a high correlation between usage of renewable sources in energy production and economic development in transition countries.

6 Conclusion

Majority of transition economies are facing the numerous macroeconomic and structural disturbances, inherited from period of planned economy. One of the most important is imbalance in energy sector. Namely, system of production in command economies was based on cheap energy and enormous energy consumption. Consequently, after the disunion of USSR and SEV newly founded countries have been facing numerous macroeconomic problems at the beginning of transition process, such as slow economic growth, imported inflation, balance of payments deficit, etc.

Results of multi-criteria analysis indicated that there have been significant changes in the energy sector development in observed countries, which influenced the change of their ranking during the 22 years period. Croatia replaced Albania at the first position in 2013, due to the fulfillment of requirements for membership in the EU, which emphasizes the importance of renewable energy production. The Slovak Republic and FYR Macedonia also have made notable progress in the observed period. On the other hand, Serbia has made the lowest progress in this area, which has moved from fourth to last, the tenth, the position at the end of the period. In this sense, it can be concluded that this

country should make considerable efforts aimed at accelerating the development of the sector of energy production from renewable sources.

Efficient energy production from renewable sources enables acceleration of economic development for transition countries, but also reduces negative impacts to the environment caused by energy production from traditional sources and the correlation analysis confirm that fact. Achieving these goals requires active involvement of government in support of renewable energy sector, which leads to creation of favorable ambience for investments, followed by technological development in this sector and stabilization of energy market.

Acknowledgements: *The authors feel indebted to the company Visual Decision Inc. Montreal, Canada, for software package Decision Lab 2000 provided them free of charge.*

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DEVELOPMENT SWOT-AHP HYBRID MODEL FOR PRIORITIZATION STRATEGY OF NATIONAL PARK DJERDAP

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Abstract: The largest national park in Serbia, Djerdap is a protected natural areaof exceptional global importance, which has rich natural and cultural values, good location, pleasant climate and as such represents a great potential for the development of ecotourism. This paper presents a SWOT-AHP hybrid model for prioritization strategies defined on the basis of conduct situational SWOT analysis (S-strength, W-weaknesses, O-opportunities, T-threats). The obtained results of multicriteria analysis represent strategy ranked according to their importance, thus contributing to the definition of management action plan which generates income for the local community while preserving the environment.

Keywords: *ecotourism, strategy, SWOT analysis, AHP*

1 Introduction

The emergence of climate change in the environment has raised the awareness of environmental protection and the maintenance of ecology, which led to eco-tourism as a new direction in the tourism industry [1].Ecotourism is a type of tourism is for educational and adventurous character, focused on undeveloped and sparsely visited natural, cultural and historical sites.The purpose of such movement in tourism is understanding and appreciation of the natural and social culture of protected areas [2]. The development objective of ecotourism is to protect natural areas by providing income, and is based on the idea that the ecological environment represents a local resource which creates economic value of attracting tourists. Through the implementation of ecotourism achieved numerous positive impacts, such as: providing income, increase employment of the local population, conservation of biodiversity, protection of natural areas and educate visitors about the environment [3]. One of the main reasons why ecotourism has become a modern concept tourism is the fact that traditional tourism can no longer satisfy the needs of modern tourists. With the increase of population's income and the length of the annual holiday tourists in the world more frequently resorting to special forms of tourism.Instead of a practice that has dominated previous years that people use holidays to travel to a distant destination, in recent years, people several times during the year taken annual leave a few days for shorter journeys.Because of these changes with tourists, it becomes necessary to organize new forms of tourism activities which implemented successfully through the concept of ecotourism [4]. On the other hand, many critics believe that the development of tourism in protected areas is self-destructive and long term contribute to to environmental degradation. Increasing the number of tourists threatens the quality of life and the environment. Some of the problems which occur during the introduction the concept of ecotourism are environmental degradation, destruction of habitats of plant and animal species, economic inequality, instability and negative socioeconomic and cultural changes in local communities [5].

The concept of ecotourism among the first to define Ceballos-Lascurain as a trip to the intact and the unpolluted natural area with the specific objective of studying, admiring and enjoying the landscapes, wild plants and animals, as well as in the existing cultural events in one region [6]. The International Ecotourism Society[10]2013. proposed a simpler definition of ecotourism where ecotourism refers to responsible behavior during the travel in natural areas aimed at safeguarding the environment and sustainable benefits for the local community.The untouched natural areas and national parks represent a significant market for ecotourism that combines natural resources and local culture [7]. People who deal with the protection of nature promote ecotourism as a tool for conservation of natural resources and the development of local communities through preservation of cultural achievement [8].

National parks have become „a tool for regional development" by introducing the concept of ecotourism [9]. Managing with national parks includes functional management style that involves alignment with social needs and development priorities, respectively,that means controlling the area of the national park, the protection of biodiversity and connectivity protection and economic development [10].

For purposes of defining the optimal strategy for sustainable development of ecotourism was conducted situation analysis (SWOT analysis) of the National Park Djerdap, which also represents the largest national park in Serbia. For the purpose of making SWOT analysis, we used workshops with key stakeholders, analyzed documentation of the public importance of the region and used the local database, based on which outlines key (S) - Strengths, (W) - Weaknesses (O) - Opportunities and (T) - Threats. Based on the SWOT analysis to define optimal strategy for the development of National Park Djerdap as an attractive ecotourism destination based on natural and cultural resources which owns, good location and transport connections, this paper presents a SWOT-AHP hybrid model for prioritization strategies of sustainable development. In this way, the aforementioned research methodology contributes significantly to the concept of ecotourism, which brings the possibility of making objective strategic decisions.

2 Description of the research area - National Park Djerdap

National Park Djerdap is located in South Eastern Europe, in the northeast part of Serbia at the border area with Romania. It stretches on the right bank of the Danube from Golubac city in the west of Diana Karatas in the east. Its length is about 100 km and includes a narrow mountainous zone whose altitude ranges from 50 m to 803 m. National Park borders are legally precisely defined in 1983. by Decision of the Government of Serbia, it occupies a total area of 63 608.4 ha ("Službeni glasnik RS", 2013).It is named after the Iron Gates which is one of the most beautiful gorges in Europe. Today the Danube river bed is formally located in national park Djerdap.

Besides national protection within the National Park, this area has several international protections, such as: for birds - Important Bird Areas according to the Birdlife program for over 170 identified species; Plant life International - Plant Europe for plants; Prime Butterfly Areas (PBA)

[10]TIES (2013). What is ecotourism? http://www.ecotourism.org/what-is-ecotourism - Retrieved 17.04.2016.

according to Butterfly Conservation Europe program for over 100 different species of day flying butterflies. NPDJ is part of the Emerald Network of Areas of Special Conservation Interest - ASCI and it is part of NATURA the conservation of natural habitats and of wild fauna and flora based on which Special Areas of Conservation are protected - SACs by the EU directive (EU directive 79/409/ EEC, 1979) as Special Protection Areas - SPAs. It is in the procedure of protection as a Biosphere Reservation by UNESCO program as an area of World Heritage (World Heritage Convention).The hydropower potential of the Danube as the second largest river in Europe, within two lakes of the hydroelectric system Djerdap I and Djerdap II has 65 different species of fish which are mostly strictly protected species so it represents the most important resource of this kind in Europe. Historical and cultural identity of the area consists of an archaeological prehistoric site Lepenski vir (7000 to 6000 BC) with Lašac and Padina sites dating from the Mesolithic era which makes it unique in Europe. The remains of fortified objects built in Roman and early Byzantine period and the period of the Roman emperor Trajan (Trajan's Tablet dating from the first century AD) as well as the medieval war architecture from the 14th century (Golubac Fortress) indicates the outstanding cultural - historical value of the area. The total accommodation capacities in the NPDJ include 833 rooms with 1942 beds in 19 tourist facilities. In the tourist structure, who is visiting NPDJ, 90% are domestic tourists and only 10% are foreigners with an average 2.42 nights which equals the average tourist's stay. Domestic tourists spend 2.48 nights while the foreign ones spend 1.69 nights, which equals their stay. Also, tourists come annually by ships sailing on the Danube and about 75 ships with an average of 125 tourists per ship come year[11].

3 Theoretical framework of the research

In the academic literature, exist numerous research which identifies strategies for development of tourist destinations with different approaches to defining key performance on the basis of SWOT analysis[12-18].

In the application of a SWOT analysis as a tool for generating and ranking optimal strategy in recent times has developed numerous tools, multi-criteria decision making, which have expanded its application and opened many opportunities for objective decision-making. A model of multi-criteria decision which often used to define prioritization strategy is Analytical Hierarchy Process (AHP). Analytical Hierarchy Process is one of the most popular multicriteria methodswhich was developed by Thomas Saaty 1980.Many researches have been confirmed that the AHP method is very useful, reliable and systematic MCDM tool for solving complex decision problems [20, 21, 22, 23]. AHP method allows the decision maker to model complex problems with the help of hierarchical structures, while showing the connection of objective, criteria, sub-criteria and alternatives. Determination of the relative priorities when comparing pairs within the AHP methodology is achieved by assigning a score according to Saaty's scale $1 \div 9$ [19].Due to the numerous advantages that offered this method for decision making was applied to the SWOT analysis of National Park Djerdap in order to determine the priority strategies.

4 Development of the model for strategies prioritization

Kurtila and his associates at the beginning of XXI century, set a scientific basis for the integrated SWOT analysis with AHP method, in order to improve the quality of measurability SWOT factors, and improving quantitative basis in strategic planning. In order to rank the proposed strategy by experts in this field, in this paper, we used SWOT-AHP hybrid model which is presented through the following six steps[20, 21].

Step 1. On the basis of results the conducted SWOT analysis of National Park Djerdap, and comparing the SWOT factors: strengths, weaknesses, opportunities and threats, as well as the sub-factors within each factor, defined as possible strategies for future development of National Park Djerdap. Based on the consideration of objective strengths, weaknesses, opportunities and threats are defined SWOT criteria under each of the above guidelines, and the obtained results are presented in the form of a SWOT matrix in Table 1.

Table 1. SWOT matrix of National Park Djerdap

		Internal factors	
		Strengths (S)	**Weaknesses (W)**
		S_1- Unique ecosystems and international importance of the protected bio and geo diversity values	**W_1 -** Lack of knowledge in the field of tourism and promotion of NP potential
		S_2- Cultural - historical heritage of world values	**W_2 -** Insufficient infrastructure investment of the National Park for visitors
		S_3 - The favorable geographical position in the pan-European corridor VII and easy arrival from Belgrade airport	**W_3-** Poor cooperation NP administration and the most important stakeholders
		S_4 - The hydropower potential of the Danube	**W_4 -** Inadequate wastewater treatment and municipal landfills
		S_5 - Favorable conditions for organic production	**W_5 -** Poor demographic situation
			W_6 - Insufficient education of the population on the development of environmental awareness
External factors			
Opportunities (O)		**SO – Strategy**	**WO – Strategy**
O_1 -	Creation of unique tourist product (brand)	**SO_1 - Creating a strategy for the development of ecotourism with the involvement of internal and external stakeholders**	**WO_1 - Education in the field of content ecotourism offer and its promotion**
O_2 -	The potential of the Danube, which is an integral part of the NP	**SO_2 - Developing joint eco-tourism brand with the Romanian side**	**WO_2 - Arranging NP infrastructure to EU standards**
O_3 -	The development of SMEs in partnership with NP		

O_4 - Cross-border international cooperation and use of EU funds **O_5 -** Product offers local character (organic foods) **O_6 -** Investments Diaspora **O_7 -** The development of renewable		
Threats (T)	**ST – Strategy**	**WT – Strategy**
T_1 - Slow Serbia's EU bid and disrespect of EU standards	**ST_1 - Promotion of the EU standards NP engagement of scientific institutions and NGOs**	**WT_1 - Engagement professional management to manage with NP**
T_2 - Bad economic situation in the country	**ST_2 - Involvement of state authorities on strict compliance with environmental regulations in the National Park and his surroundings**	
T_3 - Failure to follow regulations to protect sensitive sites and biodiversity in NP		
T_4 - Shadow economy around, and in the NP		
T_5 - Creating a bad image due to poor visitor experience with infrastructure NP		
T_6 - Unplanned use the resources of NP		
T_7 - The lack of interest of investors to invest in this region		

Comparative expert analysis of the SWOT factors shown in Table 1. enabled definition of possible strategies SO_1 and SO_2 by which potentials of strengths are being used to take advantage of the opportunities which are perceived in the environment.In order to overcome internal weaknesses by using the opportunities in the environment, strategy WO_1 and WO_2 was defined. Strategies ST_1 and ST_2 allow the use of internal strengths to avoid threats. Finally, strategy WT_1 allows reducing the weaknesses in order to avoid threats.

Based on the SWOT - AHP hybrid model for prioritization of the development strategy, based on the results of the SWOT factors, sub-factors, defined strategies and established goal of determining the best strategy, the AHP working model is presented in Figure 1. for defining mutual relations of SWOT groups and factors in order to prioritize defined strategies for the development of the National Park Djerdap.

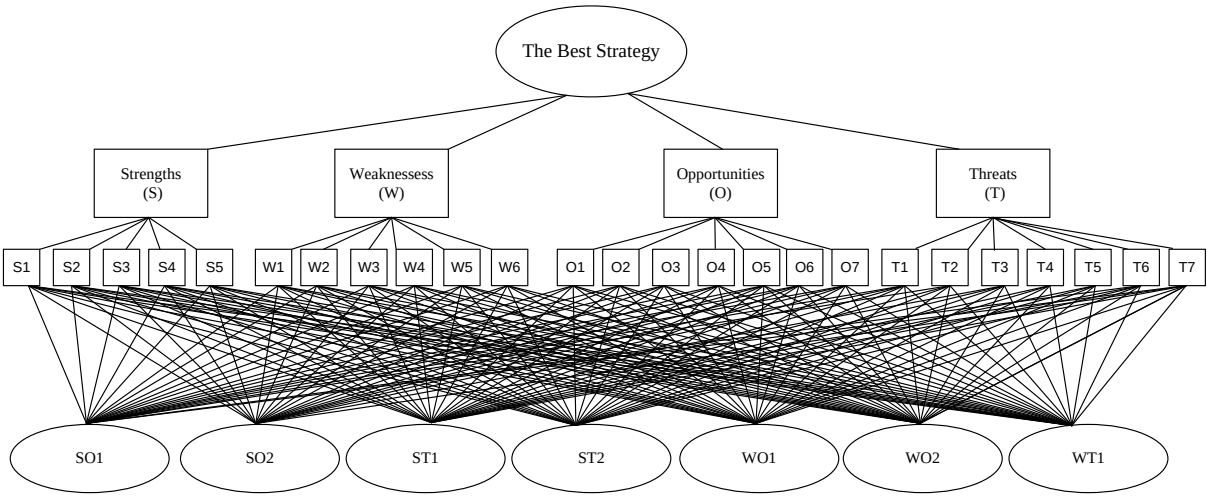

Figure 1. AHP model for the selection of the best strategies NP Djerdap

Step 2. Based on the assessment of the expert team, the importance of each of the SWOT groups (criteria) in the model is determined, where their internal interdependence was not taken into consideration, but only importance in relation to the set objective within the level 1 - SWOT criteria Strengths - S, Weaknesses - W, Opportunities - O and Threats - T (see Figure 1). The resulting importance of each SWOT group is shown in Table 2, where it can be noticed that the greatest importance, based on the assessment of the expert team, is given to the SWOT group Strengths (41.2% importance).

Table 2. Pairwise comparison of the SWOT groups

SWOT group	**S**	**W**	**O**	**T**	**Importance of the SWOT group**
Strengths (S)	1	5	1	3	**0.412**
Weaknesses (W)		1	1/2	3	0.169
Opportunities (O)			1	3	0.322
Threats (T)				1	0.097
Consistency ratio relative to the goal: CR=0.03					

From the previous Table 2, it follows that:

$$w_1 = \begin{bmatrix} S \\ W \\ O \\ T \end{bmatrix} = \begin{bmatrix} 0{,}412 \\ 0{,}169 \\ 0{,}322 \\ 0{,}097 \end{bmatrix}$$

Step 3. In this step, the local importance of SWOT sub-criteria were determined by the expert team, while the scores of comparative pairs of SWOT sub-criteria, defined in Table 1, are given in tables 3-6.

Table 3. Pairwise comparison of the SWOT sub-criteria Strengths

Strengths (S)	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**	Local weights
S_1 - Unique ecosystems and international importance of the protected bio and geo diversity values	1	2	3	4	5	0.416
S_2 - Cultural - historical heritage of world values		1	2	3	4	0.262
S_3 - The favorable geographical position in the pan-European corridor VII and easy arrival from Belgrade airport			1	2	3	0.161
S_4 - The hydropower potential of the Danube				1	2	0.099
S_5 - Favorable conditions for organic production					1	0.062
The consistency ratio in relation to the group Strengths: CR = 0.015						

Table 4. Pairwise comparison of the SWOT sub-criteria Weaknesses

Weaknesses (W)	**W_1**	**W_2**	**W_3**	**W_4**	**W_5**	**W_6**	Local weights
W_1 - Lack of knowledge in the field of tourism and promotion of NP potential	1	2	3	4	5	6	0.379
W_2 - Insufficient infrastructure investment of the National Park for visitors		1	2	3	4	5	0.249
W_3 - Poor cooperation NP administration and the most important stakeholders			1	2	3	4	0.160
W_4 - Inadequate wastewater treatment and municipal landfills				1	2	3	0.102
W_5 - Poor demographic situation					1	2	0.065
W_6 - Insufficient education of the population on the development of environmental awareness						1	0.043
The consistency ratio in relation to the group Weaknesses: CR=0.02							

Table 5. Pairwise comparison of the SWOT sub-criteria Opportunities

Opportunities (O)	**O_1**	**O_2**	**O_3**	**O_4**	**O_5**	**O_6**	**O_7**	Local weights
O_1 - Creation of unique tourist product (brand)	1	2	4	3	5	6	7	0.354
O_2 - The potential of the Danube, which is an integral part of the NP		1	3	2	4	5	6	0.241
O_3 - The development of SMEs in partnership with NP			1	1/2	2	3	4	0.108
O_4 - Cross-border international cooperation and use of EU funds				1	2	3	4	0.140
O_5 - Product offers local character (organic foods)					1	2	3	0.074
O_6 - Investments Diaspora						1	2	0.049
O_7 - The development of renewable							1	0.033
The degree of consistency in relation to the group Opportunities: CR=0.022								

Table 6. Pairwise comparison of the SWOT sub-criteria Threats

Threats (T)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	Local weights
T_1 - Slow Serbia's EU bid and disrespect of EU standards	1	1/3	1/2	3	2	4	5	0.159
T_2 - Bad economic situation in the country		1	2	5	4	6	7	0.350
T_3 - Failure to follow regulations to protect sensitive sites and biodiversity in NP			1	4	3	5	6	0.237
T_4 - Shadow economy around, and in the NP				1	1/2	2	3	0.070
T_5 - Creating a bad image due to poor visitor experience with infrastructure NP					1	3	4	0.106
T_6 - Unplanned use the resources of NP						1	2	0.046
T_7 - The lack of interest of investors to invest in this region							1	0.032
The degree of consistency in relation to the group Threats: CR=0.024								

Step 4. Through mutual multiplying of obtaining weight factors from Step 2 and Step 3, global importance of SWOT sub-criteria are calculated, as presented in Table 7.

Table 7. The importance of the criteria and sub-criteria of the SWOT analysis

SWOT groups - criteria	Importance of the SWOT criteria	SWOT sub-criteria	Local importance of SWOT sub-criteria	The overall importance of SWOT sub-criteria
Strengths - S	**0.376**	S_1 - Unique ecosystems and international importance of the protected bio and geo diversity values S_2 - Cultural - historical heritage of world values S_3 - The favorable geographical position in the pan-European corridor VII and easy arrival from Belgrade airport S_4 - The hydropower potential of the Danube S_5 - Favorable conditions for organic production	**0.416** 0.262 0.161 0.099 0.062	**0.157** 0.099 0.061 0.037 0.023
Weaknesses - W	0.163	W_1 - Lack of knowledge in the field of tourism and promotion of NP potential W_2 - Insufficient infrastructure investment of the National Park for visitors W_3 - Poor cooperation NP administration and the most important stakeholders W_4 - Inadequate wastewater treatment and municipal landfills W_5 - Poor demographic situation W_6 - Insufficient education of the population on the development of environmental awareness	**0.379** 0.249 0.160 0.102 0.065 0.043	**0.062** 0.041 0.026 0.017 0.011 0.007
Opportunities - O	0.310	O_1 - Creation of unique tourist product (brand) O_2 - The potential of the Danube, which is an integral part of the NP O_3 - The development of SMEs in partnership with NP O_4 - Cross-border international cooperation and use of EU funds	**0.354** 0.241 0.108 0.140 0.074 0.049 0.033	**0.110** 0.075 0.033 0.043 0.023 0.015 0.010

		O_5 - Product offers local character (organic foods) O_6 - Investments Diaspora O_7 - The development of renewable		
Threats - T	0.151	T_1 - Slow Serbia's EU bid and disrespect of EU standards T_2 - Bad economic situation in the country T_3 - Failure to follow regulations to protect sensitive sites and biodiversity in NP T_4 - Shadow economy around, and in the NP T_5 - Creating a bad image due to poor visitor experience with infrastructure NP T_6 - Unplanned use the resources of NP T_7 - The lack of interest of investors to invest in this region	0.159 **0.350** 0.237 0.070 0.106 0.046 0.032	0.024 **0.053** 0.036 0.010 0.016 0.007 0.005

The obtained normalized results indicate the dominant influence of the following sub-criteria: S_1 - Unique ecosystems and international importance of the protected bio and geo diversity values (0.416-local weight and 0.157-globalweight) and O_1 - Creation of unique tourist product (brand) (0.354-local weight and 0.110-global weight), and W_1 - Lack of knowledge in the field of tourism and promotion of NP potential (0.379-local weight and 0.062- global weight) and T_2 - Bad economic situation in the country (0.350-local weight and 0.053-global weight) as negative sub-criteria. It is obvious that the global strength of the positive sub-criteria is greater than the global strength of the impact of the negative sub-criteria which is of crucial importance for choosing the best strategy in the considered case.

Whence it follows that:

$$W_2 = W_{SWOTsub-factros(global)} = \begin{bmatrix} 0.157 \\ 0.099 \\ 0.061 \\ 0.037 \\ 0.023 \\ 0.062 \\ 0.041 \\ 0.026 \\ 0.017 \\ 0.011 \\ 0.007 \\ 0.110 \\ 0.075 \\ 0.033 \\ 0.043 \\ 0.023 \\ 0.015 \\ 0.010 \\ 0.024 \\ 0.053 \\ 0.036 \\ 0.010 \\ 0.016 \\ 0.007 \\ 0.005 \end{bmatrix}$$

Step 5. In this step, by expert scoring, importance weights of each alternative strategy (SO_1, SO_2, WO_1, WO_2, ST_1, ST_2, WT_1) were determined relative to the defined SWOT sub-criteria, and the resultant matrix W_3 was obtained:

$$W_3 = \begin{bmatrix} 0.187 & 0.187 & 0.129 & 0.107 & 0.154 & 0.111 & 0.070 & 0.129 & 0.176 & 0.258 & 0.193 & 0.182 & 0.114 & 0.158 & 0.144 & 0.222 & 0.222 & 0.154 & 0.125 & 0.083 & 0.100 & 0.154 & 0.080 & 0.111 & 0.143 \\ 0.098 & 0.098 & 0.237 & 0.316 & 0.077 & 0.111 & 0.070 & 0.129 & 0.059 & 0.070 & 0.193 & 0.182 & 0.310 & 0.158 & 0.250 & 0.222 & 0.222 & 0.077 & 0.125 & 0.167 & 0.200 & 0.154 & 0.192 & 0.222 & 0.143 \\ 0.187 & 0.187 & 0.129 & 0.197 & 0.154 & 0.333 & 0.129 & 0.237 & 0.176 & 0.134 & 0.193 & 0.182 & 0.191 & 0.158 & 0.250 & 0.111 & 0.111 & 0.154 & 0.250 & 0.167 & 0.100 & 0.154 & 0.062 & 0.111 & 0.143 \\ 0.187 & 0.187 & 0.070 & 0.107 & 0.154 & 0.111 & 0.237 & 0.070 & 0.059 & 0.134 & 0.193 & 0.091 & 0.065 & 0.082 & 0.082 & 0.111 & 0.111 & 0.154 & 0.125 & 0.167 & 0.100 & 0.077 & 0.192 & 0.111 & 0.143 \\ 0.187 & 0.187 & 0.129 & 0.107 & 0.154 & 0.111 & 0.129 & 0.237 & 0.176 & 0.134 & 0.062 & 0.091 & 0.065 & 0.082 & 0.050 & 0.111 & 0.111 & 0.154 & 0.125 & 0.167 & 0.200 & 0.154 & 0.192 & 0.222 & 0.143 \\ 0.098 & 0.098 & 0.237 & 0.107 & 0.154 & 0.111 & 0.129 & 0.129 & 0.176 & 0.134 & 0.062 & 0.182 & 0.191 & 0.082 & 0.082 & 0.111 & 0.111 & 0.154 & 0.125 & 0.167 & 0.100 & 0.154 & 0.192 & 0.111 & 0.143 \\ 0.058 & 0.058 & 0.070 & 0.060 & 0.154 & 0.111 & 0.237 & 0.070 & 0.176 & 0.134 & 0.105 & 0.091 & 0.065 & 0.280 & 0.144 & 0.111 & 0.111 & 0.154 & 0.125 & 0.083 & 0.200 & 0.154 & 0.091 & 0.111 & 0.143 \end{bmatrix}$$

Step 6. Finally, the overall priority of the considered strategies was calculated as:

$$W_{alternatives} = \begin{bmatrix} SO1 \\ SO2 \\ WO1 \\ WO2 \\ ST1 \\ ST2 \\ WT1 \end{bmatrix} = W_3 \times W_{SWOTsub-factros(global)} = \begin{bmatrix} 0.149 \\ 0.163 \\ 0.138 \\ 0.135 \\ 0.183 \\ 0.129 \\ 0.104 \end{bmatrix}$$

5 Results and Discussion

Obtained results indicate that based on the SWOT-AHP hybrid model defines prioritization strategy for development National Park Djerdap in the following descending order:

ST1 → SO2 → SO1 → WO1 → WO2 → ST2→ WT1

Considering that the AHP is a basis for ranking SWOT criteria, Strengths criterion (S) has the largest weight in relation to the other 0.376. The sub-criteria in some SWOT criteria with the greatest significance are: S (S_1- Unique ecosystems and international importance of the protected bio and geo diversity values: 0.157); W (W_1- Lack of knowledge in the field of tourism and promotion of NP potential: 0.062); O (O_1- Creation of unique tourist product (brand): 0.110); T (T_2- Bad economic situation in the country: 0.053).

In the interest of preserving the natural and cultural attractions of the National Park Djerdap, increasing employment of the local population, the economic viability of the park, education of visitors and raising awareness of the importance of preserving this natural area, it is crucial to apply appropriate strategies that will ensure the sustainable development of this area. In order to achieve this goal, it is necessary first of all, to make the promotion of EU standards by engaging scientific institutions and NGOs, i.e. to implement ST_1 strategy. In order to make this area an attractive tourist destination both for the local and foreign tourists, it is necessary first to adopt and then implement the business practice which had already been used by the best in this industry. Opposite the National Park, on the Romanian side, there is a nature reserve Portile de Fier, which falls under the II degree of protection in that country - this is also a fact of great significance. Realization of mutual interest can be enabled by applying the following ranked strategy SO_2 - Development of the joint ecotourism brand with the Romanian side. Through cross-border cooperation, the possibility of reducing the competitiveness in the region can be achieved through marketing of the joint tourist offer, which further consolidates waterpower potential of the Danube River -the natural border between these two natural systems. Realization of these two mentioned strategies creates conditions for the implementation of the primary strategy for sustainable development of the National Park, and it is a strategy SO_1 - Creating a strategy for the development of eco-tourism with the involvement of internal and external stakeholders. In order to become a recognized industry of the region, coordination of a certain number of stakeholders that complement ecotourism offer is essential. This segment can be developed through mutual cooperation between the NP management, local authorities, the locals, the farmers who work and earn on the territory of the park and nearby, local entrepreneurs, owners of accommodation and catering facilities and others. In order to successfully implement this strategy, it is essential to define the management plan, which gathers and defines in detail the activities of all interest groups so that better cooperation, which contributes to the development of the whole region with a focus on preserving the natural and cultural heritage, would be achieved. After a well thought out management plan, sustainable development can be achieved by implementation of the following strategies: WO_1 - Education in the field of ecotourism content concerning offer and its promotion and WO_2 - The NP infrastructure arrangement according to EU standards. What emerged as a significant problem, after the situational analysis, is the lack of knowledge in the field of tourism. Many locals have recognized the opportunity for the development of ecotourism in this area, but they do not have enough knowledge and experience of starting an independent business as well as on its promotion to potential visitors. In order to solve this problem, it is necessary to educate the local population on the needs of visitors and on the method of selling

products and services in an adequate manner, which can be done through various forms of practical seminars and trainings by the experts in this area. Another significant problem in this area is poor infrastructure which does not meet the needs of visitors. Therefore, investments in this segment are vital for building the adequate accommodation and catering facilities, restructuring of the road network, which connects this area with the rest of Serbia, pedestrian, bicycle paths and signposts on the territory of the National Park and the viewpoints as well. For such a significant investment it is important to engage both state institutions and EU through projects, which will provide funds to finance these needs. After realizing strategies in this particular order, control of state authorities is also fundamental so that the concept of ecotourism would preserve the existing natural resources. This can be achieved by applying ST_2 strategy- Engaging state authorities in strict compliance with environmental regulations in the National Park and its surroundings. Also, WT_1 strategy - Hiring professional management to manage NP, contributes to the sustainable development of the ecotourism concept.

6 Conclusion

A modern business in the conditions of the changing environment in the global market requires that organizations optimize their multiple objectives simultaneously under conditions of uncertainty during the processes of planning and decision making. For this reason, the application of traditional SWOT analysis, which uses arbitrary ranking criteria and sub-criteria independently of each other by ignoring the potential interactions between them, is not sufficient to respond to all the challenges that go with the modern business.

In order to overcome these shortcomings of traditional SWOT analysis, in this paper, an attempt of its improvement has been made by using AHP techniques for multi criteria decision making. Our objectives in this study were: (a) to define the quantitative basis for the ranking criteria and sub-criteria in SWOT analysis by using AHP multicriteria methods, (b) to carry out a prioritization of the defined strategies on the basis of SWOT analysis which included multicriteria decision-making in order to achieve sustainable development of the National Park Djerdap.

The main limitation of this study is the fact that the defined methodology was applied only in one area of sustainable development of the National Park Djerdap - in the concept of ecotourism. Further research directions include the application of this methodology in other areas so that its effectiveness and usability would be determined as well as its improvement would be carried out for the sake of its generalization.

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SERBIAN WATER QUALITY INDEX AS A TOOL FOR EFFECTIVE WATER QUALITY MANAGEMENT

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Abstract: The water quality evaluation is one of the most important aspects of integrated water quality management. Besides standard methods, that are based on the comparison of measured and limited values of water quality parameters, it has been developed index method for water quality evaluation. Water quality indices enable significant data reduction and a simpler interpretation of water quality status. Also, the index method provides overall display of water quality and better insight into the changes to the scientific and general public. *Serbian Environmental Protection Agency* has developed the numerical indicator of surface water quality – *Serbian Water Quality Index* (*SWQI*).

This article presents spatial and temporal water quality changes on main courses of the Morava River System. Thereby, there were calculated and applied SWQI to the period of 2005–2012. Also, it was conducted the comparative analysis of South, West and Great Morava water quality status.

***Keywords*:** Water Quality, Environmental Management, Serbian Water Quality Index, Morava River System

1 Introduction

Water resources in Serbia are not temporally and spatial allocated according to the requirements and distribution of industry and population, because there is the least amount of water in the summer and in economically undeveloped areas [1]. During the last decade, the utilization of water resources had amounted 80% approximately, which was confirmed by Water Exploatation Index. This value is alarming, especially if we take into account that, according to the European Evnironment Agency methodology, 40% represent the limit value [2]. Consequently, protection of water from irrational usage and pollution should be one of the prime tasks of water managment in the future [3].

Republic of Serbia strives to join the European Union (EU), so it is necessary to create conditions for totally adoption of EU regulations regarding the environmental issues. The complexity of this process is reflected in the fact that current state in the area of environmental protection significantly lags behind the state in the EU member states. Situation is especially difficult in the water quality management. As an active member of International Commission for the Protection of the Danube River, Serbia has commitment to implement Water Framework Directive. Therefore, thoroughly monitoring of Serbian rivers (especially those that belong to the Danube basin), during the short and long-time periods, is not only ecological, but also political issue of international interest.

1.1 Water quality index

Standard methods for water quality evaluation were based on the comparison between recorded and limited values of water quality parameters. However, in order to reduce data and interpret it in an easier way, index method have been developed.

Water quality index (WQI) is numerical expression used in transforming complex data set into a number which defines water quality level [4];[5]. Uniqueness and complexity of water quality chemical composition and parameters (indicate the influence of different dissolved supstances as mineral and organic compounds, gases, colloides, suspended solids and microorganisms that are present in water because of natural and artificial influences) emphasize the importance of applying index methods in water quality assessment and identification of mutual factors [6].

There are number of methods for calculating surface water quality index and they are adapted to the monitoring areas [7]. First-ever modern WQI was the Horton's index – which was defined in 1965. After him, numerous authors had continued to use and promote this way of water quality determination [8];[9];[10];[11];[12];[13].

1.1.1 Sebian Water Quality Index

Serbian Environmental Protection Agency has developed index for water quality determination – *Serbian Water Quality Index* (SWQI). Use of this index, as one of the environmental indicators, simplifies reporting to scientific and general public about the water quality. Previous studies and results indicated that this index enables comprehensive image of surface water quality status and trends [14];[15];[16].

Calculation of SWQI is based on the WQI method (Scottish Development Department, 1976). Ten physico-chemical and microbiological water quality parameters (oxygen saturation, biological oxygen demand, ammonium ion, pH value, total nitrogen, orthophosphates, suspended solids, temperature, electrical conductivity and coliforms) compose indicator of surface water quality [16]. Every parameter has its own coefficients q_i (quality) and w_i(weight). According to the different share in overall water quality, it was assigned adequate weight score to each parameter (w_i), whereby the sum of all coefficients is 1. Then, products of q_i i $w_i$values for all parameters separately were calculated.

Sum of obtained products presents water quality index [14]. Method for calculation of SWQI is represented by formula:

$$SWQI = \sum_{i=1}^{n} q_i w_i \quad (1)$$

According to the value of SWQI, surface water could be classified in one of the five categories presented in Table 1.

Table1. Numerical and descriptive indicators of surface water quality

Serbian Water Quality Index (SWQI)	
Numerical indicator	***Descriptive indicator***
100 – 90	Excellent
84 – 89	Very good
72 – 83	Good
39 – 71	Poor
0 - 38	Very poor

2 Methodology

In order to achieve research goals, it was used data set that presents a part of the data fund of the Republic Hydro - meteorological Service of Serbia published in Hydrology almanacs for the period of 2005 – 2012 [17]. The numeric value of the water quality index was calculated by using the "Calculate your SWQI" software package of the Serbian Environmental Protection Agency [18]. For calculating SWQI it is necessary to enter values of considered parameters in appropriate fields. In further data processing were used software packages EXCEL 2007 and SPSS v.17 that enable the realization of defined study aims.

2.1 Monitoring area

The most important river system in Serbia is Morava which is consisted of South Morava, West Morava and Great Morava rivers and their tributaries (Figure 1). Considering the fact that Great Morava belongs to the Basin of Danube River, the second longest European river, it is necessary to underline the importance of assessment and monitoring of this river system quality.

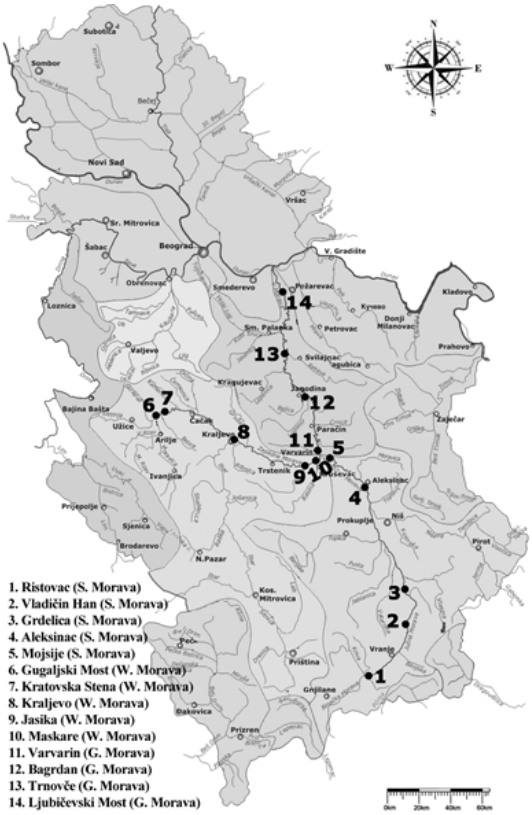


Figure 1.Study area and surface water quality monitoring stations (listed 1-14) in the Morava River System (Source: Voza et al., 2015.)

In this study have been analyzed fourteen (14) monitoring stations located along the main courses of the Morava River System – the South Morava, the West Morava and the Great Morava (Figure 1).

3 Results and discussion

3.1 Correlation between SWQI and year and location of monitoring

In order to determine correlation between SWQI values and monitoring year and location, it was conducted correlate analysis for every main course of Morava River Basin, individually.

Table 2. Correlation matrix of quality index, location and year of monitoring

		Year	Location	SWQI
South M.	SWQI	-,155**	.293**	1
West M.	SWQI	-,127**	-0,075	1
Great M.	SWQI	-,210**	-,106*	1

** Statistically significat at level p < 0,01(2-tailed).

* Statistically significant at level p < 0,05 (2-tailed).

The results presented in the Table 2 indicate that there is statistically significant, negative, correlation between water quality index and year of monitoring in analyzed rivers. This means that water quality have been decreasing during the period 2005 – 2012. Correlation between SWQI and monitoring location was not recognized only in case of West Morava. According to the direction, it could be concluded that at South Morava water quality level has increased, while at Great Morava decreased from entry to exit profil.

3.2 Spatial and temporal changes of SWQI on the main courses of Morava river system

For determination of spatial and temporal water quality variations, it has been analyzed changes of mean values of SWQI in function of location and year of monitoring. Trends are displayed by three-dimensional graphs, which enable better visual insight (Figures 2-4). Horizontal x and y axis represent the time (years of monitoring from 2005. until 2012.) and space (monitoring stations located along the courses), respectively. On vertical z axis are recorded SWQI mean values.

Spatial analysis of South Morava has indicated an increasing trend of SWQI changes, which led to the conclusion that water quality was getting better from the entry to the exit point. Observation of the changes during the analyzed period didn't show the existence of any temporal trend (Table 3).

Results of the study has showed that, in the case of South Morava, the lowest water quality during the whole monitoring period was on its' entry profile – location Ristovac (Picture 2). This pointed out the strong negative influence of anthropogenic factor. Regarding that Ristovac represents the entry profile where rivers Binačka Morava and Preševska Moravica form South Morava, it should been taken into account water quality level of these tributaries. Water quality monitoring had not been performed on Preševska Moravica, while evaluation of water quality on Binačka Morava had been performed only near Bujanovac. Analyses of RHMS reports for the period of 2005 – 2012. indicate that there was not any measurement near Bujanovac from 2005 – 2008. Also, water evaluation for the years of 2009., 2010. and 2011. had chategorized it as the water of III/IV quality class. In Hydrology Almanac for 2012. there has not been presented classification of the river flows. Very low level of water quality sampled at location Ristovac, could be explained with high pollution of river Binačka Moravica. During the high-water period, river withdraws the waste from the landfills and as the result of this appear the congestions of the river. Nearby this profile is located the Factory of cellulose and paper „FOPA". All wastewater, inccured as a result of a production, are discharged directly into the South Morava river. The bottom of the river is covered by the particulate cellulosic material whose decomposition requires a

huge amount of oxygen. This factory is considered as the most important polluter of surface waters in Serbia [15]; [20].

Table 3. Mean values of SWQI for South Morava River

	Year of Monitoring							
Monitoring station	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Ristovac	71	78	57	70	69	67	63	69
V. Han	80	82	73	78	75	76	76	
Grdelica	85	81	89	85	80	82	87	79
Aleksinac	80	80	80	78	79	76	78	78
Mojsinje	83	77	77	77	77	76	77	78

On the other side, the best water quality was on the location Grdelica (Figure 2). Here is the water quality higher because of the influence of natural factor. Therefore, water on this part of South Morava course has capability for self-purification and assimilative capacity that help in reducing the pollution.

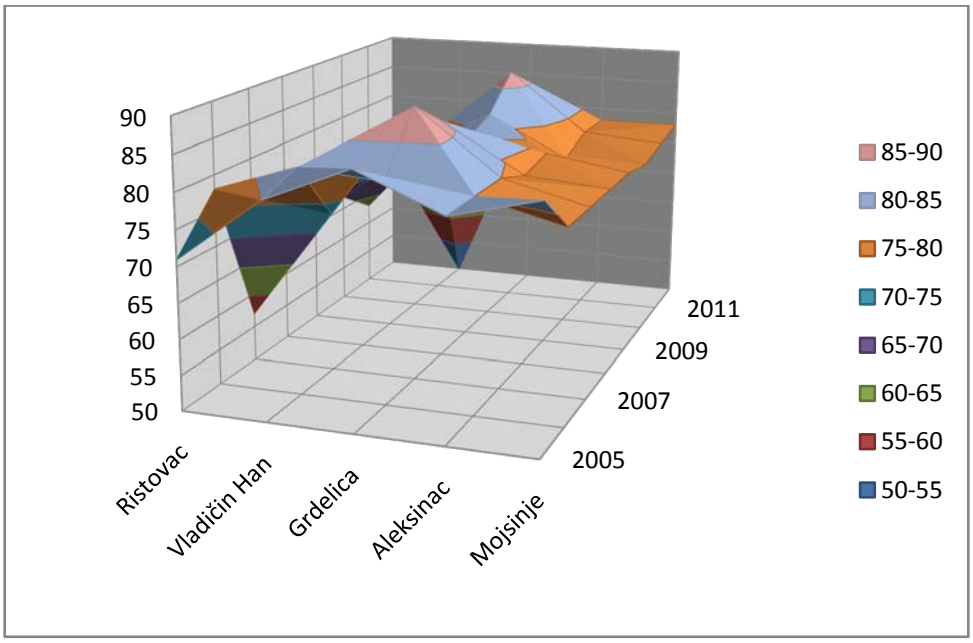


Figure 2. Changes of SWQI on the course of South Morava

In the case of West Morava is notable a small range of SWQI mean values, so it can't be recognized any spatial or temporal water quality trend (Figure 3). Values of this index were between 75 and 85 which indicate on water with good or very good quality (Table 4).

Table 4. Mean values of SWQI for West Morava River

	Year of monitoring							
Monitoring station	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
G. Most	79	82	81	81	78	78	77	81
K. Stena	81	80	80	75	77	75	80	
Kraljevo	80	81	81	83	79	76	81	81
Jasika	84	79	80	80	78	79	78	77
Maskare	80	77	82	79	76	81	76	

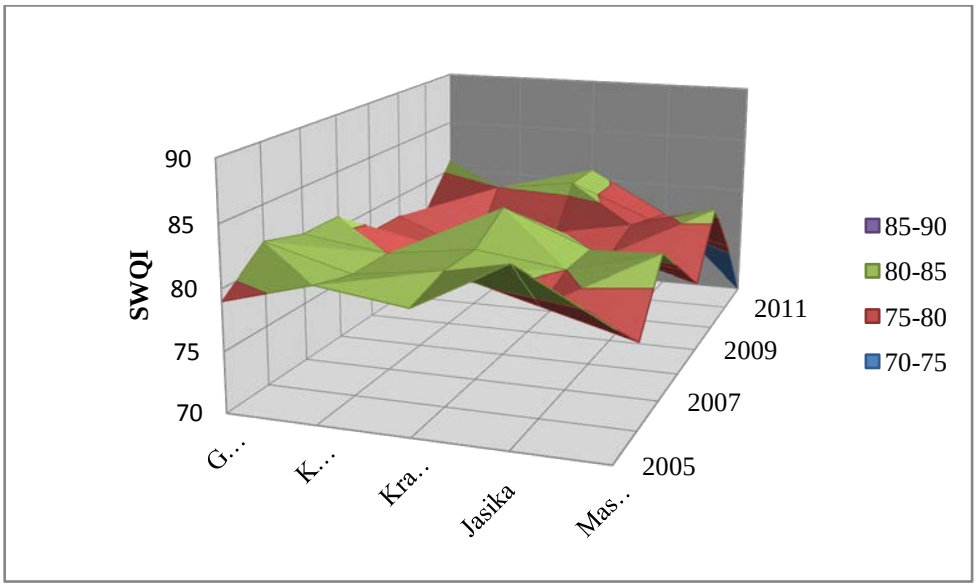


Figure 3. Changes of SWQI on the course of West Morava

As in the previous case, on the course of Great Morava have it couldn't been recognized any spatial or temporal trend of SWQI changes (Picture 4). During the eight-year period, the lowest water quality level had been recorded at the measuring station Trnovče (Table 5). Water from the following tributaries: Lepenica (downstream from Kragujevac), Resava (downstream from Resava mines), Veliki Lug (downstream from Mladenovac) and Jasenica (from its confluence), flow in the Great Morava at this measuring point. These tributaries bring with them huge amount of industrial and municipal waste. According to the level of pollution, river Lepenica could be distinguished as the most polluted, especially because of the detected heavy metals and various types of poison in water. Also, numerous urban and rural settlements are located along the entire bank of Lepenica.

Table 5. Mean values of SWQI for Great Morava River

	Year of monitoring							
Monitoring station	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Varvarin	81	80	83	78	79	74	78	
Bagrdan	82	78	81	80	76	80	81	78
Trnovče	74	77	79	75	71	67	78	79
Lj. Most	85	78	79	84	78	69	79	80

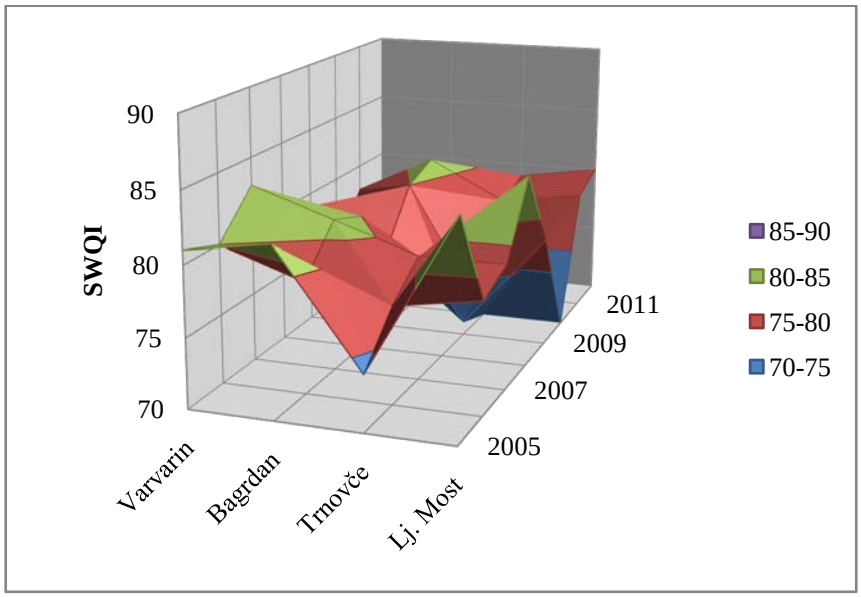
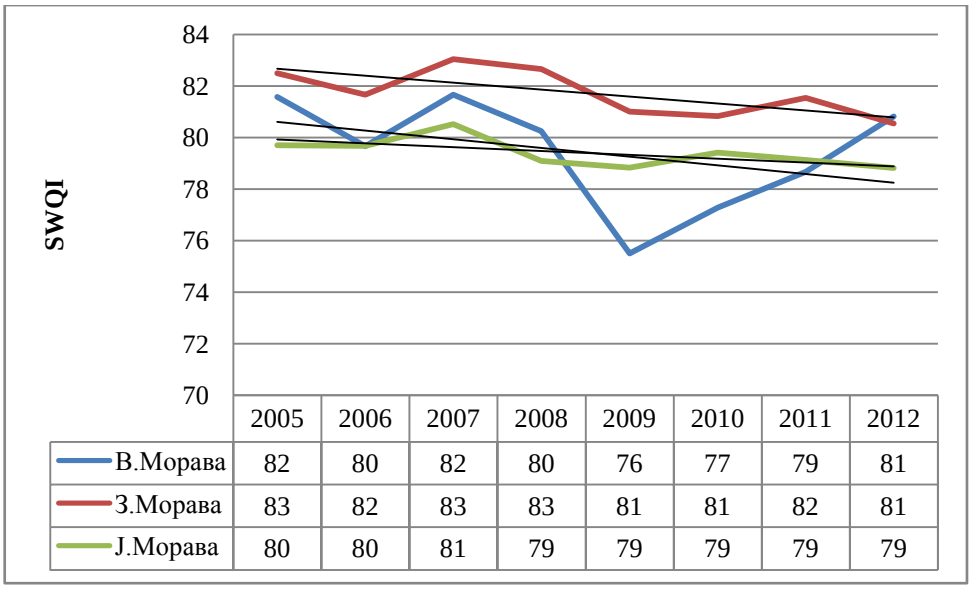


Figure 4. Changes of SWQI on the course of Great Morava

3.3 Comparative analysis of water quality onthe main courses of Morava River system

In the Figure 5 are presented the annual changes of SWQI along the main courses of Morava river basin. Observation of median values of SWQI means for every location on the selected course, has been indicated that, during the period of 2005 – 2012., the overall water quality of the analyzed rivers belonged to the III class (good), without deviations. The significant oscillations of SWQI variations have been detected on the Great Morava where was rapidly decrease of water quality during the period 2007 - 2009. On the examples of South Morava and West Morava, there were not detected important water quality oscillations during the analyzed period.



	2005	2006	2007	2008	2009	2010	2011	2012
В.Морава	82	80	82	80	76	77	79	81
З.Морава	83	82	83	83	81	81	82	81
Ј.Морава	80	80	81	79	79	79	79	79

Figure 5. Linear trend of SWQI changes at the main courses of Morava river system

Using the trend line it is possible to present long-term changes of water quality. In all three cases, it could be noticed that water quality decreased during the particular eight-year period.

4 Conclusion

Serbia is country with huge amount of surface and ground water, while most of the watercourses belongs to the international river basins. From this distance, it could be said that water supply in Serbia is not threaneted. However, this fact should accepted with reserve, because this situation will be viable only by reducing and controll of pollution from the existing sources, as well as by establisment of sustainable water management. Despite all, the process of sustainable water management implementation in Serbia is currently faced with huge problems.

Identification of locations and period of monitoring with low water quality implies the need to undertake the activities aimed to reduce and prevent the pollution in the future. Graphical display enables simpler way of monitoring and assessment of spatial and temporal changes of surface water quality. This provides that the results of quality analysis become transparent, not only scientific, but also general public, especially decision makers in this area.

The results of this study have shown that SWQI is very suitable in visualizing changes of water quality on the main courses of Morava basin, in dependence of monitoring location and year of sampling. Mean values of this index indicated that water quality had been decreased during the analyzed period 2005 – 2012. Also, as risk locations on these rivers were recognized stations Ristovac on South Morava and Trnovče on Great Morava. Based on these results, it is necessary to identify the main sources of pollution in this area and to undertake actions in accordance with the basic principles of sustainable management.

Acknowledgements: *Prepared as a part of the project Sustainability of the Identity of Serbs and National Minorities in the Border Municipalities of Eastern and Southeastern Serbia (179013), conducted at the University of Niš – Faculty of Mechanical Engineering, and supported by the Ministry of Science and Technological Development of the Republic of Serbia.*

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INVESTIGATORY CFD STUDY OF EXHAUST GAS DISPERSION FROM POWER PLANT IN WEST-ZAWIA CITY IN LIBYA

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Abstract: The dispersion of exhaust gases from 40 meter high stacks of the combined cycle power station located at the sea side of a highly populated area in the west Zawia city in Libya is investigated. This power station together with the old oil refinery in Libya constitute the largest sources of pollution in the area. The purpose of this study is to perform the first step toward assessment of the level of concentration of gases. The concentration of gas levels and locations of the most polluted spots in the city are highlighted. Therefore, this study is important for specifying gas sensors required and its specifications. The study is performed by ANSYS-FLUENT CFD package in steady state simulations, with K-ε turbulence model, and species transport model were performed. The power station stacks, and main station buildings, are modled inside ANSYS environment. The pollutant composition is adopted for the power station operation manual. Two different north wind speeds of 5m/Sec and 3m/sec are analysed and the resulting concentration of pollutants is calculated on the ground level. The maximum concentrations are very low, but further measurement and analysis are still required.

***Keywords*:** Pollution assessment, CFD, Gas Dispersion, Stack gases.

1 Introduction

One of the most important health issues is understanding how toxic gases travel in the air that the humans breathe, animals and plants use. Rapid assessment of risk associated with routinely operated factories, fire accidents, large oil storage fires, or chemical spills is of vital concern to first responding organizations, local officials, governments and to the public. Risk assessment requires that the phenomena of air flow are fully understood and a series of expected scenarios are thoroughly examined. CFD methods have been in use in the field of aerospace and mechanical engineering for a few decades. It takes into account the details of airflow around complex engineering objects to be fully investigated, analysed and understood. Recently CFD techniques have shown promising results in environmental studies because it is based on solving the most general equations governing fundamental physics,

although not yet adopted as a routine tool. One example of massive oil fires is the shelling of Libyan Sidra and Ras-Lanuf giant oil storage tanks as shown in figure 1 where the pictures are taken on January 2016 by NASA satellite Terra. The smoke forms a huge cloud that travels across the region covering the coast Sert to Bengazi.

In response to the concern of Libyan Authority for Science, Technology and Research (LASTAR) to the field of environment, the authors decided to conduct this investigation, study upon one of the largest electric power stations in the west of Libya. West-Zawia electric power station produces more than 1440 MWatt of electric energy. The electricity produced is distributed to the Libyan electric energy network and it covers a large percentage of national demands. The power station works on natural gas as the primary fuel and diesel oil as secondary fuel. The emitted Gases from the electric power station concerns the people in Zawia area which has a population of about 291,000. It is known that, combustion products from the electric power plants produces large quantities of different residues of combustion, which are very harmful for the environment. The emissions include sulphur oxides, nitrogen oxides, carbon monoxide, carbon dioxide, hydrocarbons. It is known also that, among the global environmental problems, global warming effect and acid rain are mostly associated with the air pollution problems of thermal power plants. Protection of the power plant environment is an important environmental issue worldwide. Therefore, atmospheric pollutant dispersion, originating from power station stacks needs to be determined in the region of interest. Field measurements are one common method of detecting levels of pollutants. Measurements are also necessary to gain confidence and validate theoretical and numerical methods. On the other hand, they are expensive and may not be always possible or it give a limited quantity of data. The problem of studying gas dispersion using CFD techniques has been examined by many authors [2] [3] are just an example. Numerical simulation of the flow is the most economical, fast and very reliable method in environmental studies. Computational fluid dynamic (CFD) numerically simulates various phenomena in fluid mechanics and regardless of their potential to model the wind [3]. Although, the flow of pollutants of large-scale environmental applications have not been yet established as a routine technique as noted in [2]. The applications of CFD for pollution dispersion showed their capabilities during the last decade. Comparisons of the CFD results with wind tunnel tests and field measurements, in general, support such approach [3]. Therefore, CFD approach is adopted to understand the influence of pollution emitted from the stack of West Zawia electric power station to the closest populated.

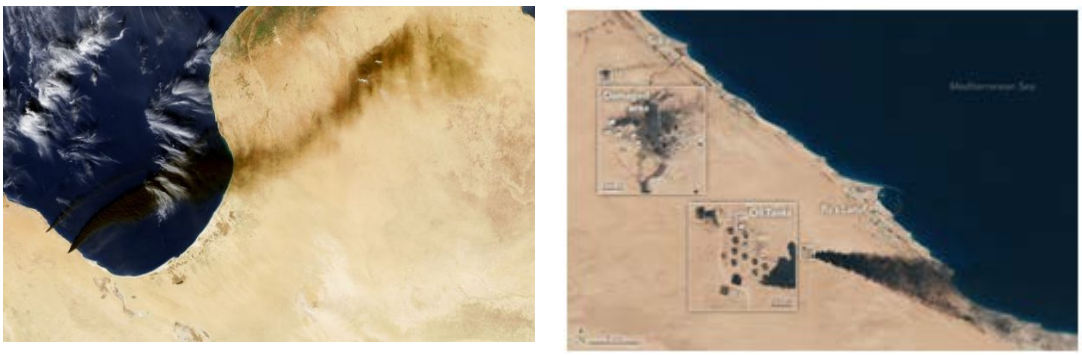

Figure 1. NASA captured images of the oil fires in Sedra and Ras-Lanuf in Libya on January 2016 caused by shelling of a giant oil tank.

2 West-Zawia electric power station

The West-Zawia power plant is a Combined Cycle Power Plant runs on natural gas and diesel oil. Figure 2 shows an overview of the station and its location relative to a populated area. The power station starts the operation with diesel fuel at 2003, in 2005 the station starts to work on the combined cycle with additional unit up to 2008. Table 1 shows the power capacity of each turbine and its manufacturer [4,5]. Today, it consists of 3 blocks of 2+2+1 combined cycle gas turbines with 1440MWatt design capacity. The stacks are about 40 meters height with 6.3m internal diameter and emits 487kg/sec of gasses at a velocity of 7m/sec and a temperature of 543^{o}C into the atmosphere when operating with full load.

Table 1. Power station unit information [4,5]

Unit	Capacity MWatt	Date commissioned	Producer	Turbine model/type
1	165	2003	Alstom	GT-1 GT13E2
2	165	2003	Alstom	GT-2 GT13E2
3	150	2005	Hyundai	ST-1
4	165	2003	Alstom	GT-3 GT13E2
5	165	2003	Alstom	GT-4 GT13E2
6	150	2005	Hyundai	ST-2
7	165	2005	Alstom	GT-5 GT13E2
8	165	2005	Alstom	GT-6 GT13E2
9	150	2007	Hyundai	ST-3

The power station operates by the General Electricity Company of Libya (GECOL). The designed composition and characteristics of exhaust gases are listed in table 2 at base load conditions when natural gas is used while the secondary fuel is light fuel oil/diesel.

Table 2. Sample design exhaust gas characteristics of base load [4]

Item	2 GT base load
Mass flow rate, kg/sec	487
Temperature, ^{o}C	543
Composition, Vol%	
Ar	0.9
N_2	72.78
O_2	13.55
CO_2	3.32
H_2O	9.45
SO_2	0

Figure 2. An overview of West-Zawia combined cycle power plant 2003 (left), a map showing the location of the Zawia station relative to the city and main coastal road.

Up to the authors' knowledge, there are no reports of any studies regards the real gas release contents to the environment, nor measuring equipments in the area. Therefore, the study relies on the data given in the operaterional manual to first estimate main characteristics of pollutant dispersion. This study firstly, comes as a response to people concern in this area about the quantity of gases released, their types, impact on general health, and secondly, to the calls of Libyan Authority for Science, Technology and Research (LASTAR) in the field of environment.

This paper gives the results of multicomponent gas dispersion from the stacks of the power station using 3D Ansys/Fluent CFD package simulations. The main aim of the paper is to investigate the modling of gas dispersion and analyse the influence of wind speed on ground concentrations. The quality of the simulation is influenced by the uncertainties in the input data and the numerical model.

3 Numerical model

ANSYS Fluent software can solve complex three-dimensional fluid flow problems. To describe the fundamental processes of momentum, mass transfer and heat, it requires to solve the Navier-Stokes equations together with a number of mathematical models that can be used with Navier-Stokes equations to solve chemical or physical processes, such as transport, combustion, or turbulence. It uses a finite volume approach to convert governing partial differential equations in a discrete system of algebraic equations by discrediting the computational domain into finite volumes. These equations lead to a solution with specified boundary conditions applied on domain boundaries.

The transport and mixing of species are modeled in ANSYS FLUENT [1]. The model takes into account convection, diffusion, and reaction sources for species. The local mass fraction for i^{th} species is calculated from the general conservation equation given by:

$$\frac{\partial(\rho y_i)}{\partial t} + \nabla(\rho \vec{v} y_i) = -\nabla \vec{J_i} + R_i S_i \quad (1)$$

Where y_i is the local mass fraction, j_i is the diffusion flux for i^{ih} species, R_i is the net rate of production of species i by chemical reaction, S_i is the rate of creation by addition from the dispersed phase, ρ is the density and v is the velocity. Modeling the dispersion of the pollutants in the atmosphere with ANSYS FLUENT a geometric model is created with various levels of geometric detail complexity depending on the type of dispersion. Studying a short term dispersion normally deals with industrial safety inside factories such as gas leakage, or fire hazards. For this reason relatively small domain size is used, but complex geometries are modeled such as, pipe lines tanks windows and doors. In long term gas dispersion studies, however, large scale gas dispersion over larger domain sizes, but with less geometric details Therefore, main geographic factors and large buildings are considered in the geometric model. The mesh is then generated in the computational domain, with different types depending on computer capacity and model size. After the boundary conditions are applied the governing equations are solved and the results processed. In this work, long term dispersion is studied, hence, only main power station buildings and stacks are included in the geometric model, which is built inside Ansys geometry modeler. The computational domain size has 3000m long, 1000m width, and 1000m height. Figure 3 shows an overview of the computational domain and different boundary conditions. The main stacks and power station buildings were included in the model as seen in figure 4. A north wind is dominant in this region, therefore two speeds are used in the analysis for 5 m/sec and 3 m/sec. The wind boundary conditions are set as uniform velocity input. The domain left and right sides together with the upper side of the computational domain are set to symmetry boundary conditions. The outlet pressure boundary condition is set to the outlet boundary. Gas emissions from the stacks with velocity of 7 m/sec at a temperature of 543^oC is applied at gas inlet area. Pollutants mass fractions are specified on this inlet boundary. Control volume mesh must be constructed in the domain to see the effects on the cloud dispersion. The mesh used in this study is an unstructured tetrahedral of 141974 elements, as shown in figure 5, a close up view of the grid is shown in figure 6.

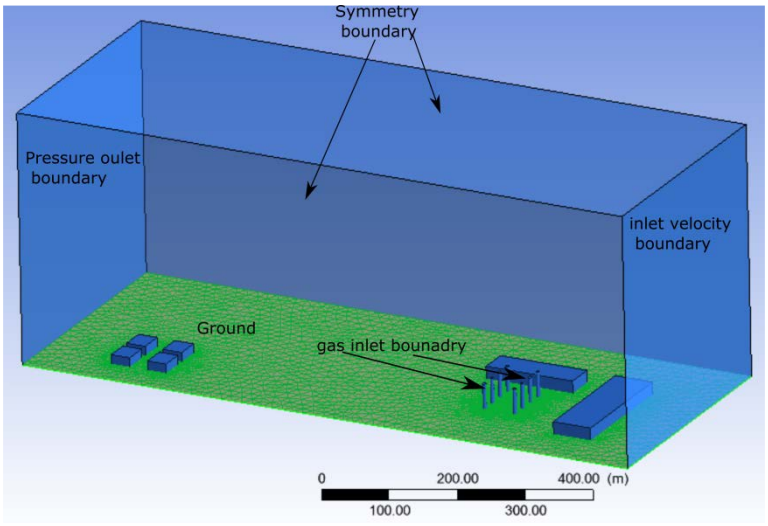

Figure 3. An overview of the computational domain.

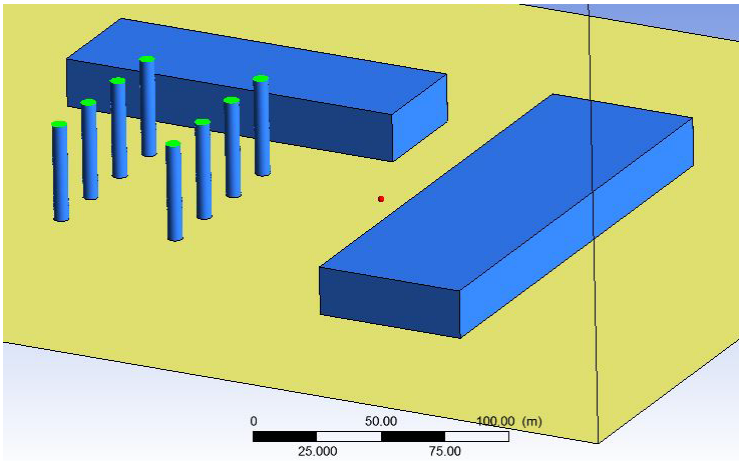

Figure 4. Close up view of geometric model

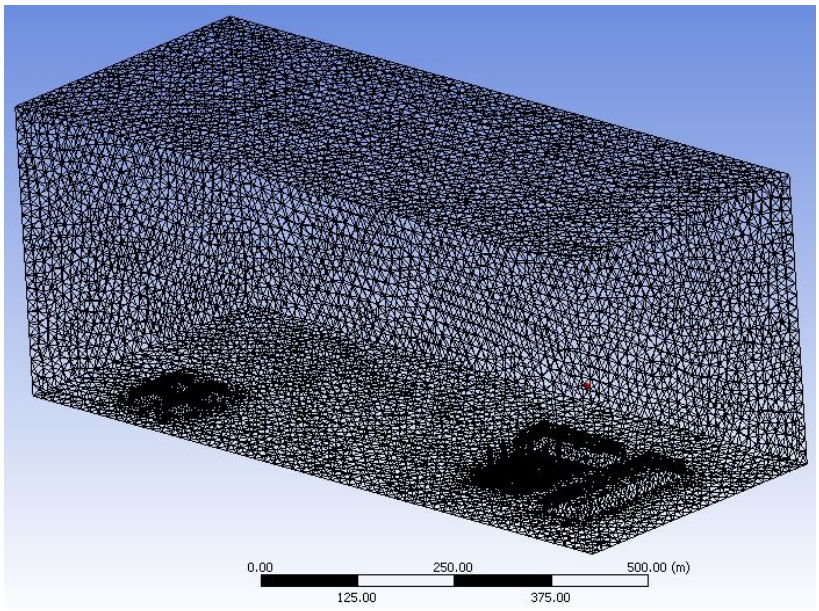

Figure 5. Mesh overview showing dense mesh near walls and curvatures

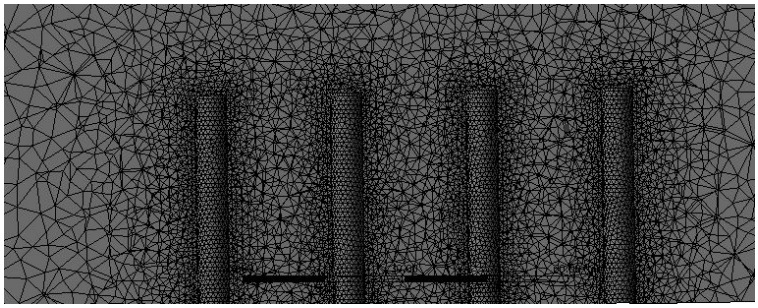

Figure 6. Close up view of stacks mesh used in the study.

4 Results and discussion

The main simulation parameters in this study are the wind velocity at the velocity inlet boundary, exhaust gas conditions at the gas inlet boundary and its total concentration. Two wind speeds are adopted in these results, 5 m/sec which is close to annual average wind speed in the area [6] and wind speed of 3m/sec which considered normal wind speed on the sea side during day time. A North wind direction is chosen because it is dominating wind direction and directs gases to the populated area. The exhaust gases conditions are supplied in fraction mass with velocity of 7m/sec to the Fluent solver. Steady state numerical simulations with K_ε turbulence model is used throughout these analyses, since it is being used by many authors [7], [8] in pollutant dispersion studies. Since, field measurements data are required for validation, which are not available at this stage of the research, the verification and validation are left for other work.

Figure 7 shows the CO_2 dispersion predicted for two wind speeds 5m/sec and 3 m/sec respectively. It can be noted from the shape of the cloud that for higher wind speed, the lower edge of the gases are closer to the ground than that for higher wind speed.

Lower wind speed allows the gases to gain vertical height compared with the high wind speed for which the cloud is narrow in high and has less width as can be seen from the top view in figure 7. Figure 8. shows a counteur plot of CO_2 concentrations on the ground level as a result of the two wind speeds. The locations of maximum concentration are different for different wind speeds. High wind speed tends to carry more gases away from the source and thus shows the maximum concentration at far away distance compared to the lower wind speed which has the maximum concentration closer to the source and two orders of magnitude less. The lower maximum concentration at lower wind speed may be explained as a direct consequence of low wind speed which allows the gases to spread in vertical and side directions.

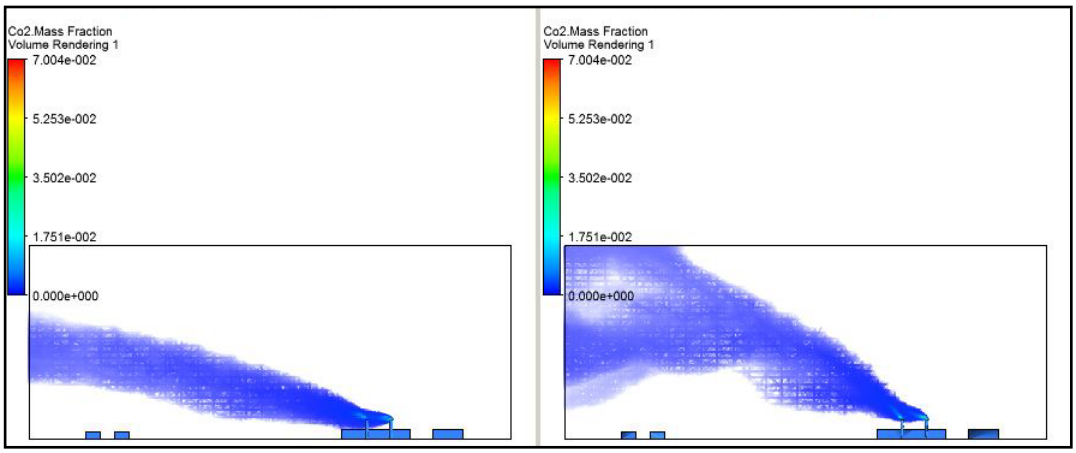

Figure 7. Side view of CO_2 dispersion of at wind speed of 5m/sec (left) and 3m/sec (right.

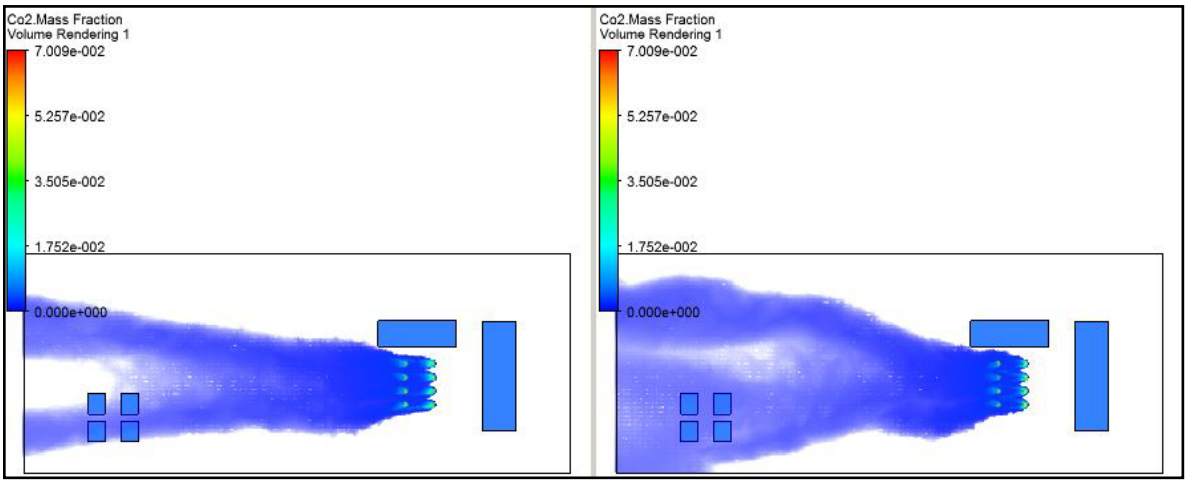

Figure 8. Top view of CO_2 dispersion of at wind speed of 5m/sec (left) and 3m/sec (right).

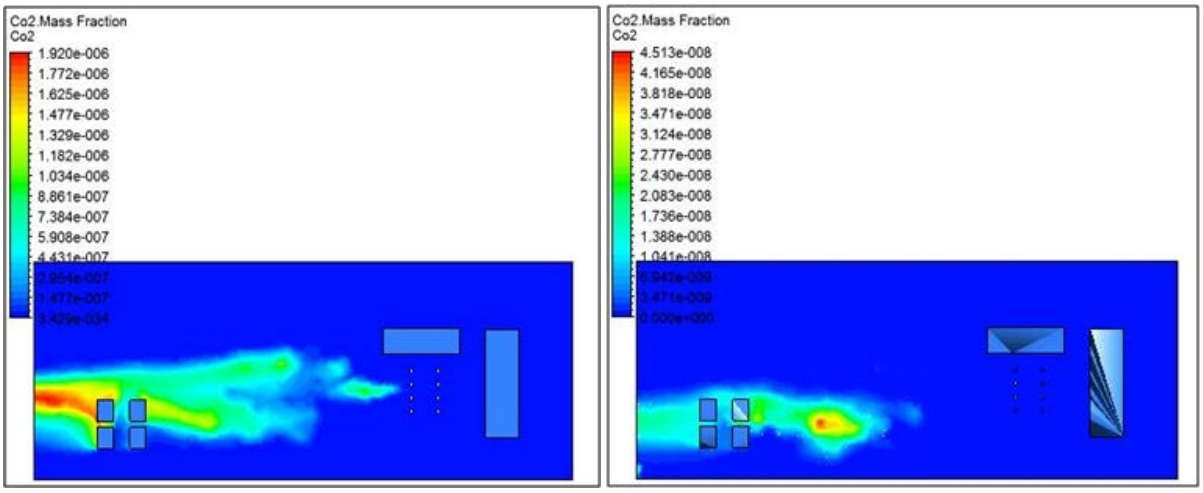

Figure 9. Ground concentrations of CO2 as a result of wind speed of 5m/sec (left) and 3m/sec (right).

The following table shows maximum mass fraction concentrations predicted for essential compositions

Table 3. Maximum mass fraction concentrations predicted

Item	Maximum mass fraction concentrations	
	5 m/sec	3 m/sec
Ar	4.395×10^{-7}	1.032×10^{-8}
N_2	2.747×10^{-6}	6.446×10^{-8}
O_2	5.494×10^{-7}	1.289×10^{-8}
CO_2	1.92×10^{-6}	4.513×10^{-8}

5 Conclusion

ANSYS FLUENT is successfully used to investigate the dispersion of the pollutants emitted from the Zawia power station which uses natural gas fuel. Gas dispersion path shapes are analyzed in horizontal and vertical directions due to different north wind speeds of 5m/sec and 3m/sec. The maximum mass fraction concentrations of the exhaust compositions are obtained at various locations in the domain. This study shows that the shape of contour concentrations is highly sensitive to wind speed.

ANSYS FLUENT software is able to describe the dispersion of the pollutants as well as their concentrations in the atmosphere. It is worth noting that, although the maximum concentrations are low, the results of this study need to be verified by comparison either with results from other methods or with experimental measurements. In addition, various velocity profiles and temperature rates need to be considered in future studies.

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POTENTIONAL CONCEPTUAL SOLUTION FOR WAREHOUSING SYSTEMS THAT USE MANUAL PALLET RACKS - AUTOMATED PALLET RACK: DESIGN, FUNCTIONALITY, PURPOSE AND BENEFITS OF USING

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Abstract: Efficient solutions mechanisms and devices that are used daily in the logistics operational purposes production facilities of various factories, companies, corporations and other business entities are one of the most important tasks in order to organize the optimal production of propulsion flows. Special emphasis in this regard should be placed in the storage systems previously mentioned subjects due to their specific position in the production chain. The paper aims to show a completely new concept of automated pallet racking which could lead to the application within a specific warehousing system undoubtedly enable savings of resources, time and energy and significantly increase the efficiency of the entire logistics sector and certain organizations.

Keywords: warehousing, automated pallet rack, advantages and benefits of using

1 Organization of warehousing system

The warehouse is habitual realization of delivery - receipt of goods, or separation or merger of cargo flows. The organization of warehouse machinery and staff must be such as to ensure optimal conditions for the placing and receiving of materials manipulated. In addition, the previously performed a comprehensive analysis of the underlying processes and sub-processes including their evaluation and diversification for easy identification and integration of the planned project. Special emphasis in this regard is placed on determining the optimal energy that should be used as well as the available resources that should be spent to the planned operation executed with minimum degree of time and money. [1]

All characteristic storage operations include at receiving, picking, packing, storage, order picking, sorting and cross docking of goods. In this paper, the workpiece will be the analysis of potentially applicable automated devices for the process of storage of goods within the pallet racks. With most warehouse and distribution systems for all common operations are carried out using more or less complex devices (various types of forklifts, cranes, pulling wagons, manipulators, etc.) And warehouse personnel (operators) which oversees the whole process but very often directly involved in the its implementation with the participation of more or less complex of manual activities. On the other hand, the presence of these necessary resources (machines, people, equipment and the like.) entails a good deal of costs in relation to the total cost of the storage system. For this reason, a relevant factor is the effect of available elements and mechanisms on the one hand and the human factor on the other hand. The following table shows the performance of individual technologies function as an integral process of picking storage system according to the level of costs that private products.

Table 1. Performance of certain technologies in terms of cost level. [1]

Technologies	Order picking intensity (pallet units/h)	Costs
Order picking forklift for horizontal transport	100-250	$1000-$10000/vehicle
Order picking forklift for vertical transport	50-100	$30000/vehicle
Pick to roller order picking	125-250	$1000/ft
Pick to belt order picking	250-400	4200/ft + $2000/turning
End-of-aisle AS/RS	200-300	$300000-$450000/aisle
Austo extract order picking	500-800	$200000/unit
Layer – tier picking	1000-1500	$150000/unit

A very important component when considering the effects of the work unit's activities focused mechanization and personnel, particularly in larger and more complex storage and distribution systems, is the time factor. Shown below is the form of the average cycle time work of highrack crane as a integrating form of all characteristic sub-processes during the movement of the highrack crane in the process of loading/unloading of goods.

$$T_{dc}^{iI/O,jI/O} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{m}\sum_{l=1}^{n} T\left(P_{\underline{iI}\,\underline{jI}}{}_{O,O}{}_{+}\,P_{i,j}\right) + T\left(P_{i,j},P_{k,l}\right)}{N} + \frac{T\left(P_{k,l},P_{\underline{iI}\,\underline{jI}}{}_{O,O}\right)}{N} + 4 \cdot t_w \qquad [4]$$

where is:

iI/O – vertical coordinate input/output range of from racks – point 1 (iI/O = 1, 2, 3...m);

jI/O – horisontal coordinate input/output range of from racks – point 1 (jI/O = 1, 2, 3...m);

i – vertical coordinate of the first place in the course of the double cycle, picking/disposal pallet – point 2 (i=1, 2, 3...m)

j – horizontal coordinate of the first place in the course of the double cycle, picking/disposal pallet – point 2;

k – vertical coordinates of the second place, during the double cycle, picking/disposal pallet – point 3;

l – horisontal coordinates of the second place, during the double cycle, picking/disposal pallet – point 3;

$T\left(P_{\underline{iI}\,\underline{jI}}{}_{O,O}{}_{+}\,P_{i,j}\right)$ – time need to highrack crane cross the road (move load – pallet) from location $P_{\underline{iI}\,\underline{jI}}{}_{O,O}{}_{+}$ to location $P_{i,j}$;

$T\left(P_{i,j},P_{k,l}\right)$ – time need to highrack crane cross the road (move load – pallet) from location $P_{i,j}$ to location $P_{k,l}$;

$T\left(P_{k,l},P_{\underline{iI}\,\underline{jI}}{}_{O,O}\right)$ – time need to highrack crane cross the road (move load – pallet) from location $P_{k,l}$ to location $P_{\underline{iI}\,\underline{jI}}{}_{O,O}$;

N = $\{^{n\cdot m\cdot(n\cdot m-1)\ za\ \frac{il}{0}=0}_{(n\cdot m-1)\cdot(n\cdot m-2)\ za\ \frac{il}{0}\neq 0}$ – total number of feasible double cycles for characteristics rack gemetry.

It's notable that the average length of a complex cycle which is calculated as the mean value of the double cycle time mainly depends on the configuration of the rack. [4]

The basic objective pursued during the execution of the set tasks in the process of storage of goods did optimization of variable operating time of identified within the means of the various sub-processes. So for example, if we look at the work of the classical frontal forklifts within the warehouse facility, we can identify different types of time that exist in the context of its function (time range of picking, the time of landing loaded fork, when turning 180° during movement laden forklifts etc.). In this operation of abstraction pallets with cargo, which is already on the shelf and its descent to the floor of the warehouse typically require 15 - 25 sec and if we add for the proper positioning of forklifts approaching the rack, which requires additional 5-10 sec especially in the case when comes warehouses with narrow aisles, we get a total time of about 30 sec which is certainly not negligible if one takes into account the total number of pallets that are used daily load/unload at the level of a system. The situation is similar in other time of partial operations performed by forklifts and other mechanized means within the system, so for example. when turning the forklift 180° is approximately 10 sec, weather trends loaded forklifts (which depends on the length of time that must pass forklift) over 45 sec, weather loaded lifting forks 5-10 sec, the delay time in the range of means of transport on average 5 sec and so on. All of these operations require a certain energy consumption, which is at the level of the entire system custom significant sums of money. [3]

2 Automated pallet rack and simulation description of his work

In most conventional pallet racks which require manual servicing mainly based on the basic mechanisms for transmitting or storing and storage of pallets present the appearance of so-called "idling" that these devices generate during their movement within the storage system. This phenomenon results in a longer time servicing the means of transportation, higher storage costs, greater expenditure of energy and fuels, by engaging additional capacities in order to achieve relatively satisfactory results of operation thereof and the like. The following figure shows the percentage ratio of "idle" forklifts and the number of locations it takes the same visit. [5]

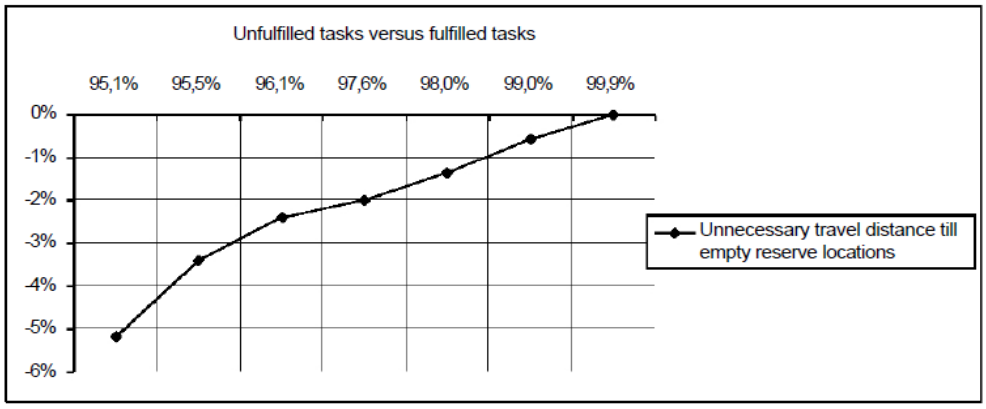

Figure 1. Correlation incorrectly allocated stocks within the storage system and unnecessary odometer forklifts to final destinations preferred stock (horizontal axis -% spare location, vertical axis -% distance traveled forklifts). [2]

In order to prevent the occurrence of excessive idling storage plants are often approached the development of solutions to the necessity of its existence reduced to an acceptable level. Such solutions are usually the starting point for the design of complex automated systems and circuits, especially in the context of large-capacity storage systems.

The following text describes the functionality of the conceptual design of the automated construction of pallet racking to better understand the benefits and amenities that the same allows. Decomposition of content elements and compounds characteristic structures, for better transparency of the composition of the whole mechanism, in this case, was not carried out (except for the display of some of the existing solutions which model are derived by individual facilities), but the emphasis is primarily placed on integrating a unique description of the functionality of the mechanism and its relevant output results. It is also important to emphasize that it is also very applicable solution for rack construction with a number of levels for the storage of pallets in which to come up with particular izrašaja convenience and advantages of such a mechanism.

Thus, the starting position the pallet on the platform of the observed level (in this case the highest level) requires an initial horizontal movement (usually drawing by forklift forks) in the direction out of the frame structure on which it is located. There are a number of solutions, already applicable in practice, that this enables the application of different cell circuits and devices (different kinds and types of forklifts, cranes moving simpler structures, devices for raising and lowering the load etc.) whose performance is such that they require more or less complex manipulation and maneuvering, which also require a higher or lower level of consumption of energy and resources to perform these seemingly simple tasks. In the base of this platform pallet racking, at all levels except at the begining one, there is a podium composed of cylindrical - cylindrical elements, however, doesn't have a compact form.

The slide mechanism has two guides through which they move sliders in both direction. Slides are projected in two pairs (internal and external) so that a pair (male) helps the movement range of a second (internal) movement of the main continent with arms of which will be discussed later. These sliders actually constitute a specific type of metal pins whose role is to "push" the pallets to a cylindrical pedestal rack construction or major continent with arms whose movement is aided dots on the bottom side through which this continent relies on the inside of the platform. These metal pins are designed perpendicular to the guide on the outside and inside of the base and their horizontal "slippage" in the guides is conditional on one another so that upon activation of the mechanism (by pressing a certain key - Figure 4) initially triggered by external pins to at a certain point defined position of the pallet that is on the move followed the launch of the second pair of inner wedges running on the outside on the basis of

a special connection. This connection can be achieved by using certain types of stops that will allow you to be based on the movement of the first pair of wedges generates movement of the second pair.

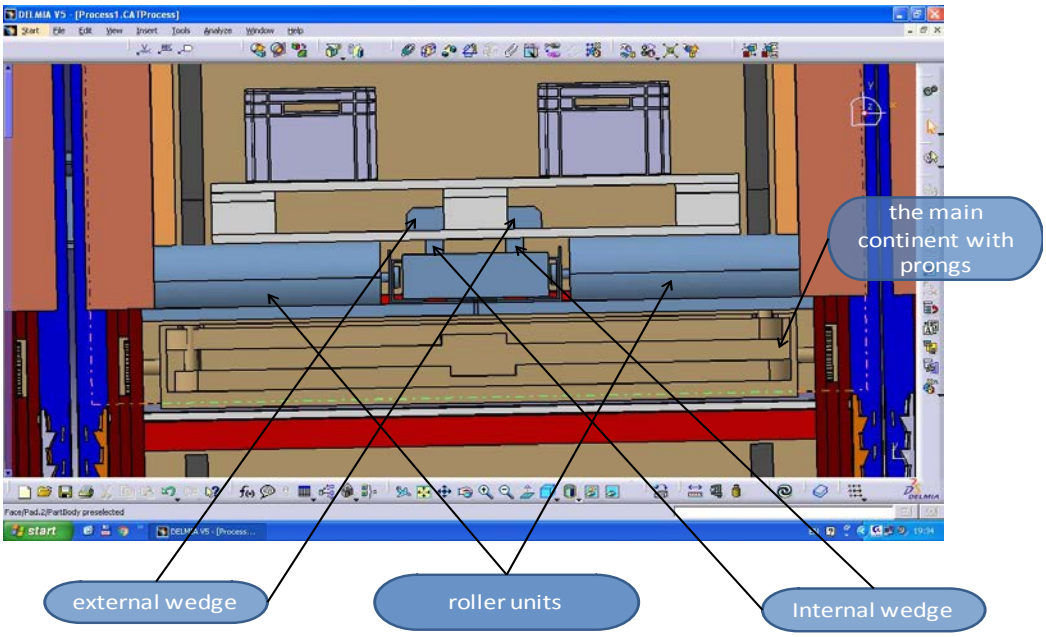

Figure 2. Position of cylindrical units and internal and external pins within the structures - frontal view.

After starting the pallets, which begins horizontal shift towards the frontal part of the structure using cylindrical elements, based on the interconnection pins starting extract the main continent with arms from the so-called. the interior of the stand. As already mentioned, the main set of the continent possesses auxiliary dots (with its lower side) will help them is a contact with the base of the inner part of the platform and thus facilitated the launch of this circuit and also avoided a solution that would require wear-contact surfaces and assembly stand. The project of this set contains two output shaft (driven by an electric motor located in the central part of the interior of the continent) on which ends are mounted the gears by which this continent is moving in a vertical plane between the pillars of the carrier structure. So, having encountered the main points of attachment gear and perforated guide rail installed in the frontal poles structures, one of which must be fixed or stationary and the other mobile and dynamic, starting the movement of the continents in the vertical plane. Driven by electric motor gears to rotate in one direction to the boundary points of the stairs structure that represents the upper limit of their possible (vertical) movement in which the upper side of the main continent equated with level ie the level of the cylindrical platform. Once the pallet load reached a position that provided arms and security triangles followed by rotation of the gear in the opposite direction and begin the process of lowering the load.

The distance between these guides must be perforated to fit the diameter of the gear, which should take its position between them. At the same time, the most suitable and also the most functional solution for dynamic edge guide would be that it rotates a sealed box under the stairs carrier formed elliptical orbit around the vertically mounted "floating stairs." Perforated guides could be designed in the form of chains (given the continent's main gear) reinforced by a column support.

The assembly of the main continent in possession of arms ("prongs") that are used to raise or lower range of the construction or the konstrkciju depending on the task that should be performed.

These arms are designed so that the ends have built-limiters to help prevent frontal overturning pallets having the same throughout its length "clicks" on the legs. The total length of the legs should not be higher than 1500 mm, given the dimensions of the pallet (we considered the case of storage pallet dimensions 1200 X 800 mm). Stops should not be too long (up to 15cm), as would otherwise be the additional problem of their integration into the main assembly of the continent. In addition, the legs are shaped so that they are in the central part of which is grooved near the compactness achieved the stability of their compound, the formation of a single planar continent, with no overlap. This is particularly important in terms of the stability of goods located on the pallet (especially in cases where goods are considered greater weight) because in this way avoids the phenomenon of her "clack". Contrary to the merger ie. overlapping branches, with the opposite process of their return to the starting position (within the main box of the continent) is necessary to ensure the precise and proper separation. This is achieved by hydrostatic telescopic lifter designed as a cylindrical button located on the bottom half of the grooved arm, compared to its longitudinal axis of symmetry, the point where the legs ie. overlapping grooves. This window is activated at a given time when the pallet (with cargo or without cargo) returned back to the base and has a direct impact on raising the upper transverse pipe contact arm.

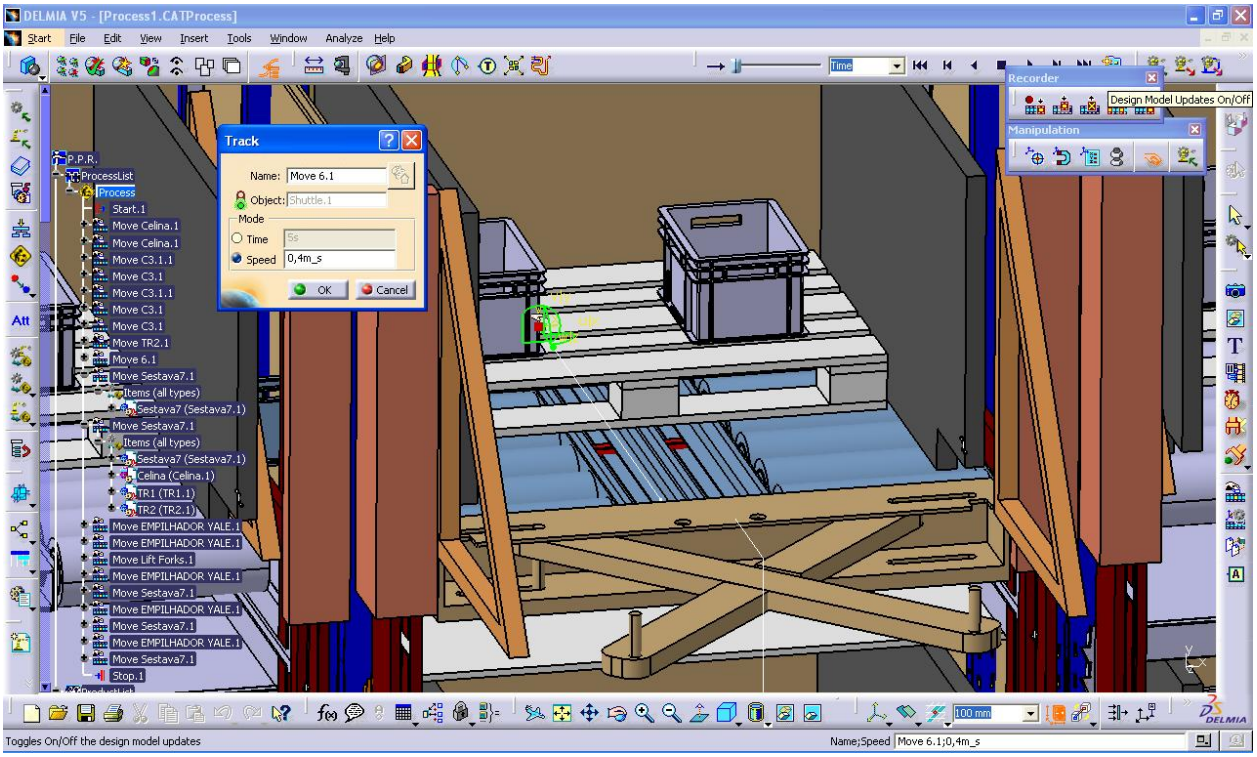

Figure 3. Position assembly formed elements of automated frame and "safety triangles".

Additional safety factor of stability ie goods that are located on the palette represents a design element that we called "security triangles". These triangles can be open and closed depending on the needs ie. goods to be stored. Closed type would imply that the entire triangle derived from a trug full profile that could also prevent separation and waste of smaller units with the observed range of packaging due to its descending/lifting. Potential components of these triangles would be horizontal struts that help ensure that the safety triangles in addition to its primary purpose of providing cargo had an inherent part of his acceptance of the work load during the lowering / lifting pallets. In this particular case, provided the solution to these triangles with three horizontal struts. At a time when the "security triangles" took their position ie. completely drawn from vertical rack construction site where they were

originally placed following their equally withdraw or vertical movement of the mountains all the way to the point where no props "interventions" palette. In this way the triangles next to the safety components persuade, and the auxiliary component element for descending/lifting. So, in this case, the total weight of the pallet with the cargo "nose" main continent (including its branches) and "security triangles".

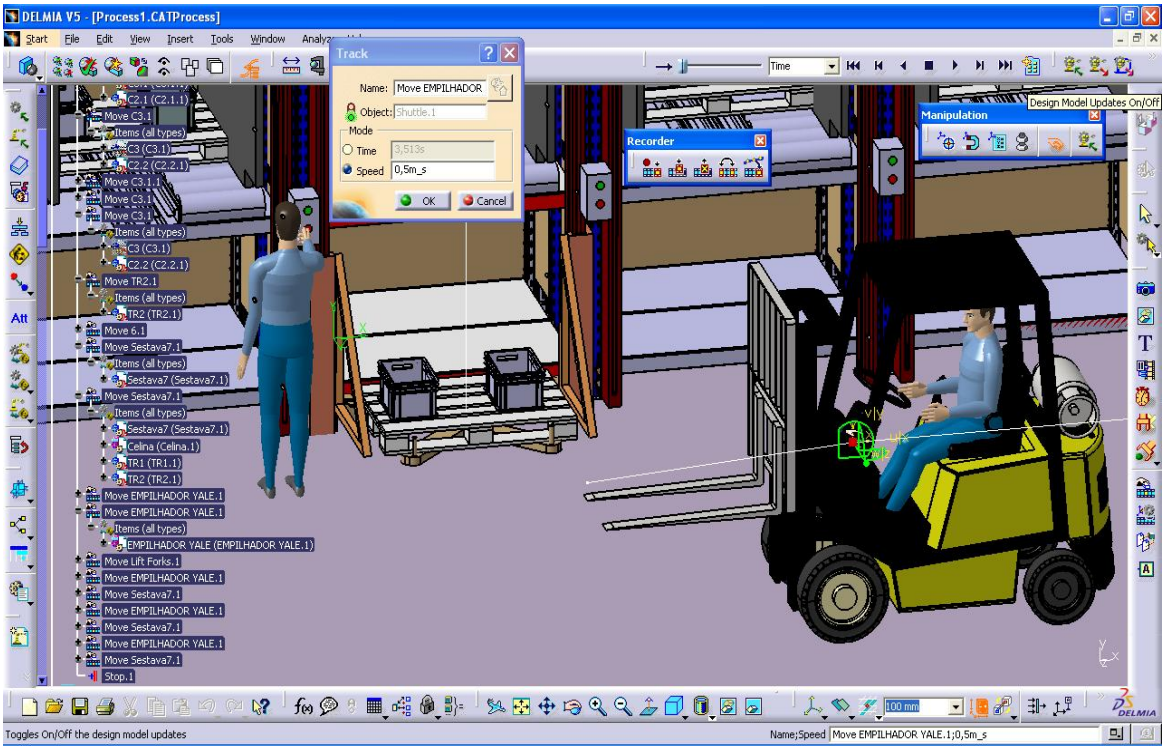

Figure 4. Position of bowed pallet.

Vercal cathetus of safety triangle must be carried out so that it contains precisely designed openings (in this case three holes) through which will allow sealing by cylindrical pins (three cylindrical wedge) having a stub carrier with which this kateta in direct contact after they came to the full extension of the triangle from the site of the structure. Therefore, the safety triangles must occupy a specific position between the trailing edge of the main continent and the column structure through which this continent is moving. In this way it is possible that the safety at the time of triangles full extension found in the lower level the level of the plane of the platform, ie. already drawn palettes, which will allow the proper blend of horizontal struts and pallets.

Special attention throughout the structure attracted a solution that is intended to reverse the process and restore the palette back to the platform structure. The most important role in the context of the envisaged mechanism that is used for the purpose of feeding range of the cylindrical platform with two horizontal jaws on its frontal ends have built-in wedges (like wedges, which are mounted on the guide rails platform construction) by which the range of "intervention" and retracts to the set from shelves platform. These horizontal gripper and the aforementioned horizontal struts directly affect the design of the entire continent's main forms of racking mechanism Given that must be made for certain openings to ensure proper and smooth extension and retraction of these elements. So, at the moment of lifting the pallet and reach the upper end point, after which should follow the pickup range of the stand, are activated by horizontal clamps which are drawn out to the point where they can spread over the entire range from its underside. Then, using the built-in pickup, projected in front of the interior of the

continent just below the level of horizontal clamps (for which prodviđeni opened for the raising / lowering) the clamps transverse raised to the point where exercise direct contact with the range in which are fully aligned the level to which the stand should retract the same. This transversal movement that is raising the grippers is realized with a length of about 20cm which is quite enough to projected pegs on them with a range of interventions by its lower peripheral edge. Pulling or retraction of these clamps is possible thanks to a built-in motor smaller dimensions which is housed in the inner rear part of the rack platform that drives vertically projected shaft (not exceeding 20 cm) on which the toothed gear that is characteristic of the two points, when the gripper draw (lower indentation) when the gripper retracted (upper indentation). The vertical movement and then the indentation gear is possible thanks to a pair of vertical telescopic columns that are derived from the static box located directly beneath the gear (in its initial position before starting drawing grippers) and passing through two holes that correspond to their diameter and shape of the gear postiskuju up. At the time of feeding grippers or pallet on the base of these pillars hold suppress gear in upper position at this point is already meshing begins when turning zupačnika (reeling sprocket) and retractable horizontal clamps. Also, using this gear is connected to another sprocket gear that is built into the back (inside) part of the horizontal grips. Diameter of the second gear is slightly larger than the width of a single gripper so that the process of unwinding and drawing grippers or wrapping and their uvalačenja in the housing (inside the platform) run smoothly.

It should be noted that the previously described solution for the reverse process - feeding pallet on the base structure is not shown in the form in which it should be modeled due to the complexity of the inner assembly and the difficulty for a comprehensive presentation of the functioning of its components or the constituting part simulating flow.

3 Conclusion

Application of specific automated system for storing of pallets includes its installation inside the warehouse and distribution systems for high-capacity, especially in terms of high-level buildings planned storage structures. Thus, consideration of the viability of its application otherwise it would necilishodno. In addition savings in terms of energy consumed and raposloživog time for the execution of a child process commissioning, significant effects are achieved in the field of efficiency, economy and safety of the storage of certain goods. The reduction of personnel and the elimination of various types of forklifts, lifters, cranes and other mechanisms within the warehouse and distributnivnih system in which order these pallet racks have been applied to significantly reduce the ongoing costs of functioning. The main drawback of this system is installed racks would be reflected in a relatively limited load continent that transports pallets which would come to the fore especially in systems with high frequency shift that is loading/unloading of the goods.

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EFFECT OF INITIAL RELATIONS C/N ON THE STABILITY OF THE PROCESS OF COMPOSTING SLUDGE FROM MUNCIPAL WASTEWATER TREATMENT PLANT

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Abstract: The stability of the composting process in general depends on many factors such as temperature, humidity mixture of sludge and additional components, PH value, the particle size of each component, oxygen, C / N ratio and other factors. This paper analyzes the impact of initial relationship carbon / nitrogen (C / N) as a condition for starting and stability of the composting process of different formulation formed from a mixture of sludge from municipal wastewater treatment plant and various types of biowaste. Nutrients, especially nitrogen and carbon, play an important role in the composting process as aerobic process because they are a base for microbiological growth and activity. It is evident that the starting composting process is no questioned in the samples with values of C / N ratio greater than 20/1. By monitoring the temperature as an indicator of microbial activity also was found that in these samples occurs more stable process. The optimal initial C / N ratio is achieved by the correct ratio of materials in the mixture. In the case of composting the sludge it is achieved by the addition of materials with a higher carbon content such as wood chips, straw, etc.

Keywords: sludge, composting, value, impact

1 Introduction

One of the most comprehensive definition of the process of composting is given by Haug (1993): "The composting biodegradation and stabilization of organic substances, under conditions which ensure the development of thermophilic temperatures produced as a result biotopline, to give the final product that is stable, with no pathogens, weed seeds and which can be useful dumping ground ". In the process of aerobic composting process flows in the presence of oxygen or air, and as the main products appear: charcoal dioxide, water, heat and compost.Speed composting is the result of microbial activity within the waste, and is caused by a number of factors. The most important factors that impact on the rate of composting are: temperature, biomass, humidity, oxygen, organic matter, porosity, particle size, the ratio of carbon / nitrogen C:N (Gray et al, 1971a, 1971b;).

Nutrients, especially nitrogen and carbon, play an important role in the process because they are essential for the microbial growth and activity. Nitrogen is an essential macronutrient for the growth and development of all living beings, because they are installed in their proteins and other nitrogen compounds. Therefore, it is mainly found bound in organic matter, and only to a lesser extent free in mineral forms, like ammonia and nitrate ion. During composting occurs a slight increase in the concentration of total nitrogen, but primarily due to the loss of mass and mineralization of organic matter (Sanchez-Monedero et al., 2001), ie. loss of organic carbon (Tiquila, 2003)

In the aerobic decomposition some of the carbon is released as CO_2 and the remainder combined with the nitrogen for microbial growth. As a result, the carbon content in the compost heap is continually decreasing. Micronutrients such as copper, nickel, molybdenum, iron, magnesium, zinc and sodium, are also essential for enzymatic activity, but little is known about their importance to the process of composting. All the nitrogen incorporated into the cell again becomes available when the microorganisms die off. Since a large portion of the carbon continuously released, and most of the nitrogen is recycled, the ratio of C: N decreases during the composting. If, however, the system comes to large losses of nitrogen, the ratio of C: N can grow. The ratio of C: N is often used as a condition of nutrients in the waste. If the ratio of C: N is too high, there is a limitation of nitrogen to speed composting. If the ratio C: N is too low, excess nitrogen can lead to volatilization of ammonia (Morisaki et al., 1989).

The purpose of this study is to determine the optimal initial C / N ratio for the starting and stable process of composting sludge from the municipal wastewater treatment plant.

2 Materials and Methods

The starting material for implemented composting process is sludge from municipal wastewater treatment plant. As a filling material are added straw, sawdust, green and kitchen biowaste in different proportions. Ventilation compost piles, conducted by daily active mixing. The starting material is sampled at nine different places by volume stabilized sludge, while sampling during composting was done at the center of the pile by taking an average of the sample immediately after mixing. Individual samples were placed into a plastic containers with volume of 6.4 dm3 and monitored for 30 days. Analyzed were samples with similar values of the other parameters: humidity 40-60%, pH value of 5.5 to 9 and the particle size of material mixed with the sludge 0.8-1.2 cm (Rynk i *sar.*, 1992). Review the composition of individual samples and initial value of moisture, PH, C and N is given in Table 1.

Table 1. Composition of samples and initial value of moisture, PH, C and N

	Sludge (%)	Woody was a waste (sawdust, straw (%)	Kitchen biowaste (%)	Green biowaste (%)	Humidity (%)	Ph value	Carbon C (%)	Nitrogen N (%)	C / N ratio
Sample1	90	10	0	0	59	7.8	44.9	2.2	20.4/1
Sample2	70	30	0	0	58	7.4	56.3	2.2	25.6/1
Sample3	70	10	10	10	55	7.0	55.4	2.7	20.5/1
Sample4	55	15	15	15	58	6.4	42.3	1.9	22.7/1
Sample5	50	0	50	0	55	6.6	31.2	2.1	14.8/1
Sample6	50	0	0	50	52	7.5	40.3	3.0	13.4/1

The initial temperature of the samples was 21-23 ◦C. The process is monitored and controlled conditions, in a closed room with a constant temperature of 25 ◦C and humidity of 45%. Temperature sensors, thermocouples (type T and K, Digi-Sense, Cole-Parmer, USA) were placed in the middle of the mass of the substrate, and are included through acquisition module (Temperature Data Acquisition Card / Thermocouple CardAcq, Nomadics, USA) on a portable computer. By weight moisture in a mixture of substrate was calculated from the difference of mass before and after drying the samples in an oven at 105°C for 24 hours to constant weight.

Organic carbon is determined by the dry sample wet oxidation method at 135◦C (ISO, 1998).Total nitrogen was determined by converting the nitrogen .

For determination of the pH-values used PC 510 Bench pH meter (Oakton, Singapore), wherein its calibration performed with three buffer solutions with pH values of 4,7 and 14 (Oakton, Singapore). Measured by the pH-value of the extracted pattern with fresh distilled water. The watery extracts were prepared by mechanical mixing of samples (for 30 minuterepeated s) with distilled water at a ratio of 1:10. The suspension was then filtered through Whatman 42 Ashless Circles 125 mm Dia (Whatman, UK). In the resulting filtrate was measured pH-value, with constant stirring using a magnetic stirrer. The procedure was three times of fresh sample in the form of ammonium, by distillation of boric acid and titration with HCl or H2SO4 (ISO, 1995). C / N ratio was obtained from the mathematical relationship of total organic carbon and total nitrogen. Both sizes are measured relative to the dry matter.

3 Results and Discussion

As an indicator of microbial activity and stability of the decomposition process was monitored temperature of individual samples.Temperature change in some samples is shown in the graph in Figure 1.

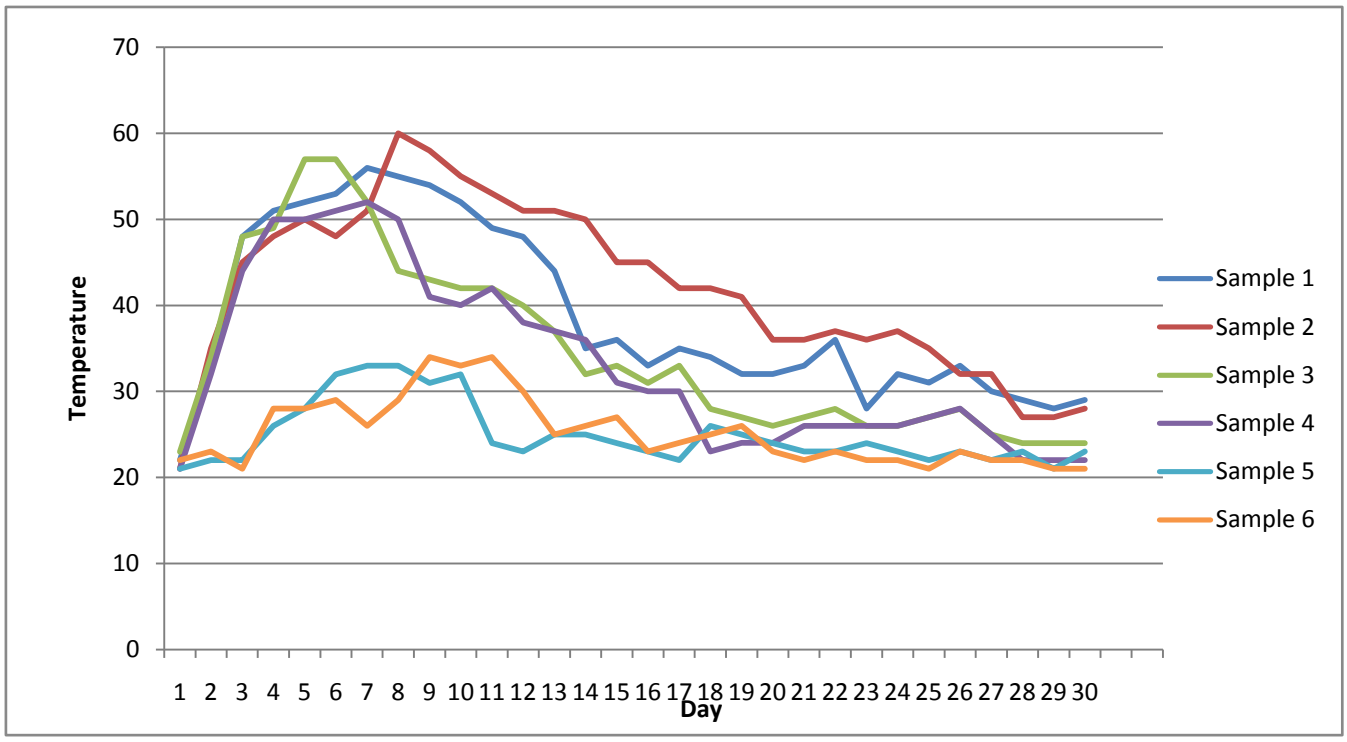

Figure 1: Change in temperature of individual samples during the composting process

Increasing the temperature in the interval of up to 55 ± 5 °C is useful for the process speed. Higher temperatures will lead to the inactivation of microorganisms and reducing the reaction rate. Accordingly, the compost mass must be sufficiently aerated to remove excess heat and to prevent too high temperatures (Gray et al., 1971a). This is provided by mixing or forced by blowing air into the body of the compost pile.In the case of the first four sample temperature compost piles grew steadily from day one, and relatively quickly, but after the third day, took the thermophilic range of temperature that is over 40 ^{0}C. This phase is characterized by a significant microbial activity and decomposition of organic matter. Maximum temperature compost pile has reached the second sample. The maximum temperature in this case is 60 ^{0}C and maintained at 50 ^{0}C over a period of 7 days. In this phase is done and hygienization of compost ie. the destruction of pathogens and weed seeds, retaining at these temperatures during min. three days (Nakasako et al., 1985d). In addition to good ratio C/N, an important role in achieving optimal degradation certainly has a content of filler material, woody biowaste, which provides the porosity of the compost mixture and quality aeration or oxygen supply necessary for the development of aerobic microorganisms that participate in this process.

Measured temperature on samples 5 and 6 shows the absence of microbiological activity in the first days of the process. Only after the fourth day of the recorded increase in temperature of the compost

pile, respectively, determined by microbiological activity or the condition is maintained in such a way that the temperature does not exceed mesophilic range (20 ◦C-40 ◦C). When these two samples was observed and the development of unpleasant odors which indicates a pronounced appearance of ammonia in the compost pile.During composting a slight increase in the concentration of total nitrogen, but primarily due to the loss of mass and mineralization of organic matter (Sanchez-Monedero et al., 2001), ie. loss of organic carbon in which first decompose lakorazgradivi compounds (simple sugars, starches, fats, proteins), then slowly degrading (cellulose and hemicellulose), while behind substances resistant to degradation (Tiquila, 2003). In mathematical terms the process of composting, means follows the reduction in the C / N.Following the values of temperature diagram in Figure 1, we can recognize the basic stages in the process of aerobic composting:

- Mesophilic (initial) phase, which lasted until the moment of temperature increase above 40 ◦C. In this phase, mesophilic microorganisms can degrade the degradable components such as sugars, starches, proteins, etc. In this case the draft lasted three days.
- Thermophilic phase at temperatures of 40 ° - 60 ° C. Interestingly, the samples 1-4 had almost identical rise in temperature in mesophilic stage while the thermophilic had different periods of reaching a maximum value which is probably caused by the different structures of additional materials and microbial activities related to the processes of decomposition of some kind. In our case, thermophilic stage for sample 1 lasted until the 13 th day, for sample 2-17-th day of a sample 3 i 4 by the 10th day.
- Cooling phase when after the end of thermophilic phase the temperature drops to a level where mesophilic microorganisms have their optimum activity and the process of entering a phase of cooling. During this phase is difficult to decompose decomposable components such as cellulose and lignin. After this phase comes the maturation phase, which could not be covered by this study.

Besides measuring the initial content of carbon and nitrogen, the contents of new nutrients was measured three times during the process, i.e. after 10,20 and 30 days. The results of these measurements are shown in Table 2.

Table 2. Results of measurement of the C / N during the composting process

	The initial C / N ratio	**C / N ratio after 10 days**	**C / N ratio after 20 days**	**C / N ratio after 30 days**
Sample 1	20.4/1	16.3/1	14.4/1	11.2/1
Sample 2	25.6/1	18.5/1	13.6/1	12.3/1
Sample 3	20.5/1	16.5/1	13.7/1	11.7/1
Sample 4	22.7/1	17.8/1	14.9/1	12.8/1
Sample 5	14.8/1	13.7/1	13.3/1	13.1/1
Sample 6	13.4/1	12.4/1	12.1/1	11.7/1

Measurements in the process of confirming the before mentioned changes of chemical composition in terms of the concentration of carbon and nitrogen. In the analyzed period registered fall in value of the relationship C / N. In the first four samples where there was a major microbiological activity, is expected at the first measurement decrease the concentration of total carbon as a result of accelerated decomposition of organic matter.

The biggest change in the relationship C / N was observed on a sample of 2 ie. the first measurement after the initial attitude 25.6 / 1 ratio recorded 18.5 /1 Samples 1, 3 and 4 also had the evident process of decomposition, which shows changes to the recorded values of carbon and nitrogen while the samples 5 and 6 even though it experienced a mild modification of these values cannot speak with certainty about the process of decomposition.

4 Conclusions

Based on the results of the research, it can be concluded that during the composting process significant changes of chemical feature of compost materials. The whole process of composting is characterized by decrease in the proportion of carbon while the opposite dynamics of the share of the total nitrogen. C / N ratio in the compost expected decreased and they are all composts after thermophilic phase had C / N below 20/1. For efficient and stable start composting, as the initial C / N ratio recommended 20/1 and higher. The higher ratios C / N are more efficient, and is to achieve such a ratio of initial base material necessary to add additional carbon source, such as straw, saw dust, etc. To determine the upper limits of optimal relationships composting is necessary to conduct additional research. It is assumed that in this

case the availability of nitrogen was a limiting factor, because in this case, microorganisms need more time to take advantage of excess carbon.

If C / N is too low because the raw materials rich in nitrogen, or if there is not enough carbon to provide energy and material for the microorganisms to incorporate a protein decomposition product, will form an unstable nitrogen. This excess nitrogen may be released as ammonia gas, or escape from the pile and potentially contaminate the soil or surface water. An additional difficulty is due to insufficientactivity of microorganisms the temperature in the primary phase does not increase above 40 ° C, then the substrate decomposes more slowly, and the pathogenic microorganisms are destroyed and remain in the compost.

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ENVIRONMENTAL AWARENESS IN COMPANIES OF EASTERN SERBIA

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Abstract: Today's business processes, especially industrial processes can cause serious environmental problems and can increase air and water pollution. Pollution is one of the greatest problems of modern world and it has damaging and unrepairable effects to the environment. Most companies are focused on economic benefits of their businesses, rather than on environmental impacts and that's why raising environmental consciousness in companies leads to ecological responsibility. Environmental awareness of companies nowadays has to be an integral part of management so that they can sustain their business positions. In order to successfully implement environmental management initiative, companies have to realize how important the members of the organization are. It is mandatory for the employees to know and understand how the environment can be affected by their decisions. This paper aims to identify how ecologically aware are companies and their members in Eastern Serbia. The paper presents the results of a research of companies' attitudes towards environmental issues.

Keywords: attitude, East Serbia, environment, environmental awareness

1 Introduction

The effect of business on the environment has become an issue since the late 1980s, especially in western economies.Up until today, managers had to improve their environmental management activities and practices(Gerrans & Hutchinson, 2000). Business environment today is unstable due to big competition and economic crisis, so the companies need to find a way to sustain their competitive advantage. One of the ways to do that is to focus the organization on environmental awareness.Bulatovic defines environmental awareness as the awareness of the environment which encompasses interpretations, behavior, motives of actions, wishes and expectations related to our natural environment(Bulatović, 2011).A lot of benefits of environmental sustainability issues were addressed by the number of authors (Feldman, Soyka, & Ameer, 1996.)(Kiernan & Levinson, 1997;)(Lowy & Wells, 2000)(Pearce, 1997).

The companies who use environmental management systems such as ISO 14000 and ISO 14001 have discovered a number of advantages, such as higher productivity and bigger performance.ISO 14001 implements regulations that define activities to have an environmental impact (King & Lenox, 2001). This standard is intended to be applied to all types and sizes of organization and to accommodate diverse conditions(Trajković, 2016).

Successful environmental management is based on one condition and that is the presence of an effective environmental education which helps employees at all levels of the organization to understand the necessary in order to think in an environmentally friendly manner and make environmentally responsible decisions at work (Wehrmeyer, 1996)(Cohen-Rosenthal, 2000)(Daily & Huang, 2001).The

social characteristics of an organization include what the employees think, feel, and do in the organization (McShane, 2001). Environmental management initiative is consisted of the employees who are the integral part, because they are able to implement the changes in their work routines that influence the improvements in environmental performance of their company. Therefore, employees need to be encouraged to participate in the environmental management initiative of the company(Bernstein, 1992).

Corporate social responsibility had the original focus on social responsibility, but nowadays the focus is on the environmental responsibility too. Environmental corporate social responsibility plays an important role in the corporate landscape (Flammer, 2013). This leads to number of advantages to businesses, such as recycling, preservation of nature, new business opportunities, economical usage of electric energy, increased market value, renewable natural resources, high quality of the product etc.

The main goal in the future is to increase awareness among people and among workforce about environmental problems. Ecological behavior can be an important part of environmental awareness of individuals and social groups.

2 Related work

The Environmental Protection Plan (EPP) was developd by RTB Bor for period 2010-2015, through which are identified major problems caused by long time work of mining and metallurgical operations. The main environmental problems are related to permanent air and water pollution from past operations over the decades, and also generation of large amounts of wastes. In environmental protection plan for period 2010-2015 some of proposed mitigation measures are (RTB BOR ENVIRONMENTAL PROTECTION PLAN, 2010-2015):

- Reducing dust generation using existing systems and introducing new methods,
- Examination of the working environment (measuring microclimate, noise, vibration, gases, dust, lighting, fumes, etc.),
- Periodic preventive testing machines,devices, electric and lightning rod,
- Staff training, who will participate inthe work of demolition and construction of new factories Smelter and sulfuric acid,
- Insufficient training of employees to work with new technology in terms of safety and health at work,
- Support the strengthening of local environmental fund budget,
- Support programs to strengthen environmental awareness and education of citizens,
- Waste management training program tostate authorities,
- Training for integrated environmental management (monitoring of labor and the environment, energy efficiency, etc.). In accordance with the relevant authorities,
- Information on activities related to environmental protection in the list on the site of RTB Bor,
- Information on activities related to environmental protection in the local media and on the municipal website,
- Information on activities to protect the environment through the activities of NGOs,

- Train existing staff and hire experts for recycling waste.

Environmental awareness of population in Bor and its surroundings is extremely contradictory (Figures 1 and 2). On the one hand there is clearly distinguished awareness about the causes and scope of environmental problems in Bor, and on the other hand people are not conscious enough of the impacts of environmental pollution on the future economic and municipal development, of the impact on health and nature. Then, on the one hand people are aware of the numerous facts concerning endangered environment, but on the other hand people are not motivated enough and they are not willing to deal with problems. People are aware that Boris "blackspot" but they are not aware that Bor surrounding is biodiversity centre of the Balkan and Europe.

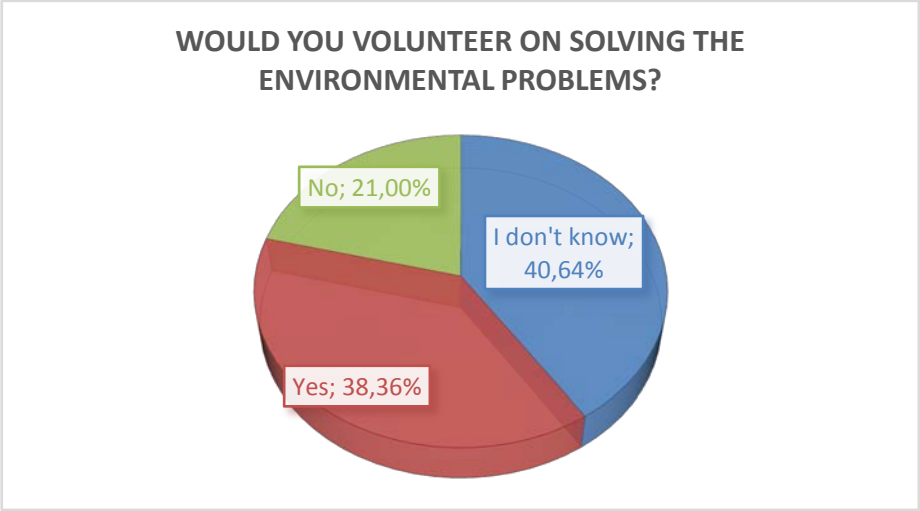

Figure 2. Citizens willingness for volunteer work with a goal to solve environmental problems Source: Young researchers association Bor(CITIZENS' FORUM, 2003.)

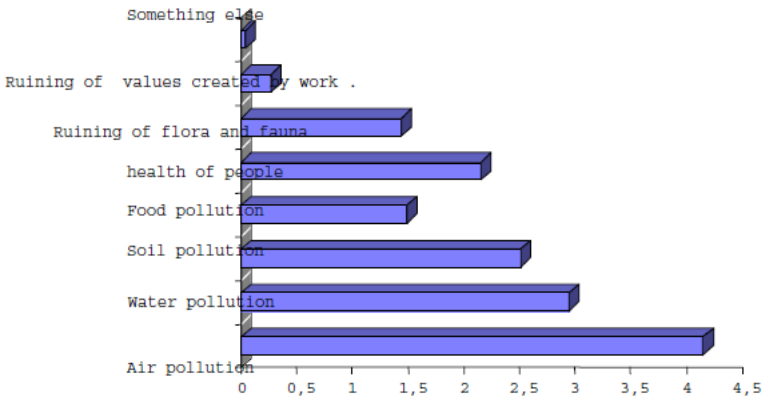

Figure 3. The most important environmental problems based on citizens' opinion Source: Young researchers association Bor ***(CITIZENS' FORUM, 2003.)***

3 The sample

The questionnaires used for this study were delivered to some of the most important companies in Eastern Serbia. This survey was conducted in September 2016. A total of 185 questionnaires were sent to the participants, but only 152 questionnaires were answered completely (82%). The responses were then coded and the data was merged into an SPSS file and then analyzed (SPSS v18). The questions from this questionnaire were taken from authors Schreiner & Sjøberg(2005)and then modified so they areappropriate for our research. The answers were given on a five point Likert scale, with a variety from 1 – absolutely disagree to 5 – absolutely agree.

After collecting responses, we tested the Cronbach's alpha in order to measure internal consistency within items. The maximum value of coefficient is 1, where .70 is accepted cut-off point for alpha. From a Cronbach's alpha of .767 we can see than 23.3% of the composite variable variance is error variance, while 76.7% is true variance.

4 Results

4.1 Demographic structure

In order to gain insight about the demographic structure of the respondents, descriptive analysis was conducted. Figures 3 to 5 show these results.

In Figure 3 we can notice that in our survey participated mostly females with a share of 52%, while men were 48%. Our respondents are mostly between 46 and 55 years old (Figure 4). Most of the respondents work in Copper Smelter Refinery in Bor (Figure 5).

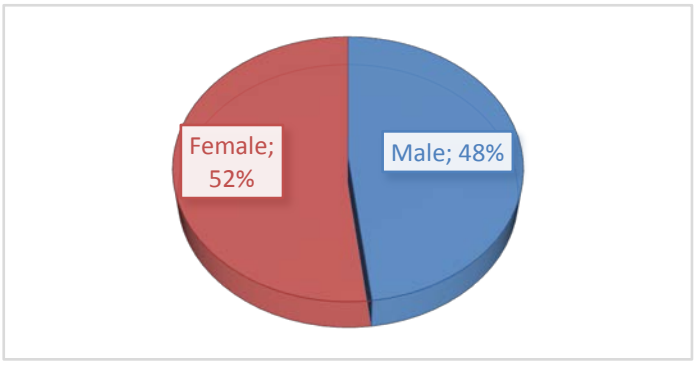

Figure 4. The structure of respondents by gender

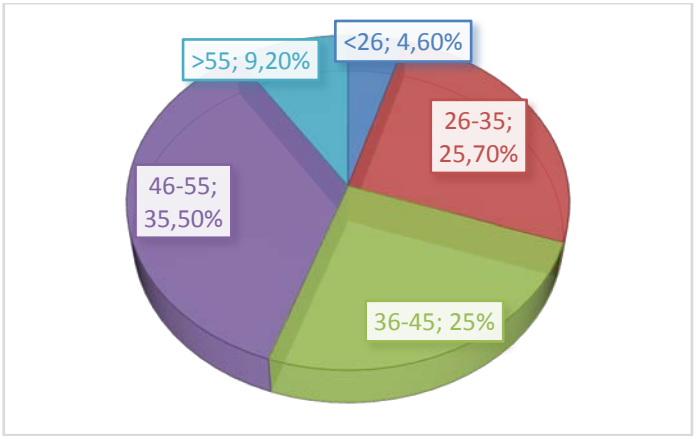

Figure 5. The structure of respondents by age

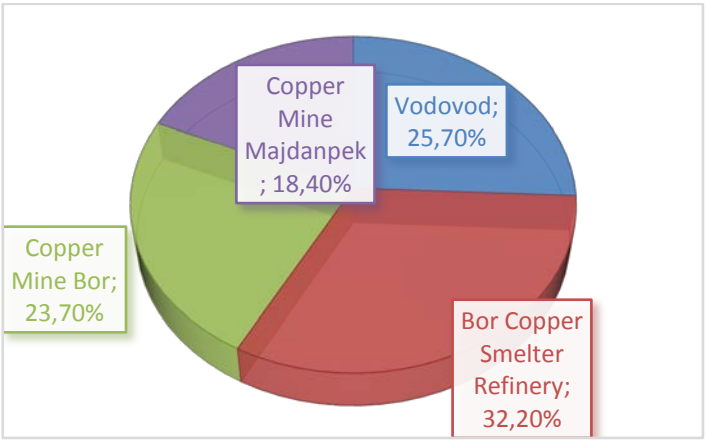

Figure 5. The structure of respondents by the company they work for

4.2 Comparative analysis

The aim of this study is to compare the level of environmental awareness among workers from different companies. The mean values of the answers are calculated and the results are shown in Table 1. Based on these results, we can conclude that the lowest mean value is for *Q17 – People worry too much about environmental problems* which means that most respondents disagree with this statement. On the other side, the highest mean value is for *Q16 – Technological developments are damaging to the environment*, which means that most people agree with this statement.

Table 1. Presents the descriptive statistics of our research

Questions	N	Mean	Minimum	Maximum	Std. Deviation
Q1	152	4.11	4	5	.380
Q2	152	4.07	3	5	.284
Q3	152	4.05	3	5	.290
Q4	152	3.09	2	5	.381
Q5	152	3.21	3	5	.616
Q6	152	4.11	4	5	.308
Q7	152	4.11	4	5	.308
Q8	152	3.93	1	5	.588
Q9	152	3.08	1	5	.453
Q10	152	4.08	3	5	.316
Q11	152	4.08	3	5	.316
Q12	152	4.09	3	5	.312
Q13	152	2.93	1	5	.516
Q14	152	4.04	2	5	.323
Q15	152	4.91	2	5	.398
Q16	152	4.94	2	5	.350
Q17	152	2.29	1	5	.637
Q18	152	4.11	2	5	.308

The influence of the company that respondents work for on their environmental awareness has been determined with conducting One-way analysis of variance (ANOVA) test (Table 2). The results show that the company has a statistically significant impact on the answers to most of the statements ($p<0.05$).

Of course, there are exceptions in this case, where there is no statistically significant impact for statements 13 and 14:

Q13 - Environmentalprotectionthinkingcausesregressionofindustry,

Q14 - I canpersonallyinfluencewhathappenswiththeenvironment.

Table 2. Anova test

		Sum of Squares	df	Mean Square	F	Sig.
Q1	Between Groups	3.332	2	1.666	22.599	.000
	Within Groups	10.984	149	.074		
	Total	14.316	151			
Q2	Between Groups	2.420	2	1.210	18.428	.000
	Within Groups	9.784	149	.066		
	Total	12.204	151			
Q3	Between Groups	1.116	2	.558	7.191	.001
	Within Groups	11.562	149	.078		
	Total	12.678	151			

Q4	Between Groups	2.644	2	1.322	10.234	.000
	Within Groups	19.244	149	.129		
	Total	21.888	151			
Q5	Between Groups	13.328	2	6.664	22.599	.000
	Within Groups	43.935	149	.295		
	Total	57.263	151			
Q6	Between Groups	3.332	2	1.666	22.599	.000
	Within Groups	10.984	149	.074		
	Total	14.316	151			
Q7	Between Groups	3.332	2	1.666	22.599	.000
	Within Groups	10.984	149	.074		
	Total	14.316	151			
Q8	Between Groups	2.420	2	1.210	3.622	.029
	Within Groups	49.784	149	.334		
	Total	52.204	151			
Q9	Between Groups	2.253	2	1.126	5.827	.004
	Within Groups	28.800	149	.193		
	Total	31.053	151			
Q10	Between Groups	1.758	2	.879	9.849	.000
	Within Groups	13.295	149	.089		
	Total	15.053	151			
Q11	Between Groups	1.758	2	.879	9.849	.000
	Within Groups	13.295	149	.089		
	Total	15.053	151			
Q12	Between Groups	2.482	2	1.241	15.123	.000
	Within Groups	12.228	149	.082		
	Total	14.711	151			
Q13	Between Groups	1.068	2	.534	2.034	.134
	Within Groups	39.135	149	.263		
	Total	40.204	151			
Q14	Between Groups	.335	2	.167	1.617	.202
	Within Groups	15.428	149	.104		
	Total	15.763	151			
Q15	Between Groups	1.642	2	.821	5.497	.005
	Within Groups	22.247	149	.149		
	Total	23.888	151			
Q16	Between Groups	1.267	2	.634	5.488	.005
	Within Groups	17.200	149	.115		
	Total	18.467	151			

Q17	Between Groups	4.564	2	2.282	5.996	.003
	Within Groups	56.700	149	.381		
	Total	61.263	151			
Q18	Between Groups	3.332	2	1.666	22.599	.000
	Within Groups	10.984	149	.074		
	Total	14.316	151			

We also wanted to test the lack of concern and personal involvement in this issue (Schreiner & Sjøberg, 2005). To do that, we composed new variables from the average scores. These variables consist of positively worded items which stand for personal involvement and negatively worded items which stand for the lack of concern about environmental problems (Tables 3 and 4).

Table 3. Positively worded items

Q5	I am willing to have environmental problems solved even if this means sacrificing many goods.
Q7	We can still find solutions to our environmental problems.
Q10	People should care more about protection of the environment
Q12	I think each of us can make a significant contribution to environmental protection
Q14	I can personally influence what happens with the environment

Table 4. Negatively worded items

Q1	Threats to the environment are not my business.
Q2	Environmental problems can be solved without big changes in our way of living.
Q3	Environmental problems are exaggerated.
Q17	People worry too much about environmental problems.

The Cronbach's alpha for these two groups of items is .867 and.707 respectively. Since this is sufficient internal consistency, we then calculated the average scores for employees from all four companies.

The mean values for the first variable, "Lack of concern" is given in Table 5, and for the second variable "Personal involvement" in Table 6.

Table 5. Mean scores for "Personal involvement"

Mean

Company	MeanC1
Vodovod	4.1333
Bor Copper Smelter Refinery	3.8245
Copper Mine Bor	3.8000
Copper Mine Majdanpek	3.8643
Total	3.9053

Table 6. Mean scores for "Lack of concern"

Mean

Company	MeanC1
Vodovod	3.8397
Bor Copper Smelter Refinery	3.5408
Copper Mine Bor	3.5347
Copper Mine Majdanpek	3.6071
Total	3.6283

The mean values for the first variable indicates that employees who work in The public utility Waterworks and Sewerage partially agree with statements indicating a personal involvement in this issue. Employees from other three companies have a neutral to partially agree standing for personal involvement (Table 5). Scores for the second variable show that the respondents from all four companies have a mean score from 3.5 to 3.9 which indicates that they are not very worried about the environmental issue (Table 6).

5 Conclusion

Environmental awareness is an important issue that has to be brought to higherlevels. Companies have to educate and motivate their employees to think in the way of preserving the environment and to make decisions that support this. Scientific institutions like Copper Institute and Technical faculty and also environmental NGOs can contribute to solving environmental problems.The fact is that employees have the same attitude regarding environmental protection as their companies. That's why the public awareness about this issue has to be raised. Some of the actions that can be taken in order to increase environmental awareness are: encouragement of public participation in environmental matters, environmental awareness trainings in companies, environmental responsibilities and incorporation of environmental education in basic education.

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MULTI-CRITERIA RANKING OF TECHNOLOGY PROCESS IN HEAVY INDUSTRY

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***Abstract*:** Copper is most commonly present in the earth's crust as copper-iron-sulfide and copper sulfide minerals.The concentration of these minerals in an ore body is low. Typical copper ores contain from 0.5% to 2% Cu. Pure copper metal is produced from these ores by the process of concentration, smelting and refining. Copper smelting has a significant impact on the ecosystem and the environment.Different copper smelting technologies have different impact on environment.

About 80% of the world's copper originates from Cu-Fe-S ores. Cu-Fe-S minerals are not easily dissolved by aqueous solutions, so the vast majority of copper extraction from these minerals is pyrometallurgical. Metallurgy of copper encompasses many processes used for its production. In this paper we will explain only those that have wide industrial application. Then, the ranking will be made on the basis of the key factors of technological processes. The technologies which we considered in this paper are the following: Outokumpu flash smelting (present Outotec flash smelting), Ausmelt/Isasmelt lance, Inco Flash, Mitsubishi,Noranda, El Teniente, Vanyukov, Reverberatory process. The following relevant parameters were discussed: Cu grade in the concentrate, matte grade, smelting dust, amount of waste gases, SO_2 capture efficiency, SO_2 in waste gases and other significant parameters.For ranking of the technological processes for copper smelting based on the mentioned parameters, we decided to apply the Multi CriteriaDecision Making methodology. In this peaper, the PROMETHEE method was used for ranking of the technological process for copper smelting, while the GAIA plane, which optionally gives a graphical interpretation of the PROMETHEE method, provides a clear picture of the problem of decision making, according to the PROMETHEE ranking.

Keywords: Ranking, Copper smelting, Technology, PROMETHEE, GAIA

1 Introduction

Heavy industries often sell their products to other industries rather than to end users and consumers. In other words, they usually make products that are used to make other products. Accordingly, when a down economy begins to recover, heavy industry is often first to show signs of improvement. Heavy industry is characterized by large and heavy products; large and heavy equipment and facilities (such as heavy equipment, large machine tools, and huge buildings), or complex or numerous processes. Of these factors, heavy industry often involves higher capital intensity than light industry does, and it is also often more heavily cyclical in investment and employment. Copper smelting is part of heavy industry,because production is often measured in thousands of tons per day. Also equipment and facilities are huge and expensive, and production processesare very complex and numerous. [1,2]

Copper has been an important commodity since 2000 BC and it is still viable as we begin the next millennium. [3]In the last 50 years, the evolutionary development of technological process has been recorded in the extractive metallurgy of nonferrous metals. Copper smelting has a significant impact on the ecosystem and the environment. Different copper smelting technologies have different impact on

environment.The thing which is especially specific is the development of pyrometallurgical technological processes for copper production. The classical process of oxidation roasting, followed by melting in reverberatory furnace and subsequent converting, with the use of SO_2 process gas for sulfuric acid production, could be regarded as the starting point for the modern copper metallurgy development. Great progress was made by introducing Outokumpu flesh furnace, Mitsubishi smelting concept, Noranda reactor, Peirce–Smith converting, El Teniente converter and others. The purposes of these improvements wasan increase in technological exploitations, better environmental protection, and the reduction of anode copper production costs. [4] The aim of this paper is to present the main technologies for copper production, the parameters which have anegative impact on the environment andtoperform a ranking of the most important technologies today. The ranking was based on the key factors of technological processes. The technologies which were considered in this paper are the following: Outokumpu flash smelting (present Outotec flash smelting), Ausmelt/Isasmelt lance, Inco Flash, Mitsubishi,Noranda, El Teniente, Vanyukov, Reverberatory process. For the purpose of ranking of the technological processes for copper smelting based on sixparameters (amount of concentrate, Cu in concentrate, Cu in matte, Cu in slag, SO_2 in off-gas, campaign life), we decided to utilizethe Multi Criteria Decision Making methodology. In this paper, the PROMETHEE method was used for ranking of the technology processes for copper smelting, while the GAIA plane, which optionally gives a graphical interpretation of the PROMETHEE method, provides a clear picture of the problem of decision making, according to the PROMETHEE ranking.

2 Impact and basic characteristics of different copper smelting technologies

All processes for the copper production can be classified into two basic groups. The first group is pyrometallurgical and the second group is hydrometallurgical. The pyrometallurgical processes for the copper production can be standard (the smelting furnace in the flame, electric furnace, furnace...) and autogenous (smelting in a floating state and smelting in the melt). These processes have produced more than 80% of world copper production. [5]

Whatcharacterizes "standard" presses for the processing of sulfide copper concentrate is that this process involves the roasting phase in which a large amount of heat is released and irrevocably lost, while the next phase of melting requires the consumption of large amounts of expensive additional heat (oil, fuel oil, coal or natural gas). Therefore, these copper production processes have become uneconomic. Also, additional unfavorable conditions such as the sudden increase in energy prices in the world and rigorous laws on environmental protection during the middle of the last century, have resulted indeveloping and implementing modern and rational technological solutions based on the principles of autogenous smelting, namely, the use of chemical energy of sulfur from copper sulfide concentrate.

Many leading companies in the field of copper production have developed their own processes of autogenous smelting of copper concentrates, which are technologically and operationally different, therefore their impact on the environment is different. These impacts will be shown through the following text. However, these technological procedures differ in mode of combustion and melting of the sulfides.

2.1 Outokumpu flash smelting

Outokumpu Technology was developed in 1949 and implemented in Harjavalta smelter in Finland. This technology was first implemented aprocess of smelting of copper concentrate in a floating state. This technology is now called Outotec. Outokumpu/Outotec flash smelting technology has a leading position in the production of copper on the basis of their cost-effectiveness, flexibility, low power consumption, and higher efficiency of sulfur. Sulfur capture efficiency of this technology is in the ranges 94% - 99%. In addition to sulfur capture efficiency as an essential parameter of this technology it can state, smelting dust that is in the range 80-250 t / day, the amount offgas 45000 Nm^3 / h, and the content of SO_2 in offgas is 24%. [5]

This technology has been developing over time, as elaborated and applied new solutions to improve processes, ecology, economics, technology and reducing energy consumption. Outokumpu Technology copper production is, in accordance to that it provides treatment of industrial water that meets all environmental requirements and reduced water consumption in the production process.

2.2 Ausmelt/Isasmelt lance

In 1971, researchers at the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) began investigating the use of top-lancing technology for injecting coal into tin slags to improve reduction kinetics. [5]

ISASMELT is a simple, highly efficient bath-smelting process for the production of non-ferrous metals. It is recognised as the most innovative, efficient and cost effective smelting process available in the world and since going into commercial production in the 1990s it has been installed in major brownfield and greenfield plants around the world. [6]

As environmental indicators of this technology we can mention: SO_2 capture efficiency 97%-98%, smelting dust 1-3 % per tonne batches, amount off gases 70000 Nm^3/h, SO_2 in offgases is 22-25%.This technology occupies a leading position in the world due to low production costs and satisfy stringent environmental standards.

2.3 Inco Flash

INCO is a Group with a long and rich history. It first started as a design consulting company in 1952 and evolved to become one of the leading contracting companies in the field of construction and erection of Industrial process plants and petrochemical plants[7] With the beginning of operating INCO smelter it eliminated the deficiencies of dominant reverberatory furnace in order to improve energy efficiency of sulphide minerals from the concentrate. In this way, reduce energy consumption, improve environmental conditions, and therefore increases the utilization efficiency of copper. The introduction of this process in industrial applications realized the integration of roasting phase and smelting. Also, using of technical oxygen instead of air, reduces the amount of gases generated in the process up to 40 times than the reverberatory furnace. On that way it is improving the economics of its work and the full protection of the atmosphere.

Beside expensive and complex preparation of batches, the main disadvantage of this technology is a big power consumption that accompanies oxygen production with a share of 50% of total costs. Other important environmental parameters are: utilization of sulfur, which is an average of 93.6%, generating

dust that ranges from 95 - 230 tons per day, the amount offgas of 35000 Nm^3/ h, while the SO_2 in the offgases is 70%.

2.4 Mitsubishi

The Mitsubishi process consists of three interconnected furnaces. In this process, smelting is distinctly separated from converting, thus single stage converting is employed in a separate furnace in the presence of molten copper phase. However, the three-furnace concept maximizes heat losses. Further, the movement of molten materials from furnace to furnace leads to fugitive emission of SO_2 gas.[8] This technological process is characterized by high utilization of SO_2 that stands out from the smelting process and converting section. Utilization of SO_2 average is about 99.5% and through electrostatic still directed into the production process of sulfuric acid or liquid SO_2. Mitsubishi process of continuous smelting of copper concentrates is permanently modernized and improved thus environmental protection is increased. This technology is applied the smelter in Naoshima, Japan with capacity of 240000 t per year of copper and Kidd Creek in Canada with capacity of 120000-150000 tons per year. Besides halved electricity consumption of processes other parameters that have impact on the environment are: dust production ranging in range 60-67 t / day, the amount offgas 500 Nm^3 / h, and SO_2 in offgases is 25-30%.[5]

2.5 Noranda

Noranda Inc. was a mining and metallurgy company originally from Rouyn Noranda, Quebec, Canada.This company merged with that company Falconbridge in 2005., which is named Falconbridge Limited. Noranda process was under continuously improvement. As the essential parameters of the technological process that has an impact on the ecosystem, it can extracted specific consumption of fuel heat which is 2321 MJ / t-2954 MJ / t of concentrate. Utilization of sulfur in range of 94%, production dust 70-100 tons per day, the amount offgases from 55000 Nm^3/h, and SO_2offgases in ranges of 16-20%.

2.6 El Teniente

Teniente technology is an important technology for smelting and processing of copper concentrates. The continuous matte converting and the autogenous smelting of concentrate constitute the basic foundations of this technology. The TC can be considered an intermediate alternative between conventional and autogenous fusion, since it uses the heat given up by matte conversion to melt concentrate in a converter. The converter is fed periodically with matte and continuously with dry (less than 1% moisture) concentrate and flux. Oxygen-enriched (30%) air is blown through tuyeres. [9] Control of the work process is a lot more complex than other control technologies. This complexity arises from the characteristics of the technological process. [10] The products of the process of smelting in this technology that have a significant impact on the environment are: utilization of sulfur ranges from 90% to 98%, the dust production 50 t / day, the amount offgas of 60,000 Nm^3 / h, SO_2 in the exhaust gases moving from 12% to 25%.

2.7 Vanyukov

The Vanjukov smelting process, belongs to the "bath smelting" family of copper smelting processes. This process has generally been applied to low grade concentrates (10-15% Cu); it seems to be well suited for high slag forming, copper smelting operations. Matte grade is 45-74% Cu, and slag Cu content is 0.7-2%. It was predicted that the Vanyukov's attributes of high productivity coupled with efficiency and flexibility eventually may compete with the Outokumpu system in the next decade to process in excess of 5000 ton per day. [3] The Gintsvetmet Institute developed technology for processing solid municipal and industrial waste based on the Vanyukov principles. "Romet" is the ferrous off-shoot of the Vanyukov process for smelting of base metal). The offgas strength is 25-40 vol.-% SO_2, depending upon blast oxygen enrichment and hydrocarbon combustion rate, utilization of sulfur is 90%, dust production in range 0.5-0.9% per ton batches, the amount offgeses in range of 35000-55000 Nm^3 / h.

2.8 Reverberatory

This traditional means of smelting sulphide concentrates in a molten bath is still employed worldwide. Daily throughput in these units, which may include hearth areas up to 380 m^2, approaches 1000 tonnes per day [11]. Reverbatory smelting is still used, despite its high energy consumption. In Balkhashmed, the reverbatory smelters supplied 70 % of copper in matte. lt is a conventional design without major improvement. Two identical furnaces are used in this section. Utilization of sulfur in range of 50%, production dust 470-700 tons per day, the amount offgases in range of 21000-23000 Nm^3 / h, and SO_2offgases in ranges of 1.5-2.5%.

3 Method for data analysis

For ranking of the technologies for copper smelting, according to their above-mentioned characteristic parameters, we decided to apply the Multi- Criteria Decision Making (MCDM) method. Many authors use the MCDM for solving environmental decision problems. In this paper, the PROMETHEE method was used for ranking the technological processes for copper smelting, while the GAIAplane, as an option, gives a graphical interpretation of the PROMETHEEmethod, thus presenting a clear picture of the problem ofmaking the decision according to the PROMETHEE ranking. The reason for using the PROMETHEE/GAIAmethod, for processing the starting data set, is in certain advantagesof this method over the other MCDM methods. Theseadvantages are reflected in problem structuring, takinginto consideration the amount of data that is possible to process,the ability for quantification of qualitative data type, good softwaresupport and presentation of obtained results. [12, 13]

The PROMETHEE presents an outranking method, for the finalset of alternatives. When this method is used, itis required to define the corresponding preference function and togive the weight criteria (weight coefficient) to each input variable.The preference function defines how a particular option is ranked,relativeto the other and it transfers the deviation between two parallel alternatives into one unique parameter, which is attached to the preference degree.The preference degree represents the increasing function of deviation, where, if the deviation is small, it relates to week preference, or in the

case when the deviation is large, it then stands for strong preference of a referent alternative.In the PROMETHEE method it is possible to choose one out of six forms of the preference function (Usual, U-shape; V-shape; Level, Linear, Gaussian) where each form could be described with two thresholds (Q and P). The P value should not be smaller than Q. The Gaussian threshold (s) is representing the median value of P and Q thresholds. The PROMETHEE V extends the field of application of the PROMETHEE II method. It can be used to solve the problem of the selection of several alternatives with the given set of constraints. [14, 15]

4 Results and discussion

For the multi-variation ranking of technologies for copper smelting, comparison was made for sixcharacteristic parameters that are selected as significant. The following parameters were chosen: amount of concentrate (t/day), Cu in Concentrate (%), Cu in matte (%), Cu in slag (%), SO_2 in off-gas, campaign life (year), Fe in matte (%), amount of mate production (t/day), amount of slag production (t/day), production of off-gas (Nm^3/h), silica flux (%), dust production (t/day), utilization of SO_2 (%) and utilization of Cu (%). For ranking of the concentrates, considering the aspect of their metal content, the PROMETHEE/GAIA method was used.

Complete ranking of the concentrates was performed using the PROMETHEE II method, from the best to the worst option according to the given parameters (see Fig. 1). The results indicate that the best technological process for copper smelting is Mitsubishi while the least preferred alternatives are alternatives no. 7 (Inco Flash) and no. 8 (El Teniente)

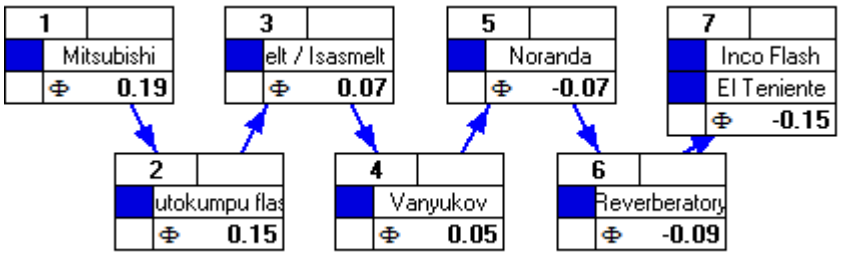

Figure 1. PROMETHEE II complete ranking of alternatives for defined scenarios.

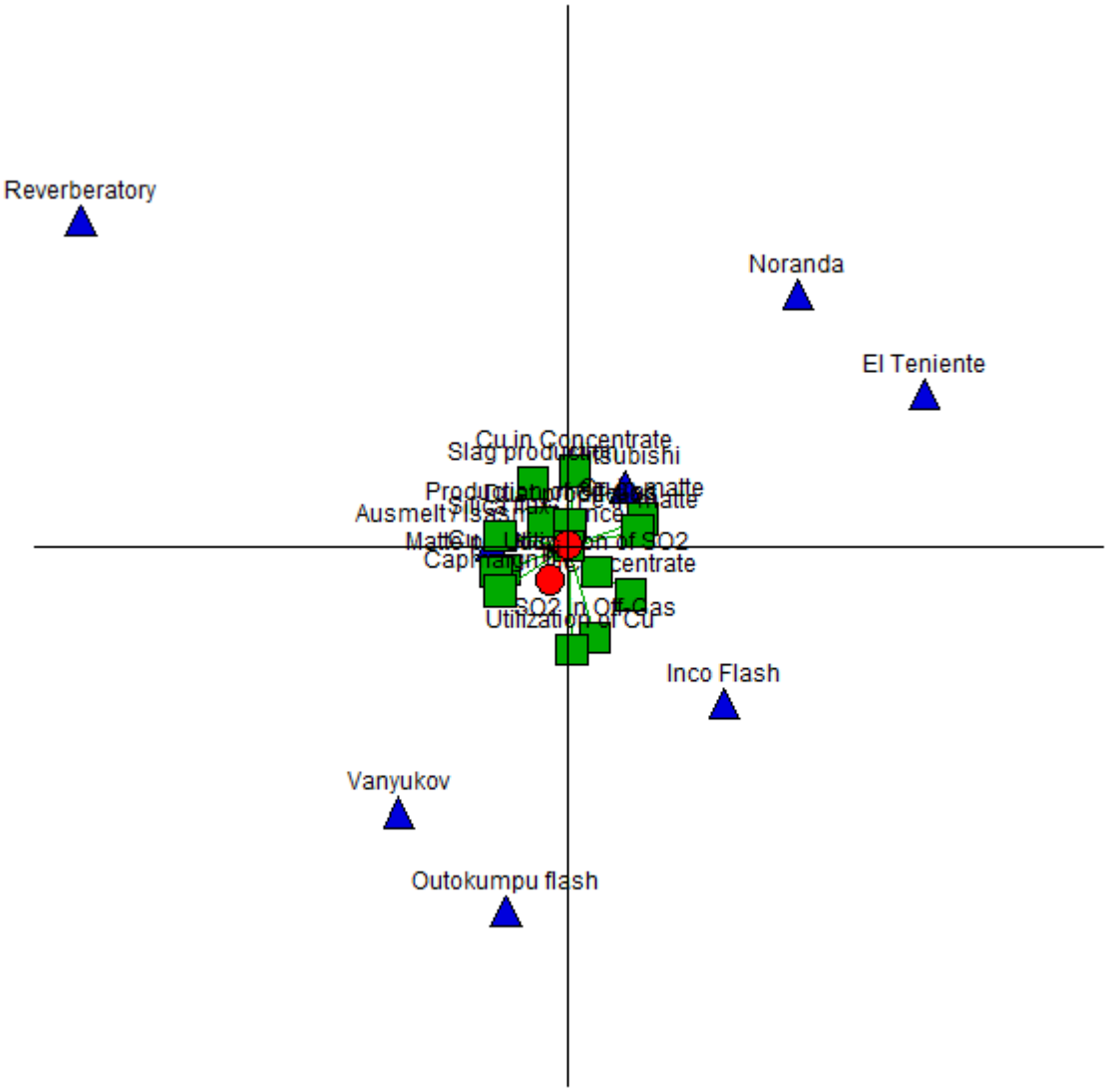

Figure 2. GAIA plain (Δ=62.1%).

Another advantage of the Decision Lab software package is it's the possibility of using the GAIA (Geometrical Analysis for Interactive Assistance) plane. After determining that the Δ value of62.1% is satisfactory,the validity of using this tool was proved, where Δ represents the measure of the quantity of information being preserved by defined model. In the real world applications, the value of Δ should always be larger than 60% and in most cases even larger than 80%. Based on the GAIA plane, it is possible and easy to determine the discriminative strength of each criterion, as well as the aspects of consistency or inconsistency as the indicator of each alternative for all criterions.The alternatives are shown as triangles, and the criterions are presented as axes with square endings in Figs. 2. The eccentricity of position of square criterion is representing the strength of influence of that criterion while the similarity in preference between certain criterions is defined with almost the same direction of these criterions axes.

5 Conclusions

Due to the fact that heavy industries often sell their products to other industries rather than to end users and consumers, they usually make products that are used to make other products. Different copper smelting technologies have different impact on environment.The technologies which we were considered in this paper arethe following: Outokumpu flash smelting (present Outotec flash smelting), Ausmelt/Isasmelt lance, Inco Flash, Mitsubishi, Noranda, El Teniente, Vanyukov, Reverberatory process.Complete ranking of the concentrates was performed using the PROMETHEE II method, from the best to the worst option according to the given criteria. The results indicate that the best technological process for copper smelting is Mitsubishi, while the least preferred are alternatives Inco Flash and El Teniente.

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INNOVATIVE SUPPLIER PRIORITIZATION FUZZY MODEL DEVELOPMENT - A CASE STUDY OF THE SERBIAN ANIMAL FEED PRODUCTION COMPANY

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Abstract: Numerous studies were aimed at identify supplier's characteristics that improve customer - supplier relationship as well as encourages customer's innovation. Through a series of marked characteristics this study is intended to presents supplier prioritization model that would contribute to the customer innovation. The optimal supplier characteristics are defined using fuzzy set theory, while customer innovation influencing factors are defined using the innovative presence in technical sector, compared cooperation, and contribution to the customer - supplier relationship development program. The research goal was the innovative supplier prioritization model creation that can be used in production systems as well as in supply chains prioritization. Main focus was on the supplier contribution to the customer's innovation processes. The created model was tested in Serbian feed production company Tenen.

Keywords: prioritization, company's innovation, fuzzy set theory, hybrid model, customer-supplier relationship

1 Introduction

Company success depends not only on the knowledge and technical resources it possess, but also on its innovations implementation capability. For many companies the innovation management process is systematic new ideas exploitation in order to achieve a competitive market advantage. Business innovation is not only the creation of new ideas, but also a profitable use of notable business opportunities.

There are the seemingly two tasks of innovation process, first - acquiring and exploiting existing knowledge and, on the other, generating new knowledge [1]. It is almost impossible to manage the knowledge necessary for innovation in a single company completely internally [2].

In the recent literature, considerable attention has been given to the supplier role in the innovation context. However, not every supplier is capable to contribute to the buyer's innovation performance. In addition, the supplier willingness and commitment to collaboration with buyers is not always apparent. Thus far, the literature has not given a conclusive innovative suppliers nature description due to a lack of empirical evidence [3].

The innovative vendors often have insufficient funds. Because of that, they met only the limited number of customers needs, and therefore are in a position to carry out the selection of customers that will be devoted to their innovative resource availability.

Many studies are aimed at finding a set of characteristics that can make significant contribution to buyer–supplier collaboration [3]. Supplier's technical characteristics and collaborative attitude, as well as the buyer–supplier relational characteristics explain an important part of a supplier's contribution to buyer innovation [3]. A wide range of multiple criteria analysis (MCA) methods in combination with the fuzzy set analysis, paired comparison and outranking methods are being used in this studies [4].

In this paper, the innovative supplier prioritization hybrid model formation will be performed by applying decision-making multi-criteria tools.

2 Defining the case of research

The research subject, related to industrial processes, is shown in a case study of the "Tenen" Novi Sad Company, Republic of Serbia. The main activity is agricultural products and animal feed components production and trade. For the animal feed production Tenen have to purchase raw material (corn, soybean, sunflower...) from individual producers and agricultural cooperatives. In the absence of goods on the market it might be purchased from other companies. When selecting suppliers, Tenen takes into account the quality of goods. Quality parameters are standard quality (SRPS) - Serbian standard which was developed by the Institute for Standardization of Serbia. The analysis refers to oil refinery.

One of the animal feed components is lysine (Lys, K - Table 1.), an essential amino acid.

Table 1. Characteristics of lysine

Lysine	
Abbreviation	Lys, K
CAS register No	70-54-2, L:[56-87-1] D [923-27-3]
Molecular formula	$C_6H_{14}N_2O_2$
Molecular mass	146.19 g mol^{-1}
Standard of material	(25 °C, 100 kPa)

Company Tenen has three amino acid lysine component suppliers.

All three supplier's characteristics comparison such as quality, price, delivery and other will be analyzed. To determine the characteristics that contribute to innovative buyer - supplier relationship, we formed the conceptual model that is graphically shown in Figure 1.

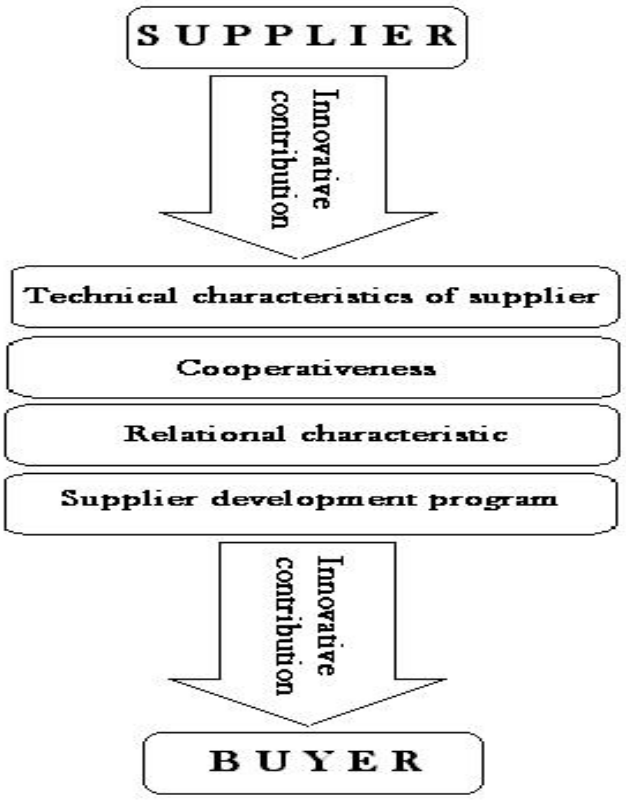

Figure 1. Conceptual model

Presented model is consisted of the following parts:

Supplier's demographic

Suppliers who participated in this study are Republic of Serbia domestic companies. The animal feed components used to produce concentrates are imported from the European Union.

Technical characteristics - professionalism, R & D supplier's activities and specialization.

Professionalism is an essential component of any organization intention for a long-term success. A professional organization generates confidence among its customers, and attracts the highest quality workforce that becomes a loyal and committed. Knowledge sharing and the business skills development demonstrate supplier's competence and promote its professional management. Of those suppliers who are characterized by a professional attitude is expected to contribute more to their customers innovation in compare to the vendors with lower professionalism.

Research and development (R&D) refers to the activities that as a final goal have a discovery that can either lead to the new products or procedures development, or to the of existing products or procedures improvement. It can be expected that suppliers with intensive R&D activities actively contribute to the customer's innovative programs.

Specialization is an organizational networks innovation prerequisite. The extensive knowledge sharing between individuals makes the network [5]. A larger number of specialized suppliers provide the customer with a wider knowledge base. Specialization refers to a supplier's unique or differentiating capabilities [6], which can be combined with the customer's own knowledge/expertise in order to innovate [03].

Cooperativeness – Successfully knowledge sharing are based on willingness of both - buyer and supplier for collaboration. In addition, communication between customers and suppliers is essential to coordinate the production, technical adaptations, delivery details, as well as a variety of strategic issues information flow [7].

Relational characteristics - preferred client status. In order to rational resources management, seller contribution to the customer's innovation is often limited as supplier becomes more selective. In this way it is important to create the climate in which companies compete to win benefits [8]. Preferred client status is business advantage, the opportunity to provide superior economic benefits, access to important resources and social compatibility [9].

Supplier Development Program – Through the positive cooperational attitude, the customer with its activities affects supplier in order to improve performance and ability to meet the customer's needs. These activities include the business supplier's assessment, encouraging performance improvements, encouraging competition among suppliers and direct work with suppliers, through training or other activities. In this way companies collaborate, allocate their financial, human and other essential resources and sharing the sensitive information.

The company's success depends on its supplier's development. Company that is satisfied with its supplier is ready to invest great effort, resources and willingness in the more efficient inter-organizational communication development as well as in activities such as supplier's development program and training.

Information exchange through buyer-supplier interactions supports new ideas, which can be crucial to encourage customer's innovation.

3 Model creation

In the earliest works of Zadeh [10] and Goguen [11] intention of generalization of the naive set notion and adequate adjustment in order to remove possible lack of human language clarity in the terms of content, prejudice, evaluations and decisions are present.

Fuzzy concept is much broader than naive sets theory and has a larger applicability, particularly when it comes to classification and data processing [10].

The first step in the suppliers assessment model creation research phase is to define variables relating to the supplier's characteristics.

The optimal supplier partial indicators will be shown over function:

μ_T – describes an innovative contribution to the technical characteristics (professionalism, R & D activities and specialization),

μ_S – describes an innovative contribution to the cooperation relations,

μ_R – referring to the innovative relational characteristics contribution (preferred client status) and

μ_I – describes an innovative contribution to the development program.

Supplier's characteristics will be able to rate as *bad, satisfactory, good, very good and excellent*.

Described functions may be represented as:

$$\mu_T(\mu_T^1, \dots \mu_T^5), \mu_S(\mu_S^1, \dots \mu_S^5), \mu_R(\mu_R^1, \dots \mu_R^5), \quad \mu_I(\mu_I^1, \dots \mu_I^5), \tag{1}$$

The introduced function is shown in Figure 2**.** It represents a set of triangular phase sets [12,13].

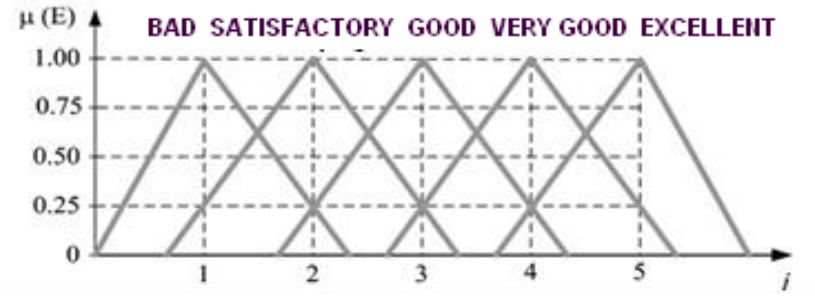

Figure 2. The function of the phase's effectiveness

Based on the displayed Figure 2**,** the values of the function (in points 1, 2, 3, 4, and 5) are:

$$\mu_{exc.} = (0, 0, 0, 0.25, 1); \quad \mu_{good} = (0, 0, 0.25, 1, 0.25);$$

$$\mu_{aver.} = (0, 0.25, 1, 0.25, 0); \quad \mu_{adeq.} = (0.25, 1, 0.25, 0, 0)$$

$$\mu_{poor} = (1, 0.25, 0, 0, 0). \tag{2}$$

In the next step min - max composition functions is performed. The composition is used for the development stage of the model, which is calculated by the total assessment optimality E, as partial expected best possible (for T, R, S and I) [14].

The case in which the partial function (for T, R, S and I) equally affect the final position E, will be considered. In some cases a min - max composition using operators AND/OR gives favor to any function in relation to the other.

For four functions (Figure 2), it is possible to make $C = j^4 = 5^4$ different combinations. Each of these represents a possible combination of evaluation functions optimality (E_c):

$$E_c = \left[\mu_T^{j=1,\dots 5}, \mu_R^{j=1,\dots 5}, \mu_S^{j=1,\dots 5}, \mu_I^{j=1,\dots 5} \dots, \mu_I^{j=1,\dots 5}\right]$$

$$\text{for all } c = 1 \; to \; C \tag{3}$$

For the values $\mu_{T,R,S,I}^{j=1,\dots5} \neq 0$, are obtained final combination ($o = 1\ to\ O, where\ O \subseteq C$).

For each final combination obtained Ω_C is calculated. The result suitable for combination c, can be obtained by the equation:

$$\Omega_C = \frac{[\sum_{T,R,S,I} j]_c}{4}.$$

(4)

All the resulting outcomes will be subject to max - min analysis, which is carried out through the following stages:

1. For each of obtained result requires a minimum value μ_{TSRI} as an optimality function E_c (3). Minimum corresponding combination o, is counted over the following equation:

$$MIN_O = min\{\mu_T^{j=1,\dots,5}, \mu_R^{j=1,\dots5}, \mu_S^{j=1,\dots5}, \mu_I^{j=1,\dots5} \dots., \mu_I^{j=1,\dots5}\}$$

$$\text{for all } o = 1\ to\ O.$$

(5)

2. Results are grouped by values Ω_C (4), and size j.

3. The maximum of the previously identified minimum for each group of possible outcomes was found. The maximum corresponding to the value j is calculated by the equation:

$$MAX_J = max\{MIN_O\} \text{ for all j.}$$

(6)

Finally, the system for the given feature obtained:

$$\mu_E = \left(MAX_{j=1}, \dots, MAX_{j=1}\right) = (\mu_E^1, \dots, \mu_E^5)$$

(7)

This expression is related to the Figure 2**,** Best - fit method [14] is used to transform the tool (7) to form presented in (Figure 2), the triangular function sets the phase. This procedure also called identification. Best - fit method uses a standard deviation (d) between obtained function E_c, the application of "min - max" composition (7) and each of the expressions (calculation is based on Figure 2).

The standard deviation is obtained from the equation:

$$d_i(E_j, H_i) = \sqrt{\sum_{j=1}^{5}(\mu^j E - \mu^j H_j)^2}, j = 1, \dots, 5$$

$$H_i = \{\text{excellent}, \text{very good}, \text{good}, \text{satisfact.}, \text{bad}\}.$$

(8)

If the deviation of μ_E (7) from i - linguistic variables is less, the standard deviation d_i is lower. The standard deviation d_i is zero, if μ_E (7) as well i – expression in a declining function. In this case, E will not be assessed in relation to the other terms, because of the exclusion of these terms.

Suppose that $d_{min}\,(i = 1,2,..,5)$ the lowest possible standard deviations obtained are reciprocal relative deviation for E_j , some are α_1 , ... α_5 reciprocal relative deviation which is calculated over the term:

$$\alpha_i = \frac{1}{d_i / d_{imin}}.$$

(9)

If $\alpha_i = 0$ follows that $\alpha_i = 1$ and the other will be equal to zero. Therefore, α_i normalize the expression:

$$\beta_i = \frac{\alpha_j}{\sum_{m=1}^{5} \alpha_{im}}, i = 1,2 \dots ,5 \quad \sum_{i=1}^{5} \beta_i = 1.$$

(10)

Each β_i represents the degree in which E participates in i - that defined the term E. If E_i fully participates in i - the term $\beta_i = 1$, while others will be zero.

The final expression of E for use may be presented as:

$$E_i = \begin{Bmatrix} (\beta_{i=1}, "bad"), (\beta_{i=2}, "satisf"), \\ (\beta_{i=3}, "good"), \\ (\beta_{i=4} "very\ good"), (\beta_{i=5} "excellent") \end{Bmatrix}$$

(11)

4 Model Testing

Research was carried out through the following levels: Level I - the supplier selection; Level II - marking the significant features of the supplier to which a supplier can affect by applying innovative approach; Level III - testing these characteristics through the survey and Level IV – implementation of fuzzy methodology (Figure 3):

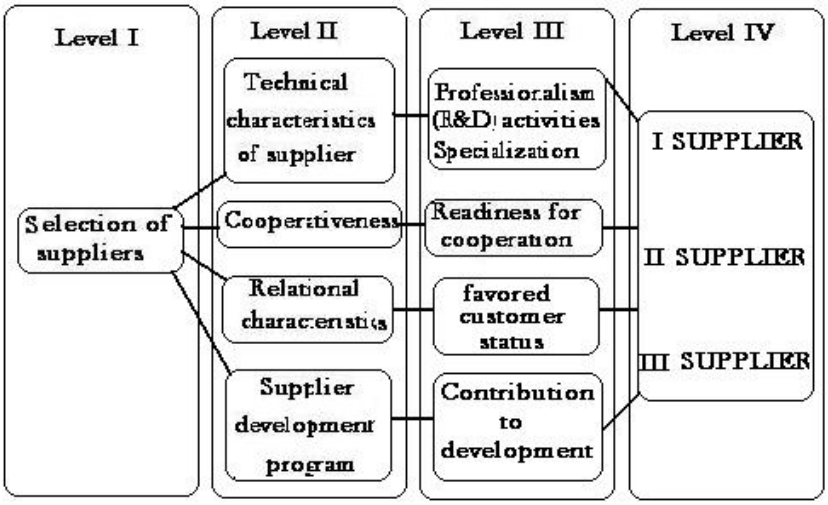

Figure 3. Hierarchical structure model

The survey was carried out on the sample consisted of " technological and economical experts employed in Tenen" Company. Experts evaluated the characteristics of the three suppliers that the company operates with. The study was conducted using a questionnaire containing four groups of questions [3]. Each group related to the specific supplier characteristics (second level shown in the Figure 3, which is still served for the four-defined functions formation.

After the review, the mean score for each of the four functions is presented in Table 2.

Table 2. Results of the research

		I supplier					***II supplier***					***III supplier***				
isp	Var.	*5*	*4*	*3*	*2*	*1*	*5*	*4*	*3*	*2*	*1*	*5*	*4*	*3*	*2*	*1*
1.	*T*		×						×					×		
	S	×							×					×		
	R		×					×					×			
	I		×						×				×			
2.	*T*		×					×				×				
	S	×					×							×		
	R	×						×						×		
	I		×					×					×			
3.	*T*			×					×				×			
	S		×					×					×			
	R				×				×					×		
	I		×						×					×		
4.	*T*		×					×					×			
	S	×							×					×		
	R			×				×					×			
	I		×					×					×			
5.	*T*			×				×						×		
	S		×					×					×			
	R	×						×				×				
	I		×						×				×			
6.	*T*		×					×					×			
	S							×						×		
	R		×						×						×	
	I	×							×					×		
7.	*T*	×							×				×			
	S	×							×				×			
	R		×						×					×		
	I		×						×					×		
8.	*T*	×						×					×			
	S	×							×				×			
	R		×					×						×		
	I		×						×					×		
9.	*T*	×						×					×			
	S	×						×					×			
	R		×					×						×		
	I		×				×							×		
10.	*T*	×						×					×			
	S		×				×							×		
	R	×							×						×	
	I		×					×					×			

The four functions of fuzzy methodology value can be calculated on the basis of information shown in Table 2.:

Features of technical characteristics – μ_T,

Features of cooperativeness - μ_S,

Functions of relational characteristics - μ_R , and

Functions of innovative characteristics - μ_I

The technical characteristics function results of the first supplier are processed in Table 3.

Table 3. Values of the function of technical characteristics μ_T *- first supplier*

	1	2	3	4	5
$^{0.4}/_{odl.}$	0 × 0.4	0 × 0.4	0 × 0.4	0.25 × 0.4	1 × 0.4
$^{0.4}/_{vrd.}$	0 × 0.4	0 × 0.4	0.25 × 0.4	1 × 0.4	0.25 × 0.4
$^{0.0}/_{dob..}$	0 × 0.2	0.25 × 0.2	1 × 0.2	0.25 × 0.2	0 × 0.2
$^{0.0}/_{zad.}$	0.25 × 0.0	1 × 0.0	1 × 0.0	0 × 0.0	0 × 0.0
$^{0.0}/_{loše}$	1 × 0.0	0.25 × 0.0	0 × 0.0	0 × 0.0	0 × 0.0
$\sum R$	**0.00**	**0.05**	**0.30**	**0.55**	**0.50**

The post fuzzy technical characteristics methodology gets the value of which four are different from zero:

$$\mu_{TI} = (0, 0.05, 0.3, 0.55, 0.5).$$

(12)

In a similar manner are calculated values of other functions.

$$\mu_{SI} = (0, 0, 0.075, 0.475, 0.775),$$

$$\mu_{RI} = (0.25, 0.125, 0.25, 0.6, 0.425) \text{ and } \mu_{II} = (0, 0.025, 0.3, 0.85, 0.3).$$

(13)

The total number of combinations in the formation of structures MAX - MIN composition is obtained using the following formula: $C = j^4 = 5^4 = 625$. For the first supplier first function has four, the second function has three, the third has five and fourth has four values that are different from zero, so the total number of required combination is $4 \times 3 \times 5 \times 4 = 240$. Table 4 shows the structure of the MAX - MIN composition of the first suppliers.

Table 4. Structure of MAX- MIN composition (part of data of Table 4)

Kom b	Ω	μ	MIN 2	3	4	5
2312	2	[0.05,0.075,0.25,0.025]	0.025			
2313	2	[0.05,0.075,0.25,0.3]	0.05			
2314	3	[0.05,0.075,0.25,0.85]		0.05		
2315	3	[0.05,0.075,0.25,0.3]		0.05		

Kom b	Ω	μ	MIN 2	3	4	5
2432	3	[0.05,0.475,0.25,0.025]		0.025		
2433	3	[0.05,0.475,0.25,0.3]		0.05		
2434	3	[0.05,0.475,0.25,0.85]		0.05		
2435	4	[0.05,0.475,0.25,0.3]			0.05	
2442	3	[0.05,0.475,0.6,0.025]		0.025		

Based on these structures MAX - MIN composition obtain following set of values:

$$MAX_{\Omega=2} = max\{0.025, 0.05\} = 0.05$$

$$MAX_{\Omega=3} = max\{0.025, 0.05, 0.075, 0.125, 0.25\} = 0.25$$

$$MAX_{\Omega=4} = max\{0.025, 0.05, 0.075, 0.125, 0.25, , 0.3, 0.425, 0.475\} = 0.475$$

$$MAX_{\Omega=5} = max\{0.025, 0.075, 0.25, 0.3, 0.425, 0.475, 0.5, 0.55\} = 0.55$$

(14)

So, that is an optimality function of the first supplier:

$$\mu_{EI} = (0; 0.05; 0.25; 0.475; 0.55).$$

(15)

The best fit method uses the deviation value obtained from the structure MAX – MIN composition of value function shown in the Figure 2.

$$\mu_{exc.} = (0, 0, 0, 0.25, 1); \quad \mu_{good} = (0, 0, 0.25, 1, 0.25);$$

$$\mu_{aver.} = (0, 0.25, 1, 0.25, 0); \quad \mu_{adeq.} = (0.25, 1, 0.25, 0, 0)$$

$$\mu_{poor} = (1, 0.25, 0, 0, 0).$$

(16)

These deviations are:

$$d_1(E, odl) = \sqrt{(0-0)^2 + (0-0.05)^2 + (0-0.25)^2 + (0.25-0.475)^2 + (1-0.55)^2}$$

$$d_1(E,odl) = 0.56402$$

$$d_2(E,vrdb) = \sqrt{(0-0)^2+(0-0.05)^2+(0.25-0.25)^2+(1-0.475)^2+(0.25-0.55)^2}$$

$$d_2(E,vrdb) = 0.60671$$

$$d_3(E,db) = \sqrt{(0-0)^2+(0.25-0.05)^2+(1-0.25)^2+(0.25-0.475)^2+(0-0.55)^2}$$

$$d_3(E,db) = 0.97756$$

$$d_4(E,zd) = \sqrt{(0.25-0)^2+(1-0.05)^2+(0.25-0.25)^2+(0-0.475)^2+(0-0.55)^2}$$

$$d_4(E,zd) = 1.22193$$

$$d_5(E,l) = \sqrt{(1-0)^2+(0.25-0.05)^2+(0-0.25)^2+(0-0.475)^2+(0-0.55)^2}$$

$$d_5(E,l) = 1.28865$$

(17)

Minimum values of these deviations are:

$$d_{min} = d_1(E,odl) = 0.56402$$

(18)

So, the following expressions can be calculated:

$$\alpha_1 = \frac{1}{d_1/d_{min}} = 1.00000;\quad \alpha_2 = \frac{1}{d_2/d_{min}} = 0.92964;\quad \alpha_3 = \frac{1}{d_3/d_{min}} = 0.57697;$$

$$\alpha_4 = \frac{1}{d_4/d_{min}} = 0.46158;\quad \alpha_5 = \frac{1}{d_5/d_{min}} = 0.43768$$

(19)

Based on this can be obtained normalizing coefficients such as:

$$\beta_1 = \frac{1.00000}{1.00000+0.92964+0.57697+0.46158+0.43768} = \frac{1.00000}{3.40587} = 0.29361$$

$$\beta_2 = \frac{0.92964}{1.00000+0.92964+0.57697+0.46158+0.43768} = \frac{0.92964}{3.40587} = 0.27295$$

$$\beta_3 = \frac{0.57697}{1.00000+0.92964+0.57697+0.46158+0.43768} = \frac{0.57697}{3.40587} = 0.16940$$

$$\beta_4 = \frac{0.46158}{1.00000+0.92964+0.57697+0.46158+0.43768} = \frac{0.46158}{3.40587} = 0.13552$$

$$\beta_5 = \frac{0.43768}{1.00000+0.92964+0.57697+0.46158+0.43768} = \frac{0.43768}{3.40587} = 0.12851$$

(20)

Finally the optimality of the first supplier obtains as:

$$E_I = \begin{bmatrix} 0.29361\ exc; 0.27295\ very\ good; \\ 0.16940\ good;\ 0.13552\ satisf.; 0.12851\ bad \end{bmatrix} \tag{21}$$

Excellent selection of the first supplier is assessed with 29.361%, very good choice with 27.295%, good with 16.940%, satisfactory 13.552% and bad with 12.851%. Based on results shown, the highest percentage of excellent selection of the first supplier and the percentage (nearly 30%) is relatively high.

The center of mass Z_I:

$$Z_I = \frac{\sum_{i=1}^{5} \beta_i c_i}{\sum_{i=1}^{5} \beta_i}$$

$$Z_I = \frac{0.29361 \cdot 5 + 0.27295 \cdot 4 + 0.16940 \cdot 3 + 0.13552 \cdot 2 + 0.12851 \cdot 1}{0.29361 + 0.27295 + 0.16940 + 0.13552 + 0.12851}$$

$$Z_I = 3.62423. \tag{22}$$

Similarly, the act of receiving the function optimality of other two suppliers:

$$E_{II} = \begin{bmatrix} 0.16030\ exc.; 0.30720\ v.good; \\ 0.25955\ good;\ 0.14451\ satis..; 0.12843\ \ bad \end{bmatrix}$$

$$E_{III} = \begin{bmatrix} 0.14855\ exc,; 0.29567\ v.good; \\ 0.28985\ good;\ 0.14215\ satis.; 0.12378\ \ bad \end{bmatrix}. \tag{23}$$

Excellent choice of the second supplier is estimated to 16.030%, a very good choice with 30.720%, 25.955% with a good, satisfactory with 14.451% and 12.843% with the bad. The highest percentage is at a very good choice, just over 30%.

Excellent choice of a third supplier is 14.855%, very good choice is estimated to 29.567%, 28.985%, with a good, satisfactory with 14.215% and 12.378% with the bad. The highest percentage of the source of a third supplier is evaluated with very well, but very close with a good score and these percentages are almost 30%.

The center of mass of the second Z_{II} and the third Z_{III}:

$$Z_{II} = 3.22643 \text{ i } Z_{III} = 3.20306 \tag{24}$$

5 Results discussion

An analysis of the results of obtained function optimal choice is shown for first, second and third suppliers. Excellent selection of the first supplier is a significantly stronger then the second and third supplier - this deviation is about 15% (Figure 4). Bad choice for all three suppliers is equal and each deviation does not exceed 1%. Similarly with satisfactory assessment, while a good estimate for the first supplier is significantly lower than for the second and third.

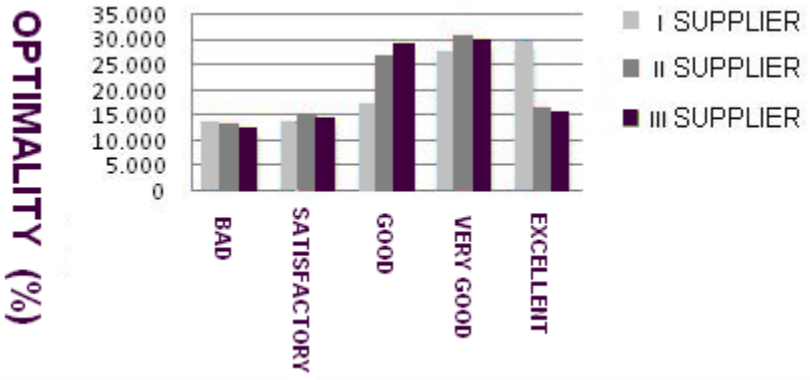

Figure 4. Optimal supplier selection expressed in percentages

On a scale of 1 to 5 the first supplier has the best result of the center of mass, while the third is the worst.

The center of mass difference value of the second and third suppliers is not statistically significant but the difference value of the first supplier is statistically significant.

On the basis of the presented analysis, it appears that the optimal function value and the centers of mass value of the second and the third suppliers are slightly different, while the value of the first supplier stands out from them and overcome them significantly.

On the basis of subsequent analysis and testing Tenen as customer, in the research results presentation, the first supplier stands out from the other two suppliers. Obtained results are in accordance with the field experience. The first supplier's initiative to replace one component in the production process led to the customer's significant profit.

6 Conclusion

The aim of the study was designing a hybrid model that can be used for the supplier prioritization purposes. In the focus of the work was the impact of supplier selection to the company's innovation processes. The model construction was based on the N. J. Pulles results [3]. The created model contains multi-criteria tools elements as well as fuzzy environment, and can be used as expert assessment platform and/or group decision making tool. The model testing was performed using data collected in Serbian feed production company Tanen, Novi Sad.

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DEVELOPMENT OF HYBRID MULTIPLE- CRITERIA MODELS IN FUZZY ENVIRONMENT FOR PRIORITIZATION OF SUPPLIERS RELIABILITY IN MINING SYSTEMS

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Abstract: The selection and the evaluation of the suppliers represent a complex problem which for the most part depends on the quality of the process of the decision making. Right choice of supplier has a huge impact on companys business results. Along with present trend in constant increase and growth in IT sector it lead to increase in quality in area of engeneering, logistics and handling production, along with that it demands better and more tight connections with the suppliers. Result is seen as a less time needed to get the supplies of any kind, right on time delivering and higher quality in chains of suppliers.

Process of selecting right suppliers became so important that companies hire experets to do this task. So, a right decision in picking the supplier can solve a lot of problems in buissnis.

Goal of this work is to show and explain possibilities of improving decisions in picking a adequate supplier in companies. Choice is made by criteriums that are chosen in advance by company. When choice of supplier is narrowed down to a small number of suppliers then choice is very simple to make but in situations when there is a lot of different suppliers picking the right one cane be very difficult and choice is made based on quality and quantity criteria and methods.

In this work is shown a support system for decision based on multi criteria concept and theory of fuzzy numbers.

Based on already defined integral PROMETHEE – GAIA – AHP – Fuzzy – TOPSIS models for priorities of reliable suppliers – but based on their performance and work, after using all this methods it came to conclusion that supplier D4 is best ranked supplier.

Received results show that suggested combined method gives excellent results and it can be used for solving a variety of even the most complex problems which appear in mining systems.

Keywords: Supplier selection, supply chain, ranking, mining systems, PROMETHEE, TOPSIS, fuzzy set and fuzzy logic

QUALITY ASSURANCE OF THE WASTEWATER TREATMENT PLANT IN RELATION TO ENVIRONMENTAL ASPECTS

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Abstract: The wastewater treatment plant activity has great influence on the quality and comfort of the local society living conditions. The quality of the treated wastewater is systematically controlled. Physical-chemical treatment analysis, that is carried out by accredited by the Polish Centre for Water Laboratories Accreditation, provides an evidence of the water quality compliance with the requirements owned water permits. The paper presents research findings on the selected Polish wastewater treatment plant activities related to the water quality ensuring and preventive activity on the aquatic environment pollution formation.

Keywords: quality assurance, wastewater, environment

ANALYSIS OF THE QUALITY ISSUES RELATED TO THE WATER PRODUCTION PROCESS

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Abstract: The aim of the study is the quality assurance system analysis with traditional quality management methods and tools applied for the quality level quantification in the manufacturing process. In the papers, there was presented the production process decomposition and its documentation. The main part of the paper is nonconformities' analysis in the selected company producing a drinking water flowing on the basis of complaints from customers. The study used traditional tools of quality management in the form of Diagram Ishikawa Diagram and Pareto-Lorenz. . The collected data were used to eliminate weak links in the running of the plant from developing recipes for purchased raw materials, manufacturing process, warehouse, customer service and ending with the transportation of the finished product to the customer.

***Keywords*:** quality analysis, production process

LIFE CYCLE ASSESSMENT OF PRODUCTS EPS-F (EXPANDED POLY STYRENE) OF POLYSTYRENE

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Abstract: This paper presents the life cycle assessment of EPS-F product polystyrene, better known as styrofoam, using the LCA method. Using this method, is determined functionally unit, the boundaries of the system, described by following the procedures and phases of the product life cycle, certain assumptions and limitations. Shows the inventory of the product life cycle, as well as a simplified block diagram of the production process. It also discusses the negative impact polystyrene production on environmental components manufacturer Laštro Kreševo. The results confirm that part of the life cycle of the product that has the greatest impact on the environment is the stage of production and consumption of energy which occurs polystyrene.

Keywords*:* LCA method, EPS-F (Expanded Poly Styrene), inventory analysis, life cycle assessment.

1 Introduction

Life Cycle Assessment (LCA) is an analytical tool used to optimize products and services on the environment in the whole of their life cycle. ISO 14040 recommends the use of technology in many areas of environmental management, such as environmental design, eco-labeling, environmental communication and assessment of the effects of environmental activities. Although it is theoretically possible, a specific application of environmental life cycle assessment, such as the ability to identify and evaluate the environmental aspects of the use of LCA are, in practice, still new to many environmental managers. [1]

The process LCA is a systematic phased approach, is used in many industries, and includes four basic components defined by the International Organization for Standardization (ISO 14040) as follows:

1. Define the purpose and object of the study (ISO 14040) - defines and describes the product, process or activity, establishes the context whereby the estimate for the establishment of borders as well as the environmental impact assessment.
2. Analysis of the inventory (LCI) (ISO 14041) includes quantification of raw materials and energy inputs and emissions of solid, liquid and gaseous waste.
3. Evaluation of the impact of the life cycle (LCIA) (ISO 14042) is characterized by ecological imperatives defined in the inventory life cycle and assumed their effects on the environment, human health and other effects, such as creating smog and global warming.

4. Interpretation of the results (LCAI) (ISO 14043) - assesses the results of the analysis of inventory and assessment of the impact of the choice of the products, processes or services with a clear understanding of uncertainty and assumptions to generate results. [2]

In this paper, a life cycle assessment "Styrofoam" by LCA methods (Life Cycle Assessment). EPS-F (Expanded Polystyrene-Facade), better known as "Styrofoam", which is used in construction as a thermal insulator. In the central part of Bosnia and Herzegovina in Central Bosnia Canton exists companies Laštro in Kreševo as a single plant for the production of Styrofoam, which in its production complex manufactures a wide range of products based on Styrofoam different technical characteristics which are mainly used for thermal insulation. (Figure 1).

Figure 1. Company "Laštro" d.o.o. Kreševo, manufacturing facility and look plate EPS-F

2 Procedure for obtaining polystyrene and lca description of the method

The manufacturing polystyrene process starts with oil, actually its exploitation and distillation. The sequence of technological operations of the polystyrene: Oil-hexane-cyclohexane-ethyl-benzene-benzene-styrene-polystyrene. Polystyrene grains are produced in the reactor by addition polymerization process water, styrene, pentane and other additives at a temperature about 90 °C. Drops of styrene at the end of polymerization exceeding the beads of expandable polystyrene various granulation. The grain is dried in the separators, separates the grit and transferred into containers. After drying packed in octagonal cardboard containers. That comes packaged in the manufacturing process for the production of EPS-F. Polystyrene is not harmful to human health. The main disadvantage of polystyrene is its fragility, instability when exposed to UV light, and flammability. [4]

EPS in construction has a long useful life because of their durability, but its disposal is not significant.

The method of LCA (Life Cycle Assessment) belongs methodological tools "eco-design" which is the integration of environmental aspects, projecting, design and development of products. The environment is a complex system that includes the physical environment (water, air, soil), living organisms and natural resources. [2] All of these components are interdependent. The human effect on the environment has mostly negative impact and thus resulting adverse consequences, such as reduction of natural resources, global warming, noise pollution and radiation, extinction of animals, reducing biodiversity, deterioration of the environment. [3] LCA method in this study will be to determine how this product throughout its lifetime than its creation, use until its incorporation or liquidation of the impact on the environment and how the environment affects it. Quantify energy consumption and

materials into the air, water and soil throughout its life cycle. The subject of the study LCA methods EPS F product contains the following: definition of the functional unit, system boundaries of the product, production phases and associated procedures, assumptions and limitations.

3 Defining the purpose of analysis, functional unit and system boundaries

The purpose of the analysis is to determine the overall eco indicator life cycle EPS-F products, as well as to determine which part of the life cycle has the most significant effect on the environment. Considering that it is insulation materials and on the market there are many types of related materials, example is taken for data availability from the factory EPS "Laštro" from Kreševo. The range, which is represented with 80% of the total production in this factory. EPS-F comprises of 98% air and 2% polystyrene packaging has been taken as a starting step is mass 4.5 kg, volume 0.3 m^3,surface 3 m^2, panel 6 pieces thickness of 0.1 m. The thermal conductivity is 0,04 W/mK.

The analysis will be not included in the materials that are included in the installation of facade panels on residential or other buildings, for example. screws, adhesive, networks and energy spent in the installation. Also, will be disreagard the metal wires used in the process of cutting plates. The functional units of the system's package EPS plate dimensions 50x60x100 cm packed in polyethylene foil. (Figure 2) It should be noted that the heat fails this amount of material with a coefficient of thermal conductivity, which is:

$$\lambda = 0{,}04\left[\frac{W}{mK}\right],$$

for a period of 50 years, the amount of plate thickness of 10 cm in the package dimensions 50x60x100 cm. In this package holds 6 plates that total area: A = 6 × 50 × 100 = 30 000 [cm^2] = 3 [m^2]. Where are: λ [W/mK] - coefficient of thermal conductivity, k [W/m^2K]- the coefficients of thermal, d [m] - plate thickness, R [m^2K/W] - resistance to heat flow.

Figure 2. Package EPS board as a functional unit

As a functional unit calculates the energy passing through a layer of EPS-F 10 cm thick, indicated thermal conductivity. Polystyrene (EPS-F) has a high durability and could be said that lasts as long a residential building. [4] Starting from this assumption is the fact that the EPS-F last 50 years, 365 days a year and 24 hours per day, so the amount of heat that fails polystyrene thickness of 10 cm as follows:

$$\mathrm{Q} = \mathrm{k}\times\mathrm{A}\times 50\times 365\times 24\left[\frac{Wh}{K}\right], \quad \mathrm{R} = \frac{\mathrm{d}}{\lambda} = \frac{0{,}1}{0{,}04} = 2{,}5\left[\frac{m^2K}{W}\right];$$

-for the plate thickness of 10 [cm], $k = \frac{1}{R} = \frac{1}{2,5} = 0,4\left[\frac{W}{m^2K}\right]$

$$Q = 525600\left[\frac{Wh}{K}\right] = 525,6\left[\frac{kWh}{K}\right] = 525,6 \times 3600 = 1892160[kJ] = 1892,16\left[\frac{MJ}{K}\right]$$

If the plate thickness is reduced to 5 cm, the amount of this energy would be doubled, which means that they relations are opposite trend. The amount of energy passing through the surface of 3 m^2, on the path of 0.1 m, during 50 years in contrast to the external temperature and the internal wall of 1 K. It is known that EPS panels thermally insulate the rooms, thereby reducing the heat exchange with significant energy savings, both in winter and in summer. [4] The difference temperature of the internal space and the external environment in our region in winter is: T_1=22 °C (average indoor temperature) and 10 °C (average outdoor temperature), and in the summer time: T_1=22 °C (average indoor temperature) and 32 °C (average outdoor temperature).

Considering that this is a product that contains a substance which for raw materials have oil system boundaries are shifted up to the exploitation of oil. The entrance to the system is the input of oil as the primary feedstock for polystyrene, polystyrene then transport and storage, production of EPS-F, packaging, transportation and installation of EPS to the building. The energy used in the production of the above products in EPS Laštro is the electricity and natural gas.

Depending on the energy used in the plant will be determined and the impact on the environment. Of natural resources in the production of consumed water and its consumption is taken in the analysis of the environmental impact. Water vapor in the manufacturing process is being prepared in the boiler room, which particularly affects the environment noise emissions and emissions of pollutants into the air. The atmosphere is discharged pentane and its smell can be felt, and the excess water vapor is also released into the air. In some parts of the production cycle, there is a surplus of water containing pentane and sinks with drains outside the production system. EPS-F does not contain, or develop greenhouse gases, does not affect the degradation of the ozone layer. [4]

Pentane, which has polystyrene composition is not a greenhouse gas, has an unpleasant flavor, and 2-3 km above the ground in the atmosphere is decomposed photodegradation, and the influence of soil microorganisms is degraded. Excess ground EPS which occurs in the process returns to the production cycle and adds in the production of new products. EPS is one of a group of non-combustible materials.[4]

It can be assumed many ways the end of the life cycle of EPS-F because of its durability mono is installation of the facility and its deposit, and secondly reuse of grinding pure waste and add it in the process of getting a new product, part of mixed waste is used for new products as park benches, flowerpots and combustion with the aim of warming. In the combustion of polystyrene is inert and non-toxic waste.[4] In the assessment of the life cycle into consideration with respect to the impact polystyrene and pentane to the environment is its production. Characteristically for EPS-F is the ratio of the volume - the value of transport because it is not worth the distribution of these products at a distance greater than 300 km, due to the increase costing transport and exhaust gases which are emitted into the air.

4 Eco indicators and life cycle phases polystyrene

LCIA (Life Cycle Impact Assessment) is the phase of life cycle assessment aimed at examining the system from the aspect of environmental protection, consisting of:

1. Compulsory elements, which results were obtained by analyzing inventory transformed into appropriate indicator values.
2. Elective elements for normalization, summarizing or evaluating the significance of the total value of indicators and techniques of data analysis. [3]

Figure 3 shows a simplified diagram of the process of EPS-F product with all stages of the life

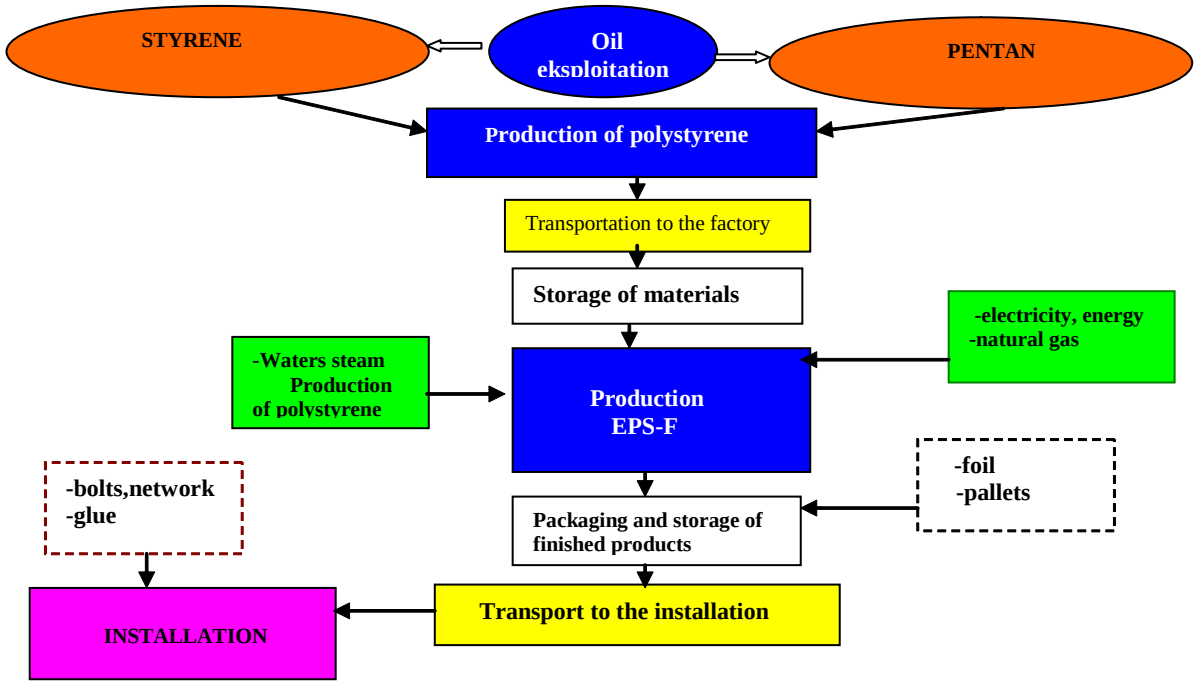

Figure 3. A simplified scheme of the process of production of EPS-F

Eco-indicators are indicators that take into account individual or multiple parameters, and point to one or more areas of the environment. Eco-indicator includes three life stages of the product: getting materials, transportation products, the consumption of energy and materials and disposal of discarded products. Eco-indicator for the observed individual process is determined so that the tablet eco indicator (usually expressed in points/kg of a substance, or point/MJ of energy produced) multiplied by the amount of matter (or energy), which is specific for a given process: $E_{in} = e_{in} \times m_n$ or $e_{in} = e_{in} \times e_n$

Where are: E_{in} - eco-indicator for the given process,
e_{in} - tablet eco indicator (expressed by the characteristic size of a process)
m_n - mass of matter in the observed process,
e_n - the amount of energy the observed process.

The overall ecological indicators for the observed production of polystyrene are determined through multiple steps (product description, define life cycle, quantification of materials and energy and the calculation points and interpretation of results) [5], and the same are shown in Table 1, for the life cycle of polystyrene, as follows:

- The production of polystyrene in the composition of the EPS-F is 2% polystyrene and 98% air, and in a package that weighs 4,5 kg amount of polystyrene is 0,090 kg, ie. $Ei_1 = e\ i_1 \times m_1 = 0{,}09 \times 360 \times 10^{-3}$ Pt/kg = 0,0324 Pt (points). [5] Total production was 215.000 m^3 and 589 m^3 daily EPS or expressed in kg, it is 1963x0,09 is 176 kg EPS.
- Transport processes: We consider transport between stages in the life cycle ie. between warehouses manufacturers of materials and manufacturing plant in which the material is processed. In this example it is the transport to the installation. Transport processes are expressed in points per ton or kg (Pt/kg). Flows are taken into account consideration arising from the extraction and production of required fuel, as well as flows that occur during the transport. The factory EPS Laštro fuel consumption is around 200.000 t/ year. Total production was 215.000 m^3 EPS and EPS-F participates with 80%. Truck with 370 packages, the average number of kilometers is 200 x 2 km x 22 l/100 km, which is 88 l/ km.
- Processes of energy consumption: The processes of generating energy for the production of polystyrene foam includes primarily flows arising from the extraction and processing of the fuel required for energy production (taking the average value in a particular region), and the resulting currents at a given conversion and distribution. Eco-indicators for these processes are expressed in points per delivered unit of electrical or thermal energy (Pt/kWh or Pt/MJ). In the present factory-treated product is registered annual electricity consumption of 25.609 kWh, while consumption of natural gas amounted to 706.481 m^3.
- Consumption of resources: Water consumption during the year amounts to 7.525 m^3/year. For 1 m^3 EPS water consumption is 100 liters. [4] For the selected functional unit is 30 l. A truck with 370 packages x30 l = 11.100 l. Daily transportation is organized by 10 trucks, which is 11.100 liters or 111 m^3 of water per day.

Table 1. Quantification of materials and processes

The material, process or type of processing	Quantity	Unit of measure	Indicator	Result
Production of polystyrene	176	kg	360[6]	63360
Transport processes	88	l/km	140[6]	12320
The process energy consumption				
Elekricity	70,16	kWh	22[6]	1543
Natural gas	1935	m^3	5,3[6]	10255
Consumption of resources				
Water	20,61	m^3	0,026[6]	0,535
Eco indicators total (mPt)				87478

5 CONCLUSION

Life cycle stages of polystyrene which have the most significant impact on the environment are production and transport processes and the total energy consumption which occurs polystyrene. According to the data from Table 1, it is evident that the stage production of polystyrene has the highest

amount of points as an indicator of activity on the environment, but also the dominant number of points have transportation processes. Energy consumption in the production process at the factory polystyrene EPS "Laštro" Kreševo is significant observing its total consumption (electricity, natural gas). By increasing the share of consumption of natural gas for the production process will contribute to the reduction of negative environmental impacts. Part of the energy that is consumed in the production process can be justified with the energy savings during the winter period for heating and during the summer period for cooling. Energy transport can be disreagard because of the short distance transportation and packaging for functional units where the best use of space intended for transport in trucks.Transport used trucks carrying capacity 35-40 t with engines with lower impact on the environment (Euro 3). Water consumption is relatively large and one of the drawbacks in the production of polystyrene, which is to be eliminated by installing a system to the steam returned to the production process, without air emissions. Particular attention should be paid in disposal polyethylene foil, which is packaged functional unit into (6 plates) polystyrene, marked for disposal in a special container, which acts on consumer awareness that partially takes over the obligations of producers.

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THE SYSTEM OF RELOADING MUNICIPAL WASTE

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Abstract: Municipal waste disposal can be divided into two activities which are interrelated and constitute the logistics solution for the provision of services in managing this type of waste.

In the process of treating household waste, hereinafter referred to as municipal waste, we differentiate two methods (phases): collection system and transport system.

The very development of the system depends on specific conditions and requirements, which are unique for every environment. The way of treating municipal waste in a given environment depends on the amount and type of waste, number of users, distance of the waste treatment facility, legal provisions which regulate the waste management and other factors.

With the gross domestic product of 3.642 € per capita (in 2014) Bosnia and Herzegovina ranks as less developed country, which is also reflected in the amount of 280 kg per person per year of waste generated (Zenica-Doboj Canton 2015) or rather in the composition of municipal waste through the share of usable materials.

Sustainable waste management, which depends on fees paid by polluters, is conditioned primarily by the economic strength of the population, which then determines the amount and the type of waste. The habits of the participants in the system of waste management, environmental protection, recycling, conservation of natural resources, development of legislation, all of which belong to factors and motives that influence the system of municipal waste treatment.

Reloading station is part of the system of waste management (reloading system). Depending on the manufacturing technology it may represent reloading into long-distance transport vehicles or the place of waste management (treatment) - such as separating certain components for their reuse (as raw materials or energy usage), which again should be consistent with other systems.

This paper presents data of a municipal waste reloading station operating under real conditions of urban environment in Bosnia and Herzegovina, with a particular reference to its economic, environmental and organizational justification in relation to the direct transport to a municipal waste landfill.

AHP APPLICATION FOR WIND FARM SITE SELECTION: CASE KOSTOLAC

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***Abstract*:** The goal of this paper is evaluation and prioritization of sites for wind farm construction. The methodology consists of several steps, and involves the application of the AHP method. The application area is Eastern Serbia - Kostolac basin. Decision making was to be done on the bases of 9 criteria comparing in pairs according to AHP methodology. The criteria are defined based on the literature review, expert opinion and specificity of the particular case. Decision making refers to the evaluation and selection of one of four potential sites for wind farm construction: Drmno, Klenovik, Cirkovac and Petka. The specificity of these sites lies in the fact that represent the mullock disposal sites from Kostolac. Pair comparison has been performed by Expert Choice 2000 software. According to the obtained results, the top-ranking alternative is Drmno.

Keywords: AHP, wind farm, RES, Serbia, alternative

1 Introduction

The growing energy needs while also striving to reduce CO_2 emissions are two opposing objectives that seek to meet the energy systems worldwide. As a matter of fact, climate change is reportedly responsible for global economic losses of between 4% and 20% of the GDP worldwide (Valentine, 2011). As one of the possible solutions imposes the transition from conventional to renewable energy sources. Safe and continuous energy supply are essential precondition for the development of every society and economy. Production and consumption should be harmonized with the principles of sustainable development, and sustainability is an important feature of RES because they use an inexhaustible energy sources and do not threaten the needs of future generations.

Renewable energy sources (RES) can be defined as sustainable resources available over the long term at a reasonable cost that can be used without negative effects (Charters, 2001; Dincer, 2013)

The advantages of RES compared to conventional sources are numerous. Renewable resources have an unlimited availability, as they are based on flows as opposed to scarce stocks, like fossil fuels (Johansson, 2013), potential price reduction for fossil fuels, improving energy security, reducing the health and environmental impacts associated with fossil and nuclear energy, mitigating greenhouse gas emissions.

One of the most frequently used renewable energy is wind. The cost of electricity generation from wind energy and wind energy technology has become more efficient and cheaper. This makes wind power a popular and safe form of renewable energy that can be economically viable, does not produce significant environmental pollution, and can contribute significantly to the reduction of CO_2, NO_x and SO_x (Satkin et al., 2014). According to the Intergovernmental Panel on Climate Change (IPCC), 80% of the world's energy supply could be produced by renewable energy sources by 2050 and wind energy will play a major role in electricity generation in 2050 (Sun et al., 2012). The growing priority for the

energy independence of Europe supported by EU policies, has put special emphasis on wind power instalations during the last two decades (Tsoutsos, 2015). Serbia as a country aspiring to become an EU member it must keep in mind, especially because currently there is no wind farm in Serbia.

One of the most important issues that are associated with wind farms is the selection of appropriate sites for construction. Site selection for the establishment of large wind turbines, called wind farms, like any other engineering project, requires basic information and careful planning (Azizi et al., 2014). Various economical, ecological, and planning factors can enormously reduce the worth of a site for wind turbine installation (Shaheen and Khan, 2015). Selection of wind power plant site is discussed in many papers and different method is used planning (Azizi et al., 2014; Gorsevski et al., 2013; Atici et al., 2015).

In this paper, for the evaluation and prioritization of a wind farm sites is used Analytic hierarchy process (AHP). AHP is an MCDM (Multiple Criteria Decision Making) method which is successfully used for solving multi criteria decision problems in many areas. MCDM methods have been widely used in RE projects in areas such as wind farm projects, geothermal projects, hydro-site selection, etc (San Cristobal, 2011). It can provide a technical-scientific decision-making support tool that is able to justify its choices clearly and consistently in the renewable energy sector (Cavallaro, 2010).

2 Power sector of Serbia – current status and potential

The main company engaged in the production and distribution of electricity in Serbia is „Elektroprivreda Srbije" (EPS). It is a public company whose main task is fully meeting the needs of economy and citizens with electricity (Stojcetovic et al., 2014). Production capacities of EPS are given in tab. 1.

Table 1. The capacity of EPS for the production of electricity

Facility	Net output Capacity MW	Percentage
Thermal Power	3.936	55.25%
Hydropower plant	2.835	39.79%
Thermal Power - heating plant	353	4.96%
Total	7.124	100%

Electricity production in Serbia mostly relies on thermal power plants that use coal (lignite). Large hydropower plants also play a major role in the production capacity and the share of Thermal Power-heating plant is negligible. As in fig. 1 can be seen the production of electricity from 2011 to 2014 in constant decline, which could endanger the country's energy security.

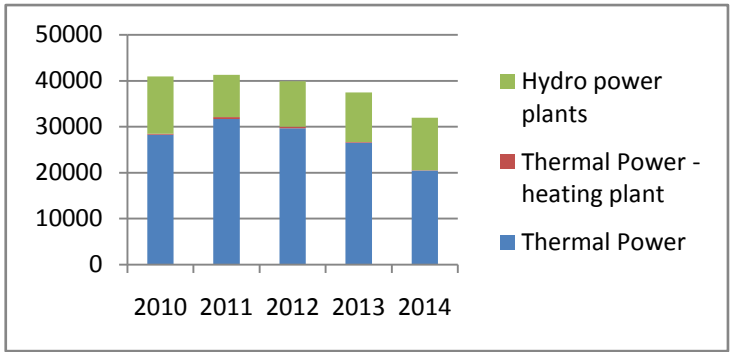

Figure 1. EPS production of electricity over the past five years (EPS technical reports 2010-2014)

2.1 Renewable energy in Serbia - current status and potential

Total technically available potential of renewable energy sources in Serbia is estimated at 5.65 million toe per year. From this potential is already used 1.054 million toe of biomass (mostly as firewood) and 909 thousand toe hydropower (EDSRS[11]).

Table 2. Overview technically exploitable potential of RES (since 2012) [16]

RES	Available technical potential that is used (million toe / yr)	Unused available technical potential (million toe/year)	Total available technical potential (million toe/ year
Biomass	1,054	2,394	3,448
Hydro power	0,909	0,770	1,679
Wind energy	≈0	0,103	0,103
Solar energy	≈0	0,240	0,240
Geothermal energy	≈0	0,1	0,180
Total	1,968	3,682	5,65

The Republic of Serbia has defined a National Action Plan for Renewable Energy as a framework for the promotion of energy produced from renewable sources and has set mandatory national targets for the share of energy from RES in gross final energy consumption (27%) as well as the participation of renewable energy in transport (10%) by 2020 (EDSRS). In order to achieve a defined objective it is necessary to install additional renewable energy facilities whose capacities are represented on fig. 2.

[11] Energy development strategy of Republic Serbia until 2025 with projections to 2030, Government of Republic of Serbia

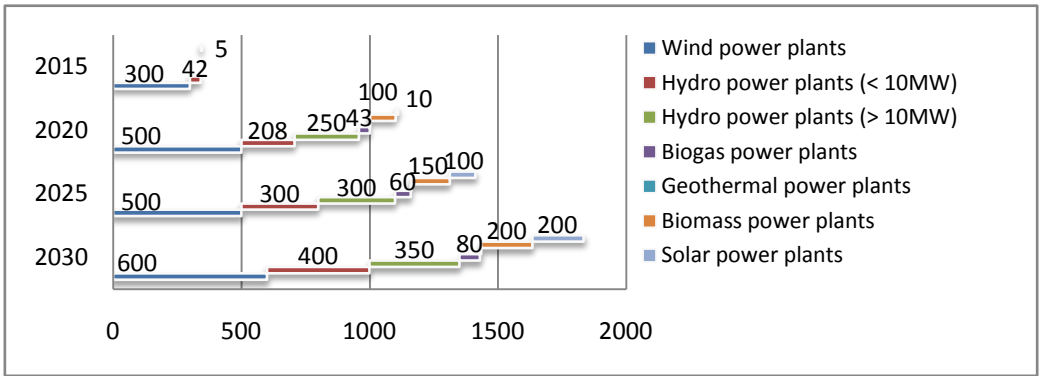

Figure 2. The capacity building projection for the production of electricity using renewable energy sources (up to 2020) (EDSRS)

2.1.1 The potential of wind energy in Serbia

In Serbia, there are currently no facilities for the production of electricity using wind energy, although there are areas with relatively favorable conditions for the exploitation of wind power for energy purposes.

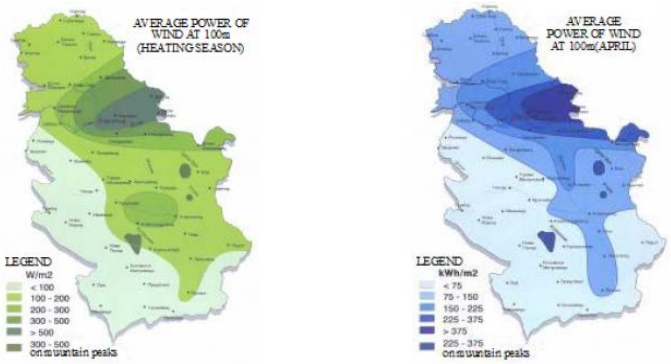

Figure 3. Average power of wind in heating season and in april (at altitude of 100m)

Suitable areas of Serbia for the utilization of wind energy are Southern Banat, Eastern Serbia, the east side of Kopaonik, Zlatibor area, Pester and localities of mountain passes at altitudes above 800 m.

Technically exploitable wind potential is determined on the existing technical capability of the power system to take this energy. Additional assumptions in determining the potential is that the maximum variation in electricity production from wind energy will not coincide with the maximum variation of the production of electricity from solar power plants and that the maximum variation shall not exceed 90% of the total installed capacity. This means that the installed capacity possible to have 500 MW from the current size of tertiary reserve power that can be provided in thermal power plants and accumulation hydro power plant (EDSRS).

Bearing in mind the maximum production possibilities of wind turbines with this installed capacity, we can count on their maximum technically exploitable potential of 1,200 GWh / year (0,103 Mtoe / year) (EDSRS).

3 Methodology

The goal of this paper is to present a methodology for evaluation and selection a optimal wind farm site from a set of available sites. In the decision-making process AHP method and Expert Choice software have been used. The methodology consists of several steps:

1. **Defining decision making goal -** first of all is necessary to define decision making goal. The goal should be clear and realistic. The goal can be defined by decision-makers, company management or end-user of decision-making results.
2. **Alternatives defining -** alternatives represent the subject of decision making. Alternatives is defined by the decision makers or end-user of decision making results.
3. **Decision criteria defining -** When defining the criteria should be taken into consideration specificities of a particular case, literature, expert opinions and preferences of the company / end-user of the decision making result.
4. **Decision-making -** Implementation of decision making process by using some of a MCDA methods. In this case it will be applied AHP.
5. **Analysis of results and sensitivity analysis -** obtained results should be analyzed. For this purpose should carry out a sensitivity analysis to check the stability of the model. If the model is unstable, ie if there are changes in the range of alternatives when criteria priority is changed it must be re-implemented steps 3, 4 and 5. If the model is stable results of the decision making can be taken as final and to the end-user of decision making results is necessary to submit a report.

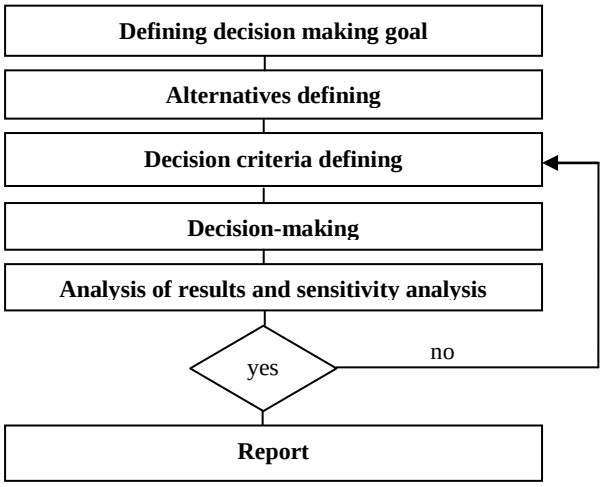

Figure 4. Decision making model

3.1 Analitical hierarchy process

AHP is a multicriteria decision making technique that can help express the general decision operation by decomposing a complicated problem into a multilevel hierarchical structure of objective, criteria and alternatives (Sharma et al., 2008). Figure 2 shows the hierarchical structure of the AHP. At

the top of the hierarchy is the goal, at the second level are selected criteria, while on the last level are alternatives. The Analytic Hierarchy Process (AHP) is developed by Saaty (1980).

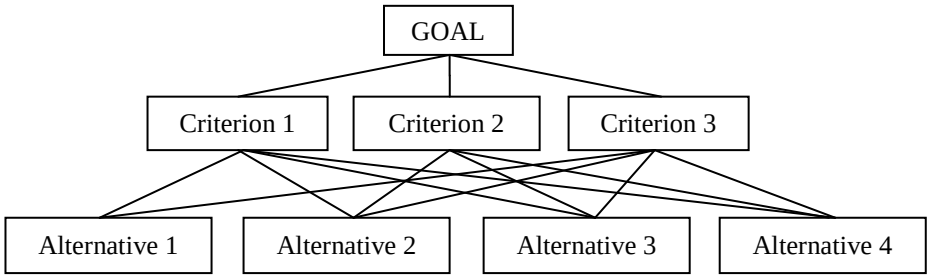

Figure 5. AHP hierarchy

Implementation of AHP implies pair wise comparison of all the elements of the hierarchy. The criteria are compared in relation to the goal to determine their mutual importance and the result of comparisons is the following matrix:

$$W = \left[w_i / w_j \right] = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \cdots & \cdots & \cdots & \cdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix}$$

where w_i is the relative weighting factor of i element. The value of the weighting factor may be obtained by summing up the rows of the matrix and by normalizing the sum:

$$\sum_{j=1}^{n} \frac{w_i}{w_j} = w_i \left(\sum_{j=1}^{n} \frac{1}{w_j} \right) \; i=1,\ldots,n \text{ (by rows)}$$

or by normalization of reciprocal values of the sum of the columns:

$$\sum_{i=1}^{n} \frac{w_i}{w_j} = \frac{1}{w_j} \left(\sum_{i=1}^{n} w_i \right) \; j=1,\ldots,n \text{ (by columns) (3)}$$

Then should be conducted the comparison of alternatives in relation to each criteria to obtain the comparison matrix A where element a_{ij} represents the ratio of the weight factor of the A_i alternative compared to the alternative A_j.

$$A = \left[a_{ij} \right] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix}$$

Evaluators express the intensity of a preference for one criterion versus another using a nine-point scale (Linkov, 2004).

Table 3 Saaty's 1–9 scale for AHP preference (Saaty, 1996)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocal of above non-zero numbers	If activity i has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

An important aspect of the AHP is the idea of consistency (Saaty, 1987). Inconsistency in AHP is checked by calculating the consistency ratio (**CR**).

$$CR = \frac{CI}{RI}$$

where CI is consistency index which is calculated according to the following relation

$$CI = \frac{\lambda_{max} - n}{n-1}$$

where $\boldsymbol{\lambda_{max}}$ is the maximum value of the matrix. If $\boldsymbol{\lambda_{max}}$ is closer to the $\boldsymbol{n}$, the smaller is inconsistency. $\boldsymbol{\lambda_{max}}$ value is calculated according to the equation

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \lambda_i$$

and RI (Random index) is index when entries of A are completely random. Its values are given in the tab. 4.

Table 4. Random index

Matrix	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0,0	0,0	0,58	0.90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,48	1,56	1,57	1,59

The general rule is that CR < 0.10 should be maintained for the matrix to be consistent. Homogeneity of factors within each group, smaller number of factors in the group, and better understanding of the decision problem would improve the consistency index (Saaty, 1993). If the CR> 0.10 is necessary to identify and remove the reasons for the inconsistency.

3.2 Study area

Kostolac basin is situated in eastern Serbia, north of Pozarevac city and south of the Danube river, occupies an approximately area of 200 km^2. There is a thermal power plant - Kostolac and important archeological site Viminacium. According to census from 2011. on the Kostolac territory there are 13,604 inhabitants (Klenovnik (1027), Kostolac (9264), Ostrovo (732), Petka (1164) and the village of Stari Kostolac (1888)).

Figure 6. The position of Kostolac basin

Kostolac has a moderate continental climate, characterized by warm summers and relatively cold winters. The average annual temperature is around 10.9 ° C, and the average amplitude of the fluctuations in temperature is 21.3 ° C. The coldest month is January with the monthly average temperature of about 0.1 ° C, and the warmest month is July with an average temperature of 21.1 ° C. The first frosts occur in mid-October, and the last in early April. Relative humidity average is around 70%.

Dominant wind direction is south-southeast and south-east, and then winds from the west and west-northwest direction. The strongest winds are from the south-southeast (27%), with average speeds values above 4m / s and from the southeast (18%) with an average speed of 3,9m / s. A minimum speeds of these winds are in June and July (about 2.5 m / s) and highest in February and March (from 5.8 to 6.1 m / s), and then in October and November (from 5.4 to 5, 5m / s).

4 The application of the methodology - case Kostolac

Step 1. Defining decision making goal- the aim is to rank potential sites and select the most suitable site for wind farm construction.

Step 2. Defining the alternatives: In this paper are considered four alternatives. All four locations are the tailings ponds from the opencast mines. Basic information about them are given in text that follows.

1. ***Alternative Drmno (A_1):*** represents the external mullock disposal site from opencast mine Drmno. Disposal site is the maximum length of about 2 km, 1.2 km in width and a height of about 50 m. The thickness of of mullock filled material is 40-50m. The nearest populated areas are]far enough away to feel the negative impact of noise.
2. ***Alternative Klenovik (A_2):*** is positioned at higher altitudes than other sites and the terrain is considerably ripple. One part represents natural terrain and partly internal and external disposal site from opencast "Klenovik". The maximum altitude is approximately 167 and the lowest is 100 meters above sea level.
3. ***Alternative Cirkovac (A_3):*** Covered with low-growing vegetation and not observed arable land. Cirkovac is the maximum length of 1.7 km, a width of 1 km and a height of about 10-40 m. The thickness of of filled material is about 10-40 m.
4. ***Alternative Petka (A_4):*** Represents mullock disposal site. Disposal site is the maximum length of 2,2km, width of 1.2 km and a height of about 60m. The thickness of filled material is from 15-18 m at the lowest layer up to 60 m at higher. Is a very successful example of land recultivation and is characterized by the voluminous vegetation (forest) and cultivated land.

Step 3 – Decision criteria defining - Site selection of a wind farm requires consideration of multiple criteria and evaluation steps to identify the best possible location and to minimize or eliminate obstacles to wind power development (e.g., visual intrusion, shadow flicker, turbine noise) (Gorsevski et al., 2013).

It is necessary to consider relevant economic, environmental, technical, demographic criteria. It is assumed that all sites meet the condition regarding the stability of the terrain, so it will not be subject to decision-making. Based on a review of literature and opinions of experts it is identified 15 criteria. However, because of the specificities of the case has been allocated 9 criteria to be used in further decision-making process. Other criteria specified in the table 5 (criteria from 10 to 15) are often found in the literature dealing with the issue of selecting appropriate sites for the construction of wind farms. Certainly they are very important and should be considered but in this paper because of its specificity they are excluded from decision-making. A detailed overview of the criteria for each alternative is shown in Table 5.

1. **Distance from settlements (C_1)** – Perhaps the most important factor in limitation of installing wind turbines in residential areas is their loud noises (Moiloa, 2009). On the other hand, from the aspect of wind farm investor it would be appropriate to be closer to the market because the delivery costs and losses would be smaller.
2. **Distance from rivers (C_2)** – Rivers are dynamic systems which can lead to floods and changes in directions which could endanger wind farm. It is desirable that distance being greater as possible.
3. **Distance from the protected natural resources (C_3)** – An environmental impact assessment for new wind farms mandates the inclusion of potential threat to local wildlife (Gorsevski et al.,

2013). Turbines may endanger birds and bats so it is important to consider whether near potential sites are certain habitats of protected and endangered species or location is on the migratory path of birds. An IBA is defined as an essential habitat that one or more avian species use during their nesting season, the winter, and/or while they are migrating.

4. **Distance from the protected cultural values (C_4)** – Wind farms should be at an adequate distance from the protected cultural values to avoid visually, shadow and noise disturbance of experience that is perceived by visiting of cultural values.
5. **Distance from road (C_5)** - It is very important that wind farm is near main roads in order to reduce transport costs to a minimum. The need to build new roads or reconstruction of existing to the desired site will greatly increase costs. Therefore, when deciding, priority should be given to sites where the need to build new roads or reconstruction of existing is minimal.
6. **The number of wind turbines that can be installed (C_6)** – From the investor standpoint number of wind turbines that can be installed in a particular site is very important because it may affect potential energy output as well as its profits. Sites where can be installed the required number of wind turbines will be certainly preferable.
7. **Wind potential (C_7)** – Annual wind speed average, wind power density and percentage of windy days are very important features for choosing a site for wind power plants (Zahedui, 2005). Any choice of wind turbine design must be based on the average wind velocity at the selected wind turbine construction site (Ucar and Balo, 2009).
8. **Noise (C_8)** - Wind turbines generate noise from mechanical and aerodynamic reasons. Mechanical noise originates from the motion of mechanical components and the dynamic response among them, aerodynamic noise comes from the flow of air around the blades. The standards relating to noise levels that are allowed vary from country to country. Noise could be reduced by better designed turbine blade geometry and by selection of proper operating conditions (Cavallaro and Ciraolo, 2005).
9. **Shadows flickering (C_9)** – Shadow flickering occurs when the sun is low on the horizon and the blades pass between the sun and an observer. It must be met several conditions that lead to shadow flickering. First, there must be a sunny day, then the observer must be close enough to the wind turbine and must be located between the wind turbines and sun. The impact of the flicker is dependent on the orientation of the tower and location of the sun. Worldwide, this phenomenon is interpreted and legally regulated in different ways.

Table 5. Decision making criteria

	Criterion	Type (min/max)	Alternative 1 Drmno	Alternative 2 Klenovik	Alternative 3 Cirkovac	Alternative 4 Petka
1.	**(C_1) Distance from settlements**	Max	1.5 km	<1 km	1 km	1.1km
2.	**(C_2) Distance from rivers**	Max	No	0.8 km	0.5	No
3.	**(C_3) Distance from the protected natural resources**	Max	No	IBA northwest and northeast	No	No
4.	**(C_4) Distance from the protected cultural values**	Max	No	540 m (monastery Rukumija)	No	No
5.	**(C_5) Distance from road (required construction or reconstruction in kilometers)**	Min	3.8	4,8	2	3
6.	**(C_6) The number of wind turbines that can be installed**	Max	7	6	3	4
7.	**(C_7) Wind potential (average annual wind speed at 50m)**	Max	5.56 (m>s)	5,71 (m>s)	No data	5.24 (m>s)
8.	**(C_8) Noise**	Min	There are no sensitive receptors of noise near the potential sites	≈ 45 dBA (above the permitted values for cultural and historical sites)	<40 dBA in accordance with EU recommendations	<40 dBA in accordance with EU recommendations
9.	**(C_9) Shadows flickering**	Min	Up to a distance 1120 meters there is not a single object	Up to a distance 1120 meters, there are 8 objects	Up to a distance 1120 meters, there are 2 objects	Up to a distance 1120 meters there is not a single object
10.	**(C_{10}) The impact on fauna**	This factor is included in the Proximity of protected natural resources criterion (C_3).				
11.	**(C_{11}) The impact on flora**	Construction is planed on the tailings ponds without particularly valuable vegetation so this criterion may be excluded from further consideration				
12.	**(C_{12}) Visual impact**	Since the potential sites are located near coal basin without valuable landscape characteristics, the construction of wind farms will not affect the quality of the landscape. Therefore, this criterion may be excluded from further consideration.				
13.	**(C_{13}) Land ownership**	All potential sites are owned by EPS so this criterion may be excluded from further consideration.				
14.	**(C_{14}) Blizina dalekovoda**	Due to the proximity of the thermal power plant there is access to transmission line to all sites and this criterion can be omitted from further consideration.				
15.	**(C_{15}) Electromagnetic interference**	Because there is no radars and transmitters this criterion may be excluded from further consideration.				

Step 4. Decision making - Before we start the process of pair wise comparison it is necessary to enter goal, criteria and alternatives in software (Expert choice). The first step is a comparison by pairs of criteria in relation to decision making goal. Criteria priorities in relation to the goal are shown in tab. 6.

Table 6. Criteria priorities in relation to the goal

	Criterion	Priority
1.	C_1	0.112
2.	C_2	0.034
3.	C_3	0.054
4.	C_4	0.044
5.	C_5	0.107
6.	C_6	0.252
7.	C_7	0.260
8.	C_8	0.079
9.	C_9	0.059
Inconsistency 0.08		

As seen from tab. 6 two factors have a distinctly higher priority compared to the other seven, they are C_7 and C_6. This means that these two criteria have a significant influence on decision making and they need to be given special attention. Then is performed comparison of alternatives in relation to the defined criteria. The comparison results are presented in tables from 7 up to 15.

Table 7. Comparison of alternatives in relation to the criterion C1

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	5	5	3	0.549
A_2		1	1/4	1/5	0.061
A_3			1	1/2	0.147
A_4				1	0.243
Inconsistency 0.08					

Table 8. Comparison of alternatives in relation to the criterion C2

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	6	7	1	0.414
A_2		1	4	1/7	0.096
A_3			1	1/8	0.043
A_4				1	0.447
Inconsistency 0.08					

Table 9. Comparison of alternatives in relation to the criterion C3

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	8	1	1	0.320
A_2		1	1/8	1/8	0.040
A_3			1	1	0.320
A_4				1	0.320
Inconsistency 0					

Table 10. Comparison of alternatives in relation to the criterion C4

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	7	1	1	0.312
A_2		1	1/8	1/8	0.042
A_3			1	1	0.323
A_4				1	0.323
Inconsistency 0					

Table 11. Comparison of alternatives in relation to the criterion C5

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	4	1/5	1/3	0.135
A_2		1	1/6	1/5	0.056
A_3			1	2	0.510
A_4				1	0.298
Inconsistency 0.06					

Table 12. Comparison of alternatives in relation to the criterion C6

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	3	6	5	0.547
A_2		1	5	4	0.285
A_3			1	1/3	0.058
A_4				1	0.110
Inconsistency 0.08					

Table 13. Comparison of alternatives in relation to the criterion C7

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	3	9	4	0.536
A_2		1	9	3	0.284
A_3			1	1/7	0.034
A_4				1	0.145
Inconsistency 0.09					

Table 14. Comparison of alternatives in relation to the criterion C8

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	7	5	5	0.621
A_2		1	1/5	1/5	0.048
A_3			1	1	0.165
A_4				1	0.165
Inconsistency 0.08					

Table 15. Comparison of alternatives in relation to the criterion C9

Altern.	A_1	A_2	A_3	A_4	Alternatives priority
A_1	1	5	3	1	0.370
A_2		1	1/3	1/5	0.066
A_3			1	1/5	0.131
A_4				1	0.434
Inconsistency 0.08					

After conducting AHP method results are obtained. According to results first ranked alternative is Drmno (A1), the second-ranked Petka (A4), third is Klenovik (A2), while the last place takes Cirkovac (A3).

Table 16. Final rank of alternatives

	Alternative	**Priority**	**Rank**
1.	A_1	0.454	1
2.	A_2	0.164	3
3.	A_3	0.160	4
4.	A_4	0.222	2
Inconsistency 0.07			

Step 5. Analysis of results and sensitivity analysis - Sensitivity analysis is to be performed after obtaining decision making results to confirm how change of weight factor criteria influences alternatives rank. The sensitivity analysis included three criteria which have the highest priority because it is assumed that they will have the most significant impact on the result of the decision. These are the C7, C6 and C1. In this paper will be considered minimal changes of these criteria that lead to changes in the ranking of alternatives.

Table 17. Sensitivity analysis

Criterion	Referent value of the criterion	minimal change + or -	Alternatives rank obtained by decision making	Alternatives rank after minimal changes
C_7	0.260	- 0.088	A_1- A_4 - A_2 - A_3	A_1- A_4 – A_3 – A_2
C_6	0.252	- 0.095		A_1- A_4 – A_3 – A_2
C_1	0.112	+ 0.211		A_1- A_4 – A_3 – A_2

Scenario 1 - Reducing the priority of C_7 criteria for 0.088 there is a change in the ranking of alternatives. The first and second place remain the same, A1 and A4, but A2 falling to fourth place and the A3 moves to third.

Scenario 2 - If the priority of C_6 criteria would be reduced for 0,095 will also be a change, in the range of alternatives but only between alternatives A2 which will fall to fourth place and A3 which will take the third place. Rank of A1 and A4 alternatives will remain unchanged compared to the results of decision-making.

Scenario 3 - Increasing the priority of C_1 criterion for 0.211 leads to same changes as in the previous two cases. Alternative A2 falls to fourth place while the alternative A3 take third. Changes in the ranking of alternatives A1 and A4 do not occur.

Based on the analysis of sensitivity can be concluded that the model is stable and that changes in the rank of the first-ranked and second-ranked alternatives do not come in any case.

5 Conclusion

Renewable energy sources are gaining more and more important role in the energy sector of each country. Wind farms are due to cheaper and more efficient technologies on the way to be the most represented RES.

One of the most important step in the development of the wind farm project is the selection of adequate site. Wind farm site selection includes numerous criteria, stakeholders and restrictions which requires an adequate approach to the process of selecting the right location.

This paper present an application of a AHP based multi-criteria approach for evaluation and selection optimal wind farm site. According to the results of decision making in this paper, the following alternative rank has been obtained Drmno > Petka > Klenovik > Cirkovac. In order to check the stability of the proposed model sensitivity analysis was conducted for criteria with the highest priority. Sensitivity analysis shows that a change in ranking of first-ranked and second-ranked alternatives do not come in any case, so the results of decision-making can be assessed as reliable.

Future papers should check the applicability of the proposed model and also check the results using different MCDM methods.

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SIGNIFICANCE OF CORPORATE SOCIAL RESPONSIBILITY AND ITS MOST IMPORTANT DIMENSIONS

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***Abstract*:** A large number of successful companies in the world have for many years applies the concept of social responsibility. Corporate social responsibility (CSR) is a commitment of the company to contribute to the sustainability of economic development working with employees, their families, local communities and society in general in order to improve their quality of life and preservation of the entire community for future generations. This way of doing business, many companies in Serbia are still considered as activities that require investment of funds not made a profit. In order to analyze the current situation and application of the concept of CSR in the Serbian companies in this paper a questionnaire that includes a review of the five most important dimension of CSR: social, economic, environmental, dimension stakeholders and volunteerism.

Keywords: Corporate Social Responsibility, dimensions of CSR, the questionnaire

1 Introduction

Corporate Social Responsibility is of great importance for all companies which hold trust as one of the key factors of doing business. It has become an inseparable part of the sustainability strategy of successful companies in the market, a holder of business decisions and reputation. Great attention has been paid to this concept of a modern organization. The goal of corporate social responsibility is taking responsibility for the actions of the company as well as encouraging positive influence through its activities related to the environment, society, economy and stakeholders.

The European Union Commission (2002), in the book by the author Dalsrud [1], proposes the following general definition: „Corporate social responsibility concerns the responsibilities of the company and taking measures within the company that go beyond its legal obligations and the economic / business goals. These broader responsibilities include the range of issues, but they are usually summarized as a social and those concerning environmental protection - Social relates to the society as a whole, not just to social issues. This can be called as the approach with three main lines: i.e. economic, social and environmental".

Corporate social responsibility in the academic context appeared back in the 50s. However, a number of definitions that showed up indicate that there is no agreement on how this term should be defined. This had led to a long debate since the mid-twentieth century [2]. A change in terminology occurred (1953) when Bowen wrote the book „Social Responsibilities of the Businessman". Until then, the term social responsibility in business has been used, and since then corporate social responsibility has been used. After that, the term significantly became popular and more and more companies tended to adapt their business to this modern concept. As a result, there are a number of terminologies and

different approaches to defining this concept, like, society and business, social issues management, stakeholders' management, corporate responsibility. These are just some of the terms used to describe phenomena related to CSR as it is most commonly used in business today [3]. The main reason is the lack of consensus in the process of generalizing different interpretations among groups, sectors and stakeholders; and also because of the constant evolution of this concept which occurs due to the combination of different approaches [4]. The lack of a clearly defined concept of social responsibility makes it difficult for companies to define the most effective program for its implementation as well as what the public actually expects from an organization through responsible business.

According to the data of the World Commission for Environment and Development, sustainable development means meeting the current needs of the people without endangering the possibilities of the future generations to achieve the same (WCED, 1987)[12], which is just one of the objectives to be achieved by carrying out activities in a responsible manner. Sustainable management enables organizations to implement strategies which take care of the importance of society at the local, regional or global level [5]. Like sustainable development, the concept of corporate social responsibility, together with the influence of internal and external stakeholders is older than it looks, but it gained popularity after the 80s of the last century [6]. Unlike neoclassical economists, who led companies as closed systems aimed only to its shareholders, after the eighties business -social relation opened up towards the business world in the region. In the opinion of old people, if you earn money, you can do positive things for society and the environment, but the real philosophy of sustainability is based on interdependence. If you are doing the right things for the benefit of the community, the community will equally reward you for your effort.

In the 90s the sudden development of conceptual frameworks and models of corporate social responsibility began, as well as international acceptance of corporate social responsibility [7]. Generally accepted theoretical framework of social responsibility does not exist yet.

In the transition from ideology to reality, this concept has also been significantly contributed to by the management of literature, where this phenomenon has been defined and characterized. Besides, the development of a number of discussions on the best international practices and their impact on the reputation of the companies and their financial effects also had a great share in popularizing this concept [8]. Especially those companies which work in the global marketplace, are focused on increasing the value of interested parties (stakeholders) and they must coordinate their social, environmental and economic elements in order to achieve competitiveness in the market.

According to Frederick (1994) CSR is based on the fact that the organization has an obligation to work intensively on improving the social prosperity [9]. Moreover, by presenting its values and principles, companies can build trust with their target clients [10]. Companies regardless of their size need to understand that they are facing with the new global reality, where they have to think about ecology and society, taking the economic aspect into account as well. Beside the responsible attitude towards consumers, this concept leads to brand improvement [11]. The Green Paper of the European Commission (July 2001) defines Corporate Social Responsibility (CSR) as - a concept where companies

[12] WCED - World Commission for the Environment and Development. (1987). Our Common Future, Oxford, Oxford University Press

integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.

Studies that explore this concept in multinational corporations are of great importance, given the huge social and environmental influence they have in many countries [11]. However, the development of CSR in these companies has particularly varied in developing countries. In recent years, this is an extremely present in terms of benefits and harms which are visible as a result of the process of internationalization of developing countries [12]. An important segment of CSR, which considerable attention has been paid to, is an annual report of the company [13].

The contribution of this paper is based on a theoretical level research on CSR in Southeastern Europe. Numerous studies have been conducted so far on this topic around the world, but in this part of Europe few studies have been carried out regarding its scientific contribution. By bringing together the relevant facts this paper includes a questionnaire which was created as a result of the Resita Network[13] teamwork, hired in the international project by the DAAD Foundation for the analysis of this topic. Based on the defined questionnaire, an examination will be carried out on the territory of Serbia, Germany, Bulgaria, Albania, Romania and Macedonia. By reviewing the relevant literature, this questionnaire covered five main dimensions of corporate social responsibility which are mentioned in leading scientific journals: social, economic and environmental dimensions, as well as two more dimensions often mentioned in the recent literature: stakeholders dimension and volunteerism. Another important contribution of this study is based on an analysis of the structure of historical findings to date. The theoretical approach used in this study is presented below.

2 The Concept of Corporate Social Responsibility in Serbia

Serbia is a country in transition and as such is still in the early stage of development of corporate social responsibility, unlike economically developed countries where this concept has been developed on a much higher level [14]. In developing countries such as Serbia, first steps in the development of corporate social responsibility have made big multinational investors who have developed a new management culture which involves sustainability when it comes to the labor force in developing countries. In some cases, this has forced local companies to adopt some of these practices in their business. Such a tendency has begun to develop in Serbia as well, but it is quite slow.

In 2005 Smart Kolektiv conducted a study that was the first major study on corporate social responsibility in our country, which covered the most important aspects of this concept.

By following modern business trends, there was a need for companies in Serbia to come out again with their activities related to corporate social responsibility, the understanding and the importance of this concept, due to the popularity of this concept in the world. The analysis of the obtained results one can get a clear picture on the application of this concept and thus make a comparative analysis of the results obtained in Serbia, as well as a comparison of the current situation of this concept in the countries of South Eastern Europe, resulting in a clearer picture of this concept and the level of its presence.

[13] http://www.resitanet.eu/index.php?id=2

With the launch of this issue, it is obvious that there is an awareness of corporate social responsibility in Serbia, but many companies still do not realize the long term benefits of socially responsible behavior, while smaller entrepreneurs consider they do not have either sufficient resources or knowledge they need to engage in the implementation of different strategies which would help them achieve the objectives of corporate social responsibility. The public is not well informed about the values of corporate social responsibility and consumer awareness is still underdeveloped in Serbia. If clients do not put pressure on companies to adopt sustainable practices in their operations, the companies will have less economic motive to plan their long-term strategy of social responsibility.

3. The Dimensions of Corporate Social Responsibility

According to the analysis of the content of current definitions of CSR what most authors adopted are the three dimensions of corporate social responsibility [15], and those are: environmental, social and economic dimensions. When it comes to the environmental dimension the companies should strive to develop its business in an environmentally sustainable manner. The social dimension refers to the relation between the company and society, where the company needs to consider both the social problems in its daily business and what kind of effects it has on the entire community. The economic dimension aims to improve the profitability of the company. Regarding these dimensions, numerous controversies appeared concerning their relevant priorities and how are they related to each other in terms of integration, communication and synergy between the goals achieved[14]. Today, development and implementation of social responsibility is strategically necessary for the public good for a company. The programs of corporate social responsibility initiate and undertake activities which are desirable for society and in accordance with social values and goals [16]. Just some of the benefits that can thus be accomplished are: creating and maintaining a positive opinion on the company; strengthening the relation with stakeholders; creating a better, safer and more stimulating working environment; improving the efficiency of business management; facilitating access to financing. On the basis of these three basic dimensions during the expansion of this concept, emerged two important dimensions, too: Stakeholders dimension and volunteering (volunteering dimension) [1]. With stakeholders dimension companies need to improve their interaction with their employees, suppliers, clients and the community in which they operate. And when it comes to volunteering, this dimension refers to the activities of companies which are not legally foreseen, but which are based on companies' ethical values and their voluntary moves.

3.1 The Economic Dimension

It takes an important place in the analysis of the business environment of companies both from the standpoint of the entrepreneur and the consumer. Fostering of this dimension in the company enables strengthening of the financial results, through the support of their business strategy, which also affects

[14] http://www.eoearth.org/view/article/

the increase of their competitive advantage [17]. In the survey conducted by Gonzalez-Rodriguez et al., in 2015, economic dimension includes following items: achieving maximum profits, meeting the expectations of shareholding, being a leader in the market, guaranteeing the satisfaction and loyalty of consumers, promoting of their products / services through expensive advertising campaigns.

3.2 The Environmental Dimension

This dimension focuses on policy and environmental protection activities. In numerous literature prevails the examining the influence of business operations on the environment [18, 19]. Such research mainly goes in two directions: it examines which factors of company business have an influence on the environment [20, 21] and how this influence on the environment can lead to improved financial performance of companies [20, 22]. A great number of studies focus on the impact of organizational performances on the environment in accordance with international standards on environmental protection ISO 14001 [23], by avoiding contamination of water, soil and air [24], by reducing energy and resource consumption. Due to intensifying market competition and globalization, many companies are faced with a green barrier, and gained ISO 14001 certification which meets customer requirements in terms of environmental protection [25]. Gonzalez-Rodriguez et al., 2015 find that within this dimension of corporate social responsibility the following influences can be examined: reducing the waste of resources, compliance with the ethics code, publishing the annual report on the influence on the environment, the protection of limited natural resources and biodiversity, care of usage of sustainable natural resources, reducing the emission of toxic and contaminated products, promoting recycling.

3.3 The Social Dimension

Gonzalez-Rodriguez et al., 2015, by examining the influence of social dimension on corporate social responsibility, included the following main aspects of this dimension: new job openings, respect for human rights, helping the developing countries, training employees, improving the quality of life in all regions where the company is operating, non-discrimination of gender, religion, race, co-operation with schools, universities and other institutions, sponsorship, promotion and participation in social and cultural activities, cooperation with NGOs and charitable organizations and improving the quality and safety of their products. Szczuka, 2015, presented examples of good business practices, where organizations have achieved sustainable development [26]. In the period from 2003 to 2012, the concept of social responsibility was analyzed through the analysis of the workplace, employee practice, the rights of employees and management.

3.4 The Volunteering Dimension

Volunteering is an activity which is growing fastest among the young population and among new members of the companies, which also has a certain financial influence. This dimension refers to the participation of employees who, with their arbitrary initiative, contribute to the common good of the society. This movement is particularly noticeable in Europe and North America [27] since there are

many reasons which positively influence the motivation and commitment of employees, promotes teamwork and contributes to professional development [28]. There are several renowned publications and reports of companies that propose a number of advantages of human resources who are volunteering [29]. Earlier studies have shown that workers, employed through voluntary programs, do not come immediately to the expected outcomes and that they need time to understand the importance of their influence.

3.5 The Stakeholders Dimension

The concept of stakeholders, first appeared in the literature of the 60s XX century. 70s of the last century appeared several theories about stakeholders in large companies such as General Electric, however, this approach has remained peripheral in the application by mid in 1980. Freeman (1984) has provided a coherent and systematic theory of managing stakeholders [30]. He stakeholders defined as groups or individuals which can affect to the achievement of the objectives of the organization [25]. Employers usually require respect for human rights, adequate compensation for work through the involvement of trade unions and the like. Unlike internal holder, external actors have no control over organizational resources. But they can regulate public opinion on the responsible business some organizations. These include customers, business partners, competitors, government agencies, banks, media, educational institutions, suppliers and other [25].

How much power are stakeholders to the organization's operations is a particularly topical issue in the developing countries, because in the process of building your company environment can use the "gray zone" in order to cause the power of stakeholders [24].

To be able to participate in international trade and gain a competitive edge, many Chinese companies are beginning to strategic consider bringing corporate social responsibility. On this way as one of the initial activities was the commitment of our suppliers to implement ISO14001 and SA8000 certification [25].

4 Defining the questionnaire

Interviewing is a special data collection method by which it comes to data on the attitudes and opinions of respondents. The purpose of interviewing is using the obtained results of scientific research, which leads to the measured characteristics, attitudes and behavior of people in the study of a social phenomenon.

Due to the advantages of such direct entry of data into the computer system, able to access your data in all countries and the choice of target groups of respondents in this survey will be conducted interviewing through the online survey questionnaires which is most appropriate for collecting the necessary data in six different countries in Southeast Europe. In order to examine the relationship of corporate social responsibility, according to the opinion of management, employees and consumers are defined three different questionnaires with a view from their perspective. Due to the perception of respondents in all three surveys is repeated a small number of questions relating to the most important

dimensions of corporate social responsibility, as well as questions of general knowledge of the concept of corporate social responsibility.

In attached is presents a questionnaire which relating to the examination of corporate social responsibility from the perspective of managers. The questionnaire is divided into three parts.

The first part of the question are related to knowledge of defined themes, the second part of the questionnaire includes questions which relating to five key dimensions of corporate social responsibility, and the third part of the question deals with the demographic indicators of the respondents and the organizations in which they work. The appearance of the whole questionnaire is attached.

5 Conclusion

Modern business involves monitoring new trends in management, which provides a competitive advantage in the market. All companies that have global success in their own business are socially responsible. If the company wants to contribute to the wider community where it operates, it is necessary to engage in solving certain social problems according to their ability. Contributing to the wider community of enterprises can be provided through activities which include investments in environmental protection, education of different social groups, protection of human rights, then, the construction of facilities for the needs of the community, scholarships for individuals and groups, improvement of conditions for the preservation of health.

For companies that operate socially responsible is not enough just to develop and implement specific activities, but also to spread the results achieved and promote, in order to the mission of corporate social responsibility was transparent.

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Appendix

QUESTIONNAIRE on CSR
For Managers

Dear Ms/Mr.
As an important principle about the economic system the European Union aspires to the social market economy; this economic system, maybe could require corporate social responsibility of the European citizens while acting economically.
With this questionnaire, we want to know your opinion on certain issues related to the "Corporate Social Responsibility", in general, but also thinking of concrete objectives and real (possible) activities.
This questionnaire is anonymous and the results will be used for the purpose of scientific research project.
Please circle only one answer.
Thank you for your cooperation!

Q1: The EU aspires to a social market economy (explanation of the social market economy should be provided by the questioner). Do you agree with these economic political objectives?
o 1 I agree completely
o 2 If anything I agree
o 3 neither …
o 4 If anything I disagree
o 5 I disagree completely

Q2: In your opinion, do we need a CSR in order to realize the social market economy?
1 - Yes; 2 - No

Q3: For our company CSR is
o 1 decisive
o 2 important
o 3 desirable
o 4 dispensable
o 5 unimportant

Q4: We should realize CSR in order to (Possible answers from 5 - I agree completely to 1 - I disagree completely):

Improve the awareness level of the company	**1 2 3 4 5**
Enhance the motivation and the engagement of the employees	**1 2 3 4 5**
Improve the customer loyalty	**1 2 3 4 5**
Improve the image of the company	**1 2 3 4 5**
Have better conditions to attract qualified employees	**1 2 3 4 5**

Q5: The important aspects of the CSR are: Environmental, Social, Economic, Stakeholder and Voluntariness dimension, please rate how much are you familiar with the meaning of each of those aspects.

Environmental	**1 2 3 4 5**
Social	**1 2 3 4 5**
Economic	**1 2 3 4 5**
Stakeholder	**1 2 3 4 5**
Voluntariness	**1 2 3 4 5**

Q6: If your answer for any aspects in Q5 was above 1, please rate the importance of all given aspects:

Environmental	**1 2 3 4 5**
Social	**1 2 3 4 5**
Economic	**1 2 3 4 5**
Stakeholder	**1 2 3 4 5**
Voluntariness	**1 2 3 4 5**

Q7: Please indicate if the following CSR dimensions are implemented within your company (1- No; 2- Yes).

Environmental	**1 2**
Social	**1 2**
Economic	**1 2**
Stakeholder	**1 2**
Voluntariness	**1 2**

Q8: If your answer for any aspects in Q7 was 2, please rate the extent to which your company is implementing those aspects:

Environmental	**1 2 3 4 5**
Social	**1 2 3 4 5**
Economic	**1 2 3 4 5**
Stakeholder	**1 2 3 4 5**
Voluntariness	**1 2 3 4 5**

Q9: Please rate the influence of applied CSR activities on following business performances of your company.

Sales (long-term increase)	**1 2 3 4 5**

Profit	**1 2 3 4 5**
Public image (perceived by the customers)	**1 2 3 4 5**
Customer loyalty	**1 2 3 4 5**
Better condition to attract qualified employees	**1 2 3 4 5**
Employee loyalty	**1 2 3 4 5**
Trust (employees)	**1 2 3 4 5**
Cost reduction	**1 2 3 4 5**

Q10: Does your company have a CSR unit/dedicated person within the company's organizational structure?
1. No
2. Yes

Q11: Does your company have a CSR policy in place?
1. No
2. Yes

Q12: Does your company report publicly on CSR practices and their impact?
1. No
2. Yes

Q13. As far as you know in what types of CSR activities is your company involved:

Workforce development activities (Listening to and engaging employees, combating harassment and bullying, skills development...):	**1 2 3 4 5**
Workforce stimulation activities (creative activities to avoid dismissals in economically critical situations, for example reduced working hours)	**1 2 3 4 5**
Stimulating sustainable local economy and community activities (supporting local events, invest in the development of the municipal sector, charity, partnerships for social investment, philanthropy, volunteering)	**1 2 3 4 5**
Stakeholder engagement in decision making (Actively engaging employees, customers, suppliers and the community):	**1 2 3 4 5**
Measures to protect the environment	**1 2 3 4 5**

Q14. Please, rate the following statements.

<u>Environmental Dimension of CSR (present situation in your company):</u>

ENV1	We are able to minimize our environmental impact using environmentally - friendly products.	**1 2 3 4 5**
ENV2	We make investments in energy savings programs.	**1 2 3 4 5**

ENV3	We adopt programs for the introduction of alternative sources of energy.	**1 2 3 4 5**
ENV4	We participate in activities related to the protection and improvement of our natural environment.	**1 2 3 4 5**
ENV5	We are in favor of reductions in gas emissions and in the production of wastes, and in favor of recycling materials.	**1 2 3 4 5**
ENV6	We have a positive predisposition to the use, purchase, or produce the ecological goods.	**1 2 3 4 5**
ENV7	We value the use of recyclable containers and packaging.	**1 2 3 4 5**
ENV8	We are aware of the relevance of firms' planning their investments to reduce the environmental impact that they generate.	**1 2 3 4 5**
ENV9	Please rate environmental aspect of your company in general	**1 2 3 4 5**

Social Dimension of CSR (present situation in your company):

SOC1.	We support the employment of disabled people and people at risk of social exclusion.	**1 2 3 4 5**
SOC2.	We foster training and professional development of our employees.	**1 2 3 4 5**
SOC3.	We comply with standards related to labor risks, health, safety and hygiene programs.	**1 2 3 4 5**
SOC4.	We are committed to job creation.	**1 2 3 4 5**
SOC5.	We have human resource policies aimed at facilitating the conciliation of employees' professional and personal lives.	**1 2 3 4 5**
SOC6.	We consider employees' initiatives and proposals in management decisions.	**1 2 3 4 5**
SOC7.	We are committed to the improvement of the quality of life of our employees.	**1 2 3 4 5**
SOC8.	Equal opportunities exist for all employees without any type of discrimination	**1 2 3 4 5**
SOC9.	We participate in social projects in the community (sponsorships, charities, etc.).	**1 2 3 4 5**
SOC10.	We are aware of the importance of making pension plans for our employees.	**1 2 3 4 5**
SOC11.	We are aware of the employees' quality of life.	**1 2 3 4 5**

SOC12.	We pay wages above the average in our region and/or in our industry.	**1 2 3 4 5**
SOC13	Employees' compensation is related to their skills and their results.	**1 2 3 4 5**
SOC14.	Employees' initiatives are taken seriously into account in management decisions.	**1 2 3 4 5**
ENV15	Implementation of reverse logistics	**1 2 3 4 5**
ENV16	Please rate social aspect of your company in general	**1 2 3 4 5**

Economic Dimension of CSR (present situation in your company):

EC1.	We have evidences or signs, that our customers feel confident that our company is particularly concerned to offer high quality products and/or services	**1 2 3 4 5**
EC2.	Our products and/or services satisfy national and international quality standards (i.e., ISO standards).	**1 2 3 4 5**
EC3.	We are characterized as having the best quality-to-price ratio for our products and/or services.	**1 2 3 4 5**
EC4.	The guarantee of our products and/or services is broader than the market average.	**1 2 3 4 5**
EC5.	We provide our customers with accurate and complete information about our products and/or services.	**1 2 3 4 5**
EC6.	Respect for consumer rights is a management priority for our company.	**1 2 3 4 5**
EC7.	We foster business relationships with suppliers of our same region.	**1 2 3 4 5**
EC8.	We have effective procedures for handling complaints by our customers.	**1 2 3 4 5**
EC9.	We offer clear and precise information in the labeling of our products related to our warranty obligations.	**1 2 3 4 5**
EC10.	We have a formal procedure for the interaction and dialogue with our customers, suppliers and the other stakeholders of our company.	**1 2 3 4 5**
EC11.	Social responsibility programs increase a company's costs.	**1 2 3 4 5**

Stakeholder dimension of CSR (present situation in your company):

ST1.	Company has strong relationships with distributors.	**1 2 3 4 5**

ST2.	Company is attracting and retaining the best distributors.	**1 2 3 4 5**
ST3.	Company is adding value to our distributors' businesses.	**1 2 3 4 5**
ST4.	Company is providing high levels of service support to distributors.	**1 2 3 4 5**
ST5.	Company is developing and executing advertising programs.	**1 2 3 4 5**
ST6.	We know from talking with our employees they are talking about our company with pleasure, sometimes with proudness outside of the working place talking with other people within their private neighborhood.	**1 2 3 4 5**
ST7.	Company is conducting brand image management skills and processes.	**1 2 3 4 5**
ST8.	Social responsibility makes it difficult for the company to better serve the customers.	**1 2 3 4 5**
ST9.	Company tries to understand our stakeholder's needs.	**1 2 3 4 5**
ST10.	Company makes use of our stakeholder's information.	**1 2 3 4 5**
ST11.	Company considers our stakeholder's requirements.	**1 2 3 4 5**
ST12.	Company serves our stakeholder's demands.	**1 2 3 4 5**
ST13.	We participate in social projects in the community.	**1 2 3 4 5**

Voluntariness dimension of CSR (present situation in your company):

VO1	Our company helps solve social problems.	**1 2 3 4 5**
VO2	Our company has a strong sense of corporate social responsibility.	**1 2 3 4 5**
VO3	Our company gives adequate contributions to local communities.	**1 2 3 4 5**
VO4	Our company allocates some of their resources to philanthropic activities.	**1 2 3 4 5**
VO5	Our company plays a role in society that goes beyond the mere generation of profits.	**1 2 3 4 5**
VO6	Our company encourages its employees to participate in volunteer activities.	**1 2 3 4 5**
VO7	Our company organizes ethics training programs for its employees.	**1 2 3 4 5**
VO8	Our company encourages employees to participate in volunteer activities or in collaboration with NGOs	**1 2 3 4 5**

Q15: Barriers/obstacles that your company encountered for behaving more socially responsibly (please rate from 1 to 5):

Lack of information on CSR	**1 2 3 4 5**
Lack of human resources/capacities	**1 2 3 4 5**
Lack of financial resources	**1 2 3 4 5**
Absence of state/government support	**1 2 3 4 5**
Absence of public support/pressure	**1 2 3 4 5**
Lack of know-how for implementation of CSR principles	**1 2 3 4 5**

Q16: Please rate following Performance indicators of your company in correlation to CSR:

P1.	Level of profitability.	**1 2 3 4 5**
P2.	Increase in sales.	**1 2 3 4 5**
P3.	Market share for our products and/or services.	**1 2 3 4 5**
P4.	Level of customer satisfaction and loyalty.	**1 2 3 4 5**
P5.	Satisfaction and retention of the best employees.	**1 2 3 4 5**
P6.	Market positioning, image, and reputation.	**1 2 3 4 5**
P7.	We are characterized as having the best quality-to-price ratio.	**1 2 3 4 5**
P8.	The guarantee of our products and/or services is broader than the market average.	**1 2 3 4 5**

Q17: Please rate following Competitive success indicators of your company in correlation to CSR:

C1.	Quality in our human resource management.	**1 2 3 4 5**
C2.	The levels of training and empowerment of our personnel.	**1 2 3 4 5**
C3.	The leadership capabilities of our managers.	**1 2 3 4 5**
C4.	Our capabilities in the field of marketing.	**1 2 3 4 5**
C5.	Quality of our products and services.	**1 2 3 4 5**
C6.	The levels of organizational and administrative management quality.	**1 2 3 4 5**
C7.	Technological resources and information systems.	**1 2 3 4 5**
C8.	Transparency of our financial management.	**1 2 3 4 5**
C9.	The cohesion of our corporate values and culture.	**1 2 3 4 5**

C10. Market knowledge, know-how, and accumulated experience. **1 2 3 4 5**

Please provide us with following Demographics:

Respondent:

I. Age _____ years.

II. Gender:

1) Male

2) Female

III. Level of education

1) High school diploma and under diploma

2) Diploma of vocational education

3) BSc

4) MSc

5) PhD

6) Other (please specify)

IV. Position in the company _____

V. Years of work experience _____

Company:

I. Firm age (years since incorporation):

1) 0-5,

2) 6-10,

3) 11-15,

4) 16-20,

5) 21-50,

6) >50.

II. Firm size (number of employees):

a) Current firm size

1) 4-10,

2) 11-50,

3) 51-100,

4) 101-250,

5) 251-500,

6) 501-1000,

7) >1000.

b) Development of the number of employees

- In the past
  - 1. Increasing
  - 2. Decreasing
- Expected in the future
  - 1. Increasing
  - 2. Decreasing

c) If possible, please, indicate the number of new employed personnel within

- the last year _____

- the last two years _____
- the last five years _____

III. Industry:

1) Chemical industry,
2) Electronics,
3) Engineering,
4) Infrastructure,
5) IT/media,
6) Professional services,
7) Retail,
8) Other - please specify _____

AN ALTERNATIVE, ENVIRONMENT FRIENDLY WAY OF OPERATION OF THE COPPERMINE IN BOR

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***Abstract*:** In 1980 an open-pit mine opened in Bor, Serbia. The mining culture that has been formed in the past 36 years supports both Bor's and its surrounding's economy. New mining regulations have set a quota on the amount of pollutants emitted. Mines that fail to stay in line with these rules are sanctioned. Restricting the operations or closing the mine in Bor would stop the region's development. In order to avoid this and its further negative effects on the local economy and society one needs innovation. This research investigates a possible technological development where diesel-powered machinery would be replaced by hybrids. This means the implementation of a ropeway to supply and store power used and produced by the machines. The lake near the mine could host a hydroelectric power station and provide clean energy to power machines working in the mine. In the first section of the study the current status of the mine and materials mined there are introduced shortly. In the second section I investigate the hypothesis; 1, whether the hybrid machinery could help meet the new legislations; 2, whether machines used in the mine currently are suitable for to be hybrids and describe how to build the upper rope way. In the third section the costs of the investment are calculated, machinery required for optimal operation is presented. As a conclusion the paper argues that the water plant is sufficient to support the mine with clean energy.

Keywords: mine, machinery, economy, hybrid, Serbia

1. Introduction

Within the territory of Serbia Europe's largest open pit copper mine can be foundin Bor. For 113 years now, since the mine has been active, unemployment has never increased in the environs of Bor. The possibilities ensured by the mine are not only favourable for the workers engaged in the mine operation but have also given an impetus to the services. The town is settled close to the mines and has been increasing since its existence. Attributably to the socialist Yugoslavia, the settlement has grown into a centre for mining and metallurgy. The town's population showed increasing tendency from 1975 to 2002.

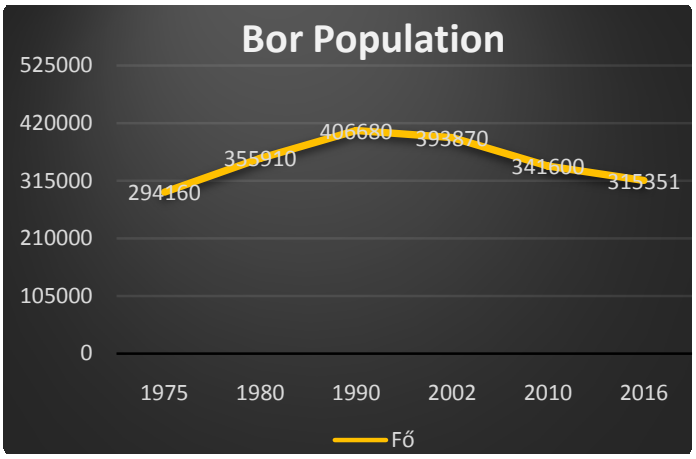

Figure 1. Developmentof the population of Bor between 1975 and 2016 (17.09.2016), source: Statistical Office of Serbia. Retrieved 28-11-2016.[1]

Decline in the population can be attributed to the decrease in the copper price on the world market, the obsolete technology and the privatisation started in 2009. Owing to sanctions imposed on mining output, the decline in the mine's operation has intensified. External impacts may result in the closing or partial idling of the mine. My research seeks for a solution that could make Bor's copper mine the first environment-conscious open pit mine in operation in Europe. If there is no production output, the relevant quotes could be sold and the revenues stemming therefrom could be used for making copper metallurgy environment conscious. My target is that through the concomitant commissioning of the Trolley technology and ahydroelectric power station, the shutdown of the mine and the metallurgy could be avoided.

In the territory of the mine the primary raw material is copper and the secondary raw materials are minerals with modest copper content. All raw materials mined from here are processed in the foundries located in the vicinity of the mine, in order to decrease costs.

During the last 100 years the quantity of raw materials within the territory of the mine of Bor could be stated: 650 Mt of mineable raw material of which 750,000 tons is pure copper. Currently the size of the mine's development area is 1.22 million square meter, its entire area is 2.84 million square meter.[2]

Other raw materials can be found in the mine are processed just like copper. An important point is that in line with the ongoing improvements, all sorts of raw materials are taken into consideration. Practically, the profit earned on the upper layers could cover the costs of the lower layers. Lignite as a raw material plays an important role in energy and heat production. From the aspect of energy production lignite can assist in the running of a new production technology, meanwhile, due to its high caloric value (29 MJ) can contribute to the energy supply of the settlement by participating in distant heating. Copper as the primary raw material of the mining in Bor can be found here in a quantity of 750,000 tons. 1 ton ore contains 1.2% copper.

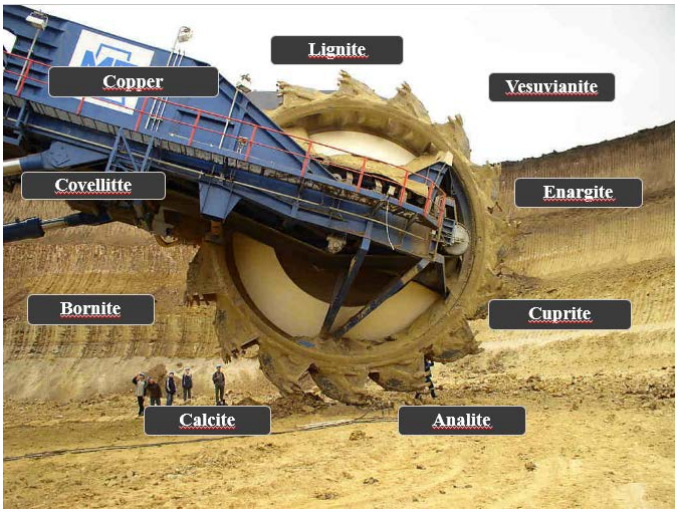

Figure 2. Bor mine product (17.09.2016), source: Mining and Metallurgy Engineering Bor br.2 2016.[3]

2 Trolley Technology

The technology we propose to develop the mine with is a well-tested one. It is used in Australia for quarrying.[4] It was designed to minimize pollutant emission, since the dumpers working in the quarries tend to emit a lot of CO. The ozone layer above Australia is weak as it is. They had the idea to build an aerial catenary along slopes. The advantage of this construction is that while the dumper climb the slope they use electricity from the grid while going downhill they feed some back to the system. It is also beneficial for the machines since it spares them structurally It is generally used for dumpers, because they are constantly on the move. Their looks and engineering change, but they fulfill their functions all the same.

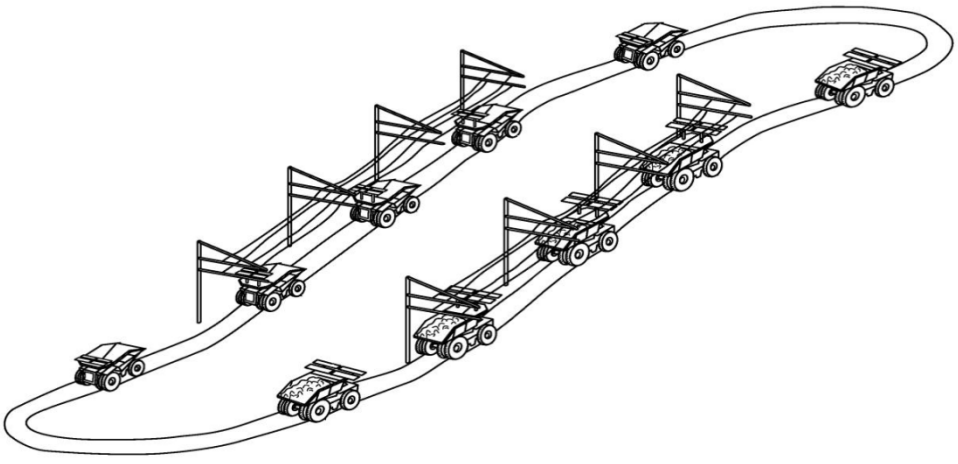

Figure 3. Trolley-assisstline (2015.04.07.), TROLLEY ASSIST TO OPTIMISE HAULING CYCLES WITH ELECTRIC TRUCKS ByVicente E. AlvaradoPlanning and DevelopmentEngineerGrootegelukCoalMine[5]

The investment has high costs, but would be returned soon. The electrical grid costs 2-2.5 million dollars per kilometer, meaning roughly 700,000,000 HUF. The grid, as seen on the picture, is disjointed, it has continuous sections only every few hundred metres. With this technology they could minimize pollution and the mining would be more economical.

All the dumpers operating in mining could be retrofitted with this technology. Only the gears, the engine and the breaking system need to be changed. For additional costs it is possible to buy machinery already built this way. Refurbishing could cost 50,000,000 HUF for each vehicle. But first we should have a look at how the system works and why it makes more sense to chose it. As seen in the table it has more advantages than disadvantages. A mine with a moderate size felt could save more than 10 million lire of gas each year.

Advantages: -higher performance (even 250 % upgrade) -environment friendly operation 40-50 litre less gas used every hour decrease of 16,000 tons of CO per year.

The copper mine of Bor needs a little less than 40 kilometer of the aerial catenary system. In order to return the costs it needs to be built in a disjointed way. Bigger Australian mines built natural gas-fired gas turbine power plants to further decrease the costs. [6]

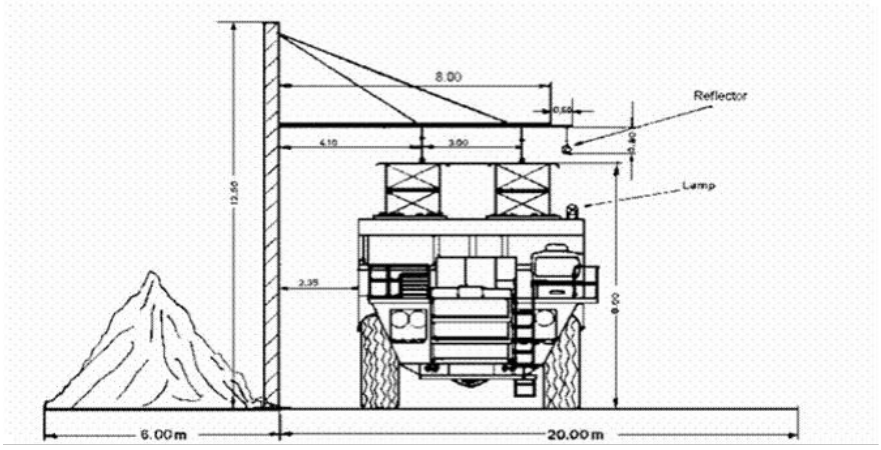

Figure 4. Trolley-assisst(2016.09.19.), TruckTrolley System by Albrecht Brodkorb[7]

However there is a big advantage that most people would not consider. In the context of crossing technologies and being environmental friendly one could find a way to produce electricity in an eco-friendly way as well.

Figure 5. Caterpillar 797B & Komatsu 860 Trolley technology dumptruck (2015.04.07.), https://www.pinterest.com/harleyman2006/heavy-equipment/,http://techstory.blog.hu/2013/09/12/komatsu_860e-1k-t_dumptruck[8]

The picture shows the Caterpillar 797B, a rigid two-axle, ultra-class machine. Its maximum capacity is 363 tonnes. Among mining machines this puts it in the upper mid-category. Gross weight when running at full capacity is nearly 700 tonnes. What makes it special is its ability to reach 62km / h when it's fully-loaded. However, regarding the Bor mine project, it is more important that it is compatible with the "Trolley-Assist" technology. It is possible to ask for a retrofitted machine with the technology already built-in, it typically costs 45-50 million HUF in addition to its base cost. It is usually between 1 and 1.5 billion HUF. Compared to this price the extra cost is very insignificant, especially considering that it could save 50 liters of gas per hour. These vehicles could operate 20 hours a day.

A Caterpillar 797B uses on average 360 liters of fuel per hour, which is costs on average 42,519 din. Using the Siemens Trolley technology a dumper requires only 45 liters / hour, which translates to 5.314 din. It means roughly 80% reduction in fuel consumption. Moreover using gas its maximum velocity is 8km / h, whereas electric powered machines can do 24 km / h, hence the transport and production rates are increased three-fold. That is a 350,000 HUF saved daily per machine, which, in the case of enterprises with not 10, but 100 dumpers, is quite significant. Not only fuel consumption but pollutant emission is reduced. Note that that the machine power acts directly next to the wheels. The electric motor works both during breaking and acceleration.The electrical grid plays a role not only in the case of dumpers but also excavating machinery. It is not necessarily to use hydraulic excavators, mechanical ones could work as well. These can be fully powered by electricity, like P & H 4100C.

Figure 6. Komatsu PC 3000 Shovel excavator in Bor Copper Mine (2015.04.14.),http://hu.123rf.com/stock-photo/large_excavator.html[9]

3 Methodology

In the interest of understanding the problem, first of all I examined the operation of the technology itself and whether or not could the mining machinery be replaced; furthermore I presented the relevant costs and benefits. Afterwards I examine the costs and opportunities associated with the operation of a hydroelectric power station, as well as the costs of the energy produced, based on data taken in a hydroelectric power station operated in the Netherlands, and made available for me. From the investment perspective not only the costs of the erection of a trolley course and those of the alteration of the machinery are the most important but also the cost of the construction of a hydroelectric power station and its energy production that are decisive regarding the size of the course and the cost reduction possibilities.

Hydroelectric power station

The waters flowing down the mountains ensure continuous supply for Lake Branathat is located at a distance of 12.6 km from Bor thus energy transportation could not represent any particular problem.[10]

Importantly the number of machines engaged in the development should be taken into consideration and their total energy consumption should be considered from the capacity aspect. In the interest of running the mine at 100% and ensure continuous exploitation, 80 mine dump trucks and 40 excavators are needed. Their total annual energy consumption is (120*1930kW+60*1800kW)=339,600kW/year). Now I examine the capacity from the aspect of the hydroelectric power station assuming that the height of the dam is 36.25 m, water density is 0.999 kg/m3, turbine efficiency is 90% and the volume of water flowing through is 30m3/s.

$P = \eta \rho gHQ$

P=90*0.999*9.81*36.25*30=959,193 kW

959,193 kW > 339,600 kW

where:

- P = power (J/s or W,kW)
- η = turbine efficiency (approx.: 76.5% or more; the degree of mechanical efficiency of modern large hydro turbines exceeds 90%.)
- ρ = water density (kg/m^3)
- g = gravity (9.81 m/s^2)
- H = height (m).
- Q = flowing volume (m^3/s)

The electric power produced at Brana is sufficient for running the machinery operated in the mine. An important aspect, however, is that if the hydroelectric power station is in operation, the water level of the river flowing towards Bor will increase and that endangers the mine. In view of this, two solutions should be contemplated. One would be the reversal of the water to the lake; the other would be the redirecting the river. In the case of pumping water back, pumps could not be operated without

additional energy supply thus the method of applying Fludd pumps could be a solution. The cost of installation of a hydroelectric power station would total EUR 1,000,000 however the energy produced could ensure environment-conscious operation of the mine.

4 Conclusion

The research revealed that the copper mine at Bor could be made environment-conscious, i.e. production could run entirely on green energy. An important factor is, however, that the production of electricity would rely on Lake Brana located 13 km from Bor. It has been proved that the electric power output of the hydroelectric power station would be sufficient for the running of the machinery and the equipment on an annual basis. The main objective of my research was to make the copper mine at Bor the first environment conscious mine in Europe. Thus the status of the environment would not deteriorate, nature could preserve its beauty and the status of diseases would stagnate. Through my research I would like to assist mines in environment-conscious thinking and in shaping technological developments accordingly.

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THE IMPORTANCE OF INNOVATION MANAGEMENT

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Abstract: Innovation has always been an essential tool for being competitive. It is quite unequivocal that being competitive is indispensable for each and every company. Through my writing, I inspect the lack of attention on innovation management and its affects.
To study competitiveness, a research was done among companies mostly located in Hungary. The questionnaire focused on crisis and change management, innovation management, as well as on strategic management.
The aim of my thesis was to measure the extent of innovation management and the changes it has caused inside different firms. I analyzed the results of the research with different methods. International academic literature as well as basic and higher statistics have been used through the processing of the questionnaire. I could draw the conclusion with the comparison of these tools.
As a final statement to end my thesis I made general and concrete suggestions for the firms which are eager to improve.

Keywords*: competitive advantages, competitiveness, innovation management, survey*

1 Introduction

According to the experts of 30 countries, the definition of innovation has been widen. Innovation does not only incorporate the introduction of a new product/process or an improvement of an already existing one, but also means a new marketing-method and the introduction of a new organizational method.[1] Product innovation means the introduction of goods or services that are new or significantly renewed. This includes the detailed technical descriptions, the ingredients and materials, the built-in software, the user-friendly features or other functional characteristics.

Process innovation includes new methods of production or logistics. This covers all the changes in techniques and in equipment or in the software.

Marketing innovation by definition is the use of new marketing-methods which are bringing significant change in product planning or packing, as well as into the introduction of new products to the market, and even inthe advertisement of goods and pricing.

Organizational innovation means the implementation of new organizational methodologies in a firm's business practices, in the organization of work or in the external relationships.

As Peter Drucker implied in his book (The Discipline of Innovation; 1985), there is no doubt that innovation has a high importance in the competitive market [2] but the real question is how to innovate, how to manage innovation. Ages ago innovation equaled professional development. According to Schumpeter [3], capitalism has its focus on searching for possibilities and opportunities, while innovation aims to aggressively demolish the balance. Innovation comes from a new idea which differs from the ordinary solutions. This is where most people usually mix up the definition of strategy and innovation.

While strategy covers a 1-5 year period, and it is planned previously, innovation come to be in a second [4][5].However, these two elements are indispensable for owning a competitive company, these have to be treated differently. When a change appears in the economy, the firms need to have a reaction. There are 3 types of strategic reactions to all types of change. When the company adapts to the environment it is called reactive reaction. In this case the change in the environment has taken place before the reaction from the firm was carried out. In the second case the company acts before the rules appear and that is called preactive reaction. The third type is proactive reaction when the organization influences or even forms the regulations.

The last option is very common when we are innovating. During innovation, the outcome has an effect on boththe environment and the members of the competitive field.[6] We must ask ourselves why we are innovating. Might be because we would like to be the first oneto provide something new and to be the market leader of that product. In Schumpeter's study (1942) he ranks basic cases of innovation into five groups: selling the new goods or producing novel goods, introduction of new transportation practices, discovering new markets, use of new production materials, creating new market situation.

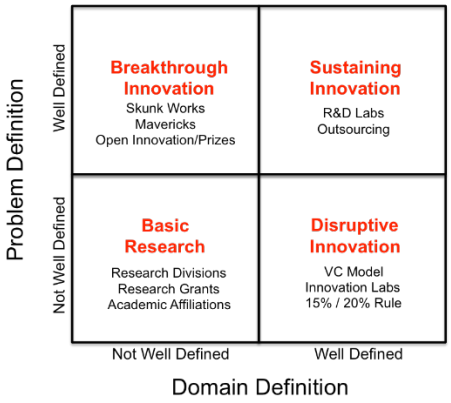

Figure 1. Innovation Matrix (Source:http://www.forbes.com/sites/gregsatell/2013/03/07/how-to-manage-innovation-2/#293c2c5533d9)

Nowadays there are different groupings of innovation, for example the innovation matrix below which differs 4 groups from each other depending on the domain definition and the problem definition. [7]

In each side we can see whether the problem or the domain is well defined or not. Part of the innovation matrix is Basic Research that gains meaning when you are about to invent something completely new to which you don't have any support, previous experience. When the domain is well defined but the problem is not, it is called disruptive innovation [8]. In this case the original manufacturer is about to upgrade its products while a new company enters the market with the same product but for a lower price. Thus the previous company gives up its originally targeted consumers, by focusing on more profitable ones. The new firm entering the market concentrates on the people/consumers with lower budget for the same product before. After a while the new company gains profit and widens its product range, focusing on the mainstream products or upgrading the previous products to acquire additional profit. In this situation the innovation for the original firm is disruptive in a way, since it lets the other company enter the market.

In the figure 2, it is easy to see how the incumbent has always had a higher product performance and focused on the most profitable costumers with the progression of time.

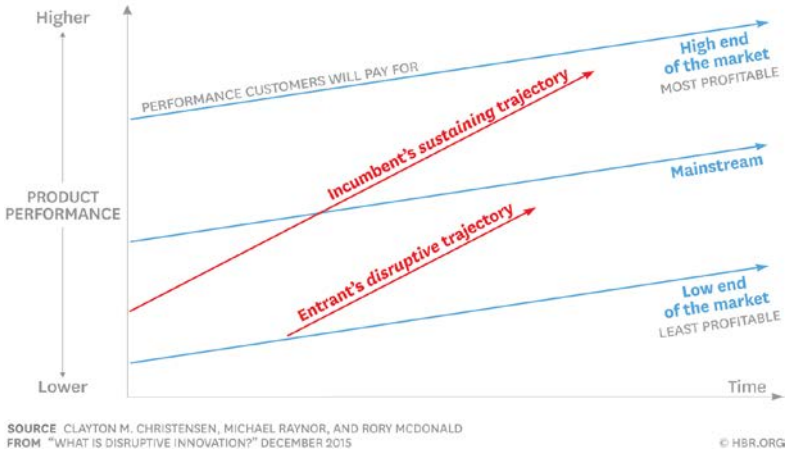

Figure 2. Disruptive Innovation

At the point where the incumbent firm serves the mainstream market, the new firm enters the market and has a disruptive trajectory.

Incumbent applies sustaining innovation which means that it is always improving and targets the high end of the market. Toyota's example is very applicable. It started to produce its first economic models then it added luxury features. Toyota still has the third biggest market share in the US.[9] Moreover in Japan it has the biggest market share.[10] Toyota improved its cars in a rapid way. They were the first in launching hybrid cars and making their cars more eco-friendly, more efficient in use. Toyota uses the well-known Japanese management behavior, Kaizen, which means continuous improvement.[11]

The last type is the breakthrough innovation where the problem is well defined but the domain is not. A good example for this kind of innovation is Procter & Gamble's innovation implementation. It created a completely new market with the help of breakthrough innovations [12].

2. Unsuccessful innovations

Having introduced some successful companies, on the other hand some bad examples can be also found. The well-known LEGO [13] Company had some struggles back in 2003. Itall started in the '90s when LEGO faced a challenging and rapidly changing market. The technology improved quickly and the themed toys gained space as well. The marketing team decided to innovate, they introduced new Harry Potter-themed toys and had an agreement with Star Wars to produce toys based on the film. The product portfolio expanded quickly, adding an amusement park, jewelry, education centers and even interactive video games. According to the forecasts, LEGO could have been the leading brand by 2005 if everything went well. The company employed plenty of marketing managers, however, it almost went bankrupt. Firstly, the toys of Harry Potter and Star Wars did not meet the expectations, hence big stocks remained unsold. The other reason why LEGO almost failed was that the marketing group made its decisions unreasonably hurriedly, not thinking enough about the consequences. They had no exact goals and just focused on more and more innovations. By managing the innovations, focusing back on its original market, from 2009 to 2012 profits have grown by 41%.

Coca Cola in 1985 had a failure with "the new coke". They introduced a new formula in taste-based on 200000 people testing it before launching the product. However, the Coca Cola Company [14] whose popularity was flagging through years expected anincrease which it eventually received, however not in a traditionalway. Receiving 1500 complaining phone calls a day, thousands of letters, Coca Cola set back its original product. Because loads of people realized the loss of their original coke, it got a big attention through that year and a boost in sales happened.

3 Fourth industrial revolution and the demographical changes

After having discussed the basic types of innovations, I would like to put the emphasis on the external environment. Our life has sped up while the life cycle of the products shortened. This caused fierce competition on the market in creativity and innovation. We must focus on the future, primarily because the Fourth Industrial Revolution [15] is at the doorstep. The Forth Industrial Revolution is going to put the emphasis on artificial intelligence and remotely controlled acts like booking a flight or ordering a cab. On the other hand, the new technological revolution can bring us some inequalities and widens the gap between those poor and wealthy within a given society.[16]This can be explained by saying that the blue-collar jobs can be done by robots while the unskilled citizens are going to remainwithout jobs. Furthermore, the talented employees are going to earn more salary and become richer and richer. This will result in a society where the intellectual and creative or innovative minds are going to have more respect and money. The changing environmentdemands relentless innovation, using the combination of platforms and mobile applications.[17]

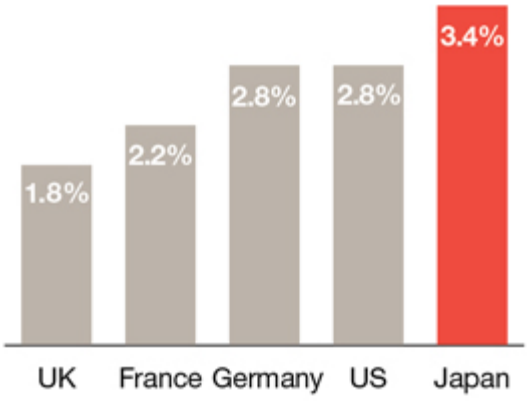

Figure 3. R&D spend as of GDP, 2010 (Source: http://www.pwc.com/gx/en/services/advisory/consulting/revitalizing-corporate-japan/embracing-innovation.html)

The [17]Japanese are pioneers in robotics, because they have monitored the demographic changes and paid enough attention to the forecasts saying that younger generations are about to stay in school for a longer period of time and not keen on doing minor tasks. Following the tendency where the workforce for traditional blue-collar job is about to decrease Japan solved the problem using artificial intelligence. [18]

In the Figure 3, we can see Japan as the forerunner of research and development according to a survey from 2010.

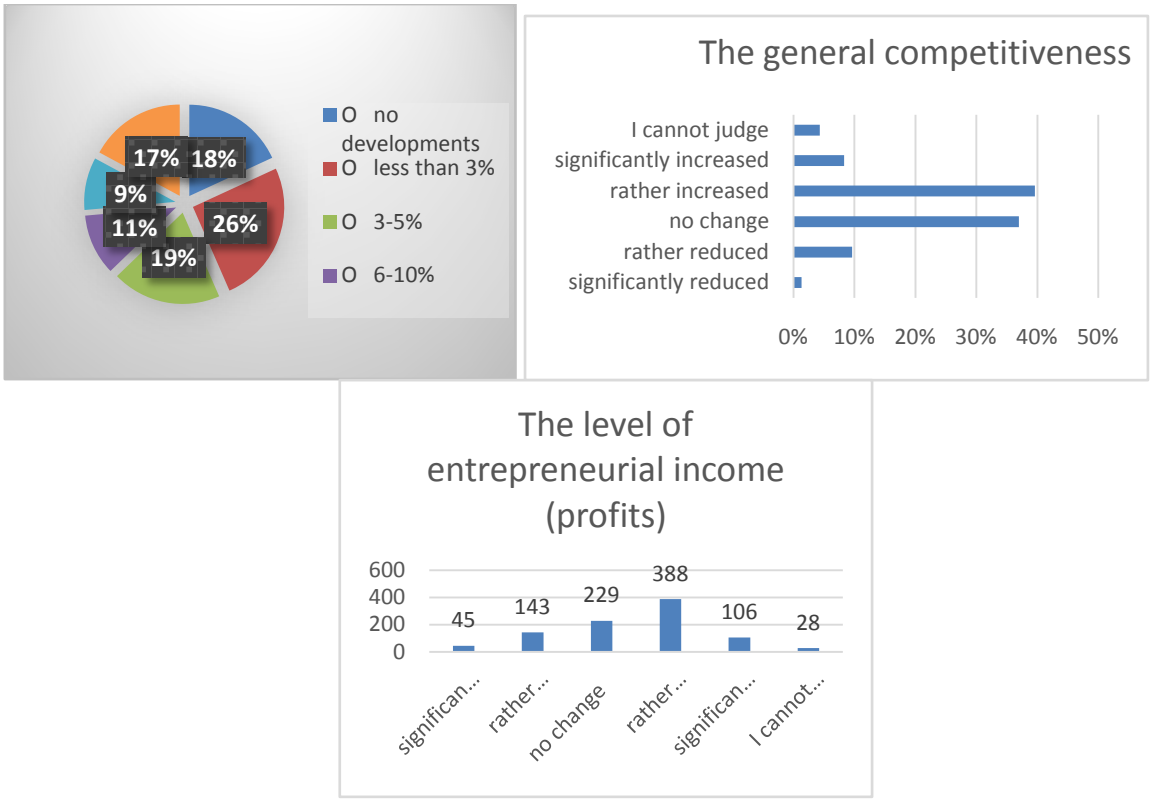

Figure 3. The % of the income spent on developmental expenditures

4 Examining Hungary's place from different points of view

In 2010, Hungary spent 1,14% of its GDP, which is less than the rate of the previous year, owing to the cut on the sources by the state[19]. [20]

During a period of 10 years, the source of R&D investment has changed drastically. While in 2004, the R&D spending were mostly supported by the state, in 2014 the companies were mostly financing their own innovations. [21]At the same time an increasing tendency can be seen on how much they expend on developments. Japan is not the only country that has an outstanding result in R&D spending in the ratio of GDP. The Scandinavian countries have already realized the benefits of innovation-driven and knowledge-based economy. Spending above the EU rate for R&D and Education, Finland became a leading innovator among the EU countries. They started the new strategy before 2000 and we can see its result, how well its economy performs. Although neither Finland nor Hungary was among the most-improved countries before the change of regime, the line-up has changed. Finland is considered as the third leading innovator, at the same time Hungary is below the EU rate in the group of moderate innovators taking the 8th place.

Between the innovation leaders and the moderate innovators the strong innovators can be found mostly above the EU rate. Some countries which belong to this group are: France, the Netherlands, Belgium, and United Kingdom.

Hungary could improve its economical accomplishment only by 3 percentage points through 8 years. In 2004 Hungary's GDP reached the 63% of the average EU rate, while in 2012 it reached 66%. For 2011 Sweden [22] had its GDP 126% more than the average EU GDP rate, Finland's GDP is quite close as Sweden's with its 115% performance, while the Norwegian GDP in 2011 was 189% higher than the EU rate.

There is a connection between the educational program, the expenditures on innovations and the GDP of the countries. The spending on innovations[23]has increased in the last 5 years. Indeed, between 2013 and 2015 it stood at the same value (1,40%; 1,37%; 1,39%). Since 2010 it increased by 0,25 percentage points.

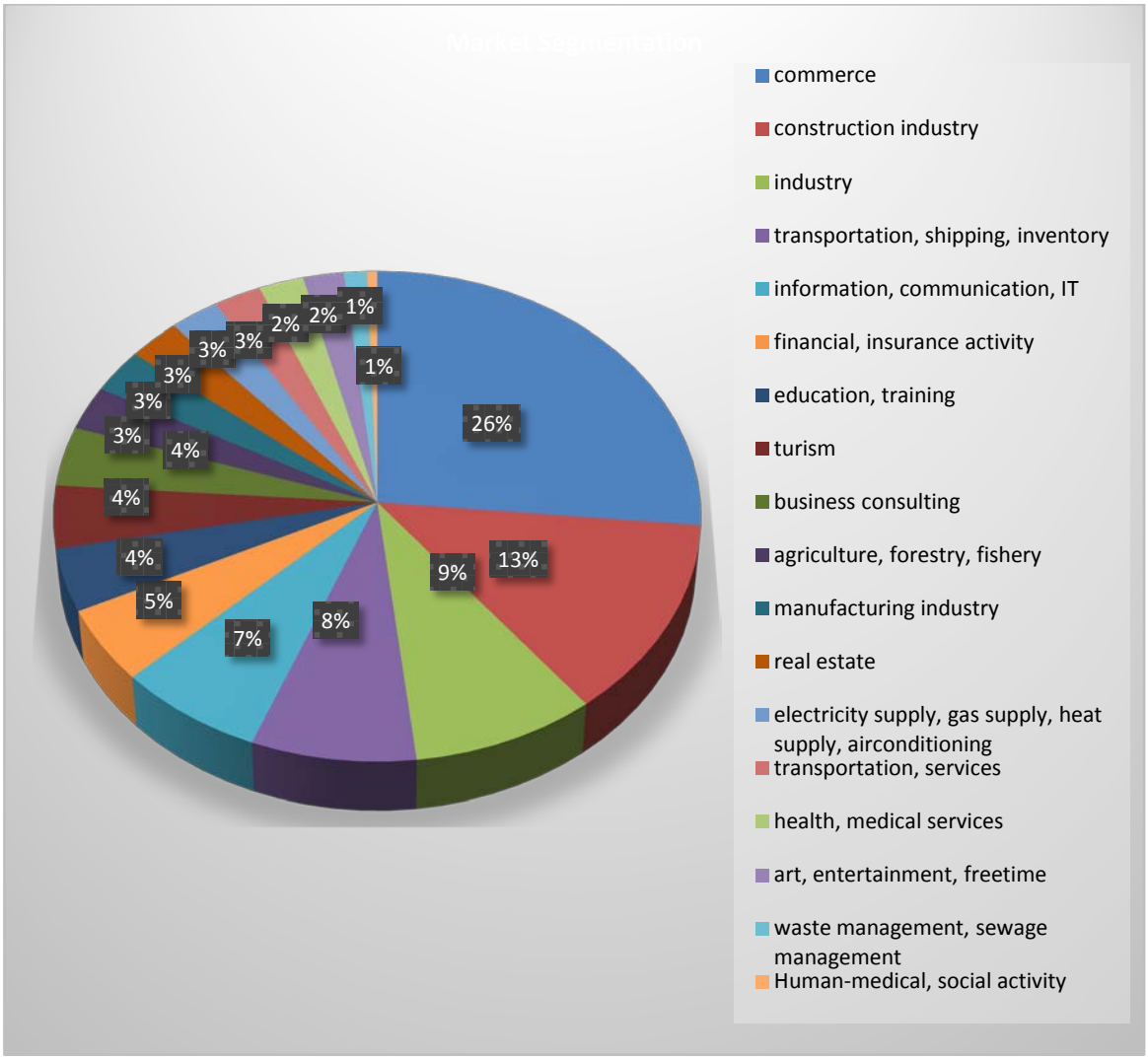

Figure 4. Market segmentation

The survey on the very matter was conducted among 944 companies and contained several questions of innovation, R&D, competitiveness through many aspects.

The firms which filled in the survey, mostly were involved in commerce (26%), on the second place they operated in the construction industry (13%), on the third place, firms were operation in heavy industry (9%). From the 944 firms, some indicated more than one field on which they operate, thus the answers sums up to 1306. Throughout 5 years the level of income slightly increased among 41,3% of

thefirms thatfilled in this part of the survey. Despite the fact that the level of income increased, the national market share has not changed for 39% of the firms, however for 31% it rather increased. The correlation coefficient is 0,91515 which implies that there is a strong connection between the income and the internal market share. 39% of the respondents have given the reply that the number of employees during the last 5 years have not changed. The general competitiveness – like the previous indicators say – has rather increased or not changed at all.

The statement "The enterprise implements several innovations every year, gradually increasing innovation performance." to which 32% of the repliers said it was rather not significant, should also be stressed.

The amount of firms that think that the environment is changeable is only 36%, while 32% of them are not paying sufficient attention to innovation. Among other things, it is also shocking that 59% of the responders had not paid great attention to R&D, which means they were not paying any attention at all or they rather not paid attention. The correlation coefficient is 0,206173 between the R&D and the consumer satisfaction indicators. This is a merely a weak connection between these factors. Precisely among the 944 firms who replied, 26% of them spends less than 3% on developmental expenditures such as Research and Development or innovations or on other improvements. This allows me to suppose that the leader/manager of 2016 does not follow the researches and does not draw conclusions e.g. how much importance innovation has when talking about improvements and sustainability.

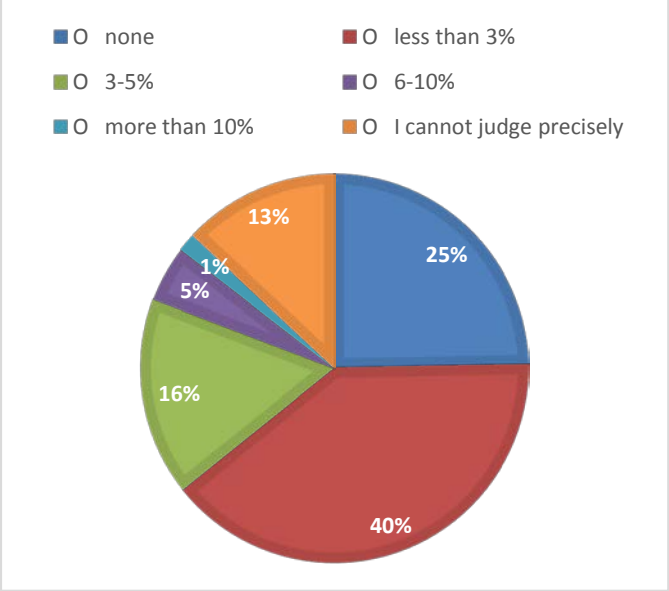

Figure 5. The % of the revenue paid for further trainings of the employees

8 years have passed since the depression in 2008 when there were many dismissals. On the graph from the survey which shows the percentage of the revenue paid for further trainings of the employees it can be clearly seen that almost two third of the corporations have spent less than 3% of their revenue or no money on trainings. The attitude of the labor force has changed with the new generation. [24] The Y generation loves challenges and novelties, does not like to stuck in the same situation, same job. [25] This generation makes the HR managers' job challenging to not only choose a good work force but making them want to stay in the company.Even today, young labor force appreciate trainings because it

adds value to the company and themselves as well, and also enables them to get higher on the career ladder. Generation Y requires more than remuneration, they demand involvement as well. Based on the study of the improvement in Finland, there is a strong connection between knowledge and competitiveness. Hence, if the Hungarian corporations had invested more to human resources it would be able to present a faster development [26].

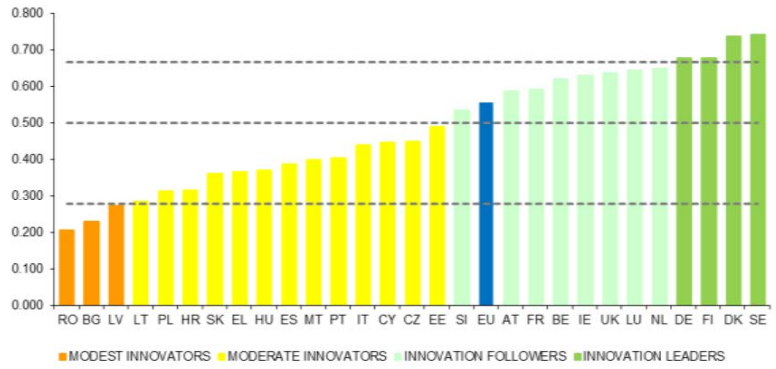

Figure 6. World ranking list of competitiveness (Source: European Innovation Rank List 2015)

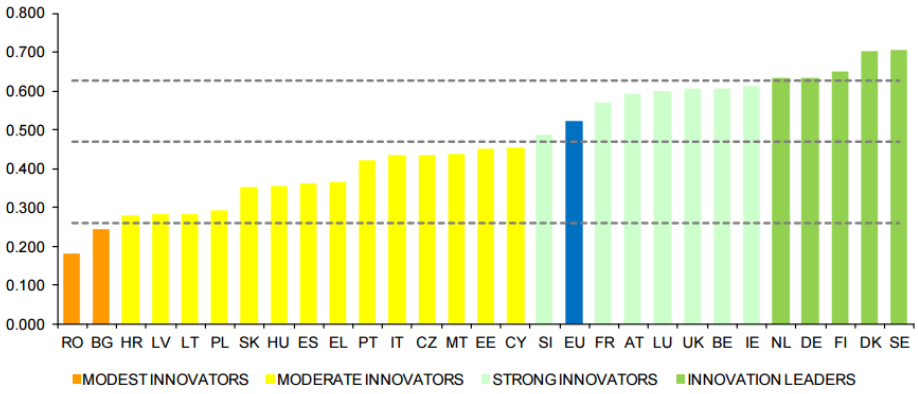

Figure 7. World ranking list of competitiveness (Source: European Innovation Rank List 2016)

In the research of the World Economic Forum from 2015-2016 Hungary is at the 63rd place among 140 countries at the world ranking list [27] of competitiveness. What remarkable is that Romania (which country was considered as a modest innovator while Hungary as a moderate innovator) got ranked 10 place above Hungary.

Bulgaria which was also considered as a modest innovator and has not owned a well-developed industry in the past years, now have been ranked to the 54th place on the scale of the competitiveness. Latvia from the same group is at the 44th place. All the modest innovators could improve fast.

Comparingthis to the research of 2014-2015, Hungaryhas lost 3 places, while Romania, Bulgaria have improved since last year.

5 Conclusion

Examining the answers of Hungarian firms, it can be stated that Hungary still has not realized the significance of the Human Resources and the demographical changes. Investing in knowledge and experience rather than saving money on further educationof the employees would foster innovation. The organizational changes have rather not been initiated by the ideas of the employees (43%). To concentrate on the inspiration of employees to have more ideas and not to keep them for themselves would also be advisable. If the employees are more open, they will be more creative and have more ideas on how to innovate.

Every government should increase the amount spent on developmental expenditures and put the emphasis on education and motivate the corporations to innovate more at their respective field.

To draw a conclusion, Hungary has a lot to change for example in its cultural attitude at the business field. We have to let good innovations from abroad enter and – as through the years in history we have already proved – we are also capable to invent new things,make the processes better and improve the competitiveness.

The companies have to spend more on R&D and trainings, while the state has to make efforts to have the country competitive against others to attract the workforce. At the same time, we have to deal with the lack of labor force, in a way that educating more engineers to develop the field of robotics. Now we do not have to examine the present but focus on the future, and face up with the competitors successfully.

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POTENTIAL MANAGEMENT SYSTEM OF THE WASTE PET PACKAGING IN THE REGION REGIONAL LANDFILL "MOŠĆANICA"

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Abstract: The packaging of liquid food products and consumer goods usually takes place in containers of poly (ethylene terephthalate) (PETused in food packaging and consumer goods. After utilization of the product's packaging becomes waste that pollutes the environment, occupies a large volume space in landfills and has a very long period degradation At the present level of technique and technology PET bottles can be successfully recycled in order to produce the same packaging as well as for other products, eg, foil, textiles and so on. At the regional landfill "Moscanica" is planned to be disposed of municipal waste from the territory of 9 municipalities of Zenica-Doboj and Central Bosnia Canton and in the next 30 years. The largest amount of waste PET bottles from the area of the municipality ends up in municipal waste. In order to achieve environmental and economic benefits related to the utilization of the waste PET bottles ,this papeworkr identified the influencing factors on the recycling and management system of waste PET packaging. It provides a potential management system waste PET packaging in the region Regional landfill "Moscanica", based on these factors.

Keywords: PET packaging, management, recycling

1 Introduction

At today's level of development, packaging made of poly (ethylene-terephthalate), PET is almost impossible to avoid. A large number of products, mainly liquid food and consumer goods are packed in it.These are: natural and mineral water, carbonated and non-carbonated juices, beer, milk, oil, various detergents, toiletries. PET packaging is widely used because of their good characteristics: an attractive appearance, good mechanical properties, good price, light weight, impact resistance and the like.

After consumption of products packaged in PET containers, it becomes packaging waste that is mostly disposed together with communal. PET packaging waste pollutes the environment, occupies a large volume space in landfills and has a very long degradation.

To establish a management system (collection, transport and processing) in the region Regional landfill "Moscanica" have been identified and investigated influencing factors, of which the most important is:

- The length of the transport of municipal waste in the region Regional landfill "Moscanica" or areas of individual municipalities to the landfill,

- Producers and amounts of waste PET bottles in the region and

- Influencing factors on the recycling of waste PET bottles.

2 Systems of collection and transport length of municipal waste in the region Regional landfill "Moscanica"

Regional landfills "Moscanica" is intended for disposal useless the rest of municipal waste from the area of 9 municipalities in the next 30 years. Region landfill "Moscanica" is an area of 9 municipalities with whom the rest of the useless waste disposal, namely the municipalities of Zepce, Zavidovici, Zenica, Visoko, Busovaca, Vitez, Travnik, Novi Travnik and Kakanj (Figure 1). The total area of this region is 3,107 km2. According to the latest census in 2013, the area of the region's 395,421 inhabitants living in 123,304 households [1].

Distance individual municipal centers of regional landfill "Moscanica" is: Zenica 14 km, 52 km Zepce, Zavidovici 68 km, 38 km high, Kakanj 20 km, 22 km Busovaca, Vitez 26 km, 41 km Travnik and Novi Travnik 41 km.

In the area of the municipalities in the region landfill "Moscanica" evening quantities of waste PET bottles collected together with household garbage.

Economically viable transport distances of municipal waste with classic vehicles for waste collection is [2]:

- in urban areas 5-10 km

- in regional areas 20-25 km

Based on these parameters the collection and transport the useless rest of municipal waste from landfills in the region "Moscanica" is planned to be carried out over transfer station that will be built in three mini region (Figure 1). To transfer station ,collection and transportation of municipal waste is performed classic vehicles for waste.The usefull components of waste (eg, paper, cardboard, plastic, PET, metal, etc.) are allocated. After extracting useful components unsufull rest is transported by the waste vehicle for long distance on the regional landfill "Moscanica".

Figure 1. Potential mini-regions in the region Regional landfill waste "Moscanica"

3 Producers and amounts of waste PET bottles in the region landfill "Moscanica"

3.1 The producers of PET packaging

Waste PET bottles can be primary (sales), secondary (collective) and tertiary (transport). The producers of PET packaging are: producers, packers, fillers, importers distributors, end suppliers and trades, and all those who put PET bottles (products in it) on the market, as well as end users of the product packaged in this packaging: households, industry, services , public institutions and others.

3.2 The estimated amount of waste PET bottles

The amount of waste PET bottles in the region landfill "Moscanica" is directly proportional to the number of producers and production of packaging materials. The relevant ministries of the Federation of Bosnia and Herzegovina, cantonal ministries of Zenica-Doboj and Central Bosnia Canton there are no data on the quantities of waste PET bottles for the region landfill "Moscanica". The only available data are that on the waste from the landfill operating records "Moscanica". According to this data is allocated a total of 507.64 tons of PET bottles waste at the landfill during the period from 05.06.2008. to 31.12.2013., and review by years is given in Table 1.

Table 1. The quantities of PET bottles waste separated from municipal waste to the Regional landfill "Moscanica"

Amount, t/years						Total, t
2008.	2009.	2010.	2011.	2012.	2013.	
15	64	84	133	124	88	507

By comparing these values can be observed that in 2011 allocated the largest amount of PET. The reason for this is the adoption of "Regulations on Packaging and Packaging Waste", which is in the Federation of Bosnia and Herzegovina entered into force in 2011. Since then, the formed authorized companies involved in the purchase of packaging waste, including unauthorizedl persons who have a financial benefit. This has led to a reduction in the quantity of waste PET bottles, which is due to the regional landfill "Moscanica".

The reference year for which the assessment was undertaken production waste PET bottles in 2013. Due to the lack of adequate data on the amount of waste, assessment of waste PET bottles was based on morphological composition of municipal waste and the number of inhabitants of areas with which municipal waste is transported to the regional landfill " Moscanica "(table 2).

Table 2 The estimated amount of waste PET bottles regional landfill "Moscanica"

Municipality	Date of sampling	Territory	The amount of municipal waste in the truck (T)	Sample of waste		PET packaging waste		% By weight. waste PET bottles
				kg	% mas	kg	%	
Zenica	24.03.	urban	7,4	504,86	6,82	33,9	6,72	6,68
	23.06.		9,2	504,47	5,48	33,52	6,64	
Žepče	31.03	urban and rural	5,32	584,76	10,99	25,24	4,32	5,00
	30.06.		4,84	472,48	9,76	27,66	5,85	
Visoko	29.03.	urban and rural	10,49	495,08	4,72	24,94	5,04	4,07
	23.06.		7,76	625,93	8,07	20,70	3,31	
Busovača	04.04.	urban	10,25	529,59	5,17	35,06	6,62	6,19
	27.06.		9,43	523,32	5,55	30,10	5,75	
Travnik	25.03.	urban	2,61	539,32	20,66	21,54	3,99	4,50
	26.06.		5,83	517,20	8,87	26,04	5,04	
Nova Bila	28.03.	rural	3,34	443,96	13,29	34,6	7,79	5,81
	22.06.		3,54	471,43	13,32	18,62	3,95	
TOTAL:			80,01	6212,40	7,76	331,92	5,34	5,34

The percentage share of PET bottles waste in range Regional landfill "Moscanica" in 5,34% should be viewed with caution:

- because the composition of the waste has a dynamic character, is subject to constant change depending on: the size of the area of the collection, the season, the social structure of the population, type of settlement (urban, rural), type of economic activity
- determination of morphological content of waste has done at the time of the increased consumption of beverages (spring, summer of 2011), mainly from urban areas, which significantly affect the the reliability of the data.

Based on the data from Table 2 in Table 3 provides an assessment of the amount of waste PET bottles in municipal waste in 2013 in the area of regional landfill "Moscanica.

Table 3. Estimated amounts of waste PET bottles in municipal waste in 2013.

Municipality	The amount of municipal waste, t	% of households included in the system	Population in the system	% Share of PET waste	Weight share of PET waste (t)
Zenica	29.085,64*	75	86.350,50	6,68	1942,92
Žepče	1.400,00**	34	10.737,88	5,00	70,00
Zavidovići	6.983,00**	35	14.095,20	5,34	372,89
Kakanj	8.774,50**	71	27.645,27	5,34	468,56
Visoko	9.208,71*	50	20.676,00	4,07	374,79
Busovača	1.143,67*	35	6.470,80	6,19	70,79
Vitez	3.360,00**	41	11.072,46	5,34	179,42
Travnik	5.758,33*	70	40.280,10	4,50	259,12
Novi Travnik	6.200,00***	71	17.825,97	5,34	331,08
Ukupno:	71.913,85	-	235.154,18	-	4069,57

* Data from the regional landfill "Moscanica"

** Data obtained by interviewing utility companies

*** Data from the Waste Management Plan SBK / KSB for the period 2015-2025 years-draft [3]

According to the data in Table 3 estimate production waste PET bottles per capita is 17.30 kg / year. If we consider the entire population of the region, estimated to be in the region of the landfill "Moscanica" annually produces about 6,841 tons of waste PET bottles.

4 Factors affecting the recycling of PET packaging waste in the region landfield "Moscanica"

Recycling waste from poly (ethylene terephthalate), PET bottles waste, is one of the most successful and the most widespread process of recycling plastics. Recycling of PET bottles waste can be done in three ways:

- mechanical process (melting)
- chemical and
- thermal processes.

Mechanical means is reprocessing which is used for production of new products of the same, similar or completely different purpose. Chemical and thermal processes receive the basic components of plastics that are used for energy production.

Capacities for recycling waste PET bottles in Bosnia and Herzegovina are relatively small. The reason is certainly the lack of an adequate management system, which is reason for expensive small amount of waste PET bottles. In Bosnia and Herzegovina is only used mechanical process of recycling waste PET bottles.The biggest impact on the efficiency of the mechanical recycling of PET bottles

waste have the following factors: mixing the PET bottles waste from other types of plastics, contamination of PET bottles waste, labels, color, adhesive, additives and the like.

The requirement for mechanical recycling of PET packaging waste is that it is separated from other types of plastics, because that the design of PET containers is need to take into account the possibility of its recycling. By mixing different types of plastics waste are narrowing the quality of their recycling. In order to make the best possible selection of plastics waste is made the standardization of their labeling. Symbols, names and abbreviations are given in Table 4.

Table 4 - Symbols, names and abbreviations of polymer [5]

Symbol							
Name of polymers	Poly (ethylene) terephthalate	High-density polyethylene	Poly (vinyl-chloride)	Poly-ethylene low density	Poly-propylene	Poly-styrene	Other multilayer materials
Abbreviation	PET	PE-HD	PVC	PE-LD	PP	PS	-

The degree of contamination or mixing other wastes from plastics waste directly affects the efficiency of their recycling. For efficient mechanical recycling of particular importance is the organization of the collection of these wastes. The type and scope of mutual interference PET bottles waste with household and similar wastes depends on their level of pollution.

According to the origin, pollution of plastics wasteare divided into two groups:

- pollution that is caused by using the product and

- contamination due to contact with other types of waste.

Because of the slight weight of packaging material in relation to which it is charged, the rest of filled materials of 1% , may amount contamination from 10 to 35 wt. %. For larger rest filled in packaging materials pollution can be 10 to 30 times greater than the mass of plastic packaging. [2] Should be taken remains of minimal amount of material in packaging that is charged to reduce its pollution.

Contamination that is formed by mixing with other kinds of waste is the greatest with the conventional waste collection (degree of contamination of 5 to 10%). Separate collection of waste fractions this level can be significantly reduced. [4]

PET packaging color has an impact on the economic aspect of recycling and the market value of recyclates. Minimising contents of color in packaging increases the value of the recycled material. It is not desirable to recycle both PET bottles waste of different colors, and at the beginning of recycling it is necessary sorting PET bottles waste by color.

Stickers, adhesive used in PET packaging affect the recyclability, ie. It is necessary to avoid PVC labels on PET bottles, and to use materials which are soluble in water.

In the production of certain products of plastics , various additives are used depending on the field of use of the finished product or of the production process and function additives. Additives for stabilization are tasked to prevent premature polymerization of monomers and thermal decomposition or oxidation at recycling thermoplastics. The stabilizing additives leads to improved stability of finished products to light, heat and oxygen. Additives are used as modifiers: softeners, fillers, coloring agents, agents for the flame retardant and the like. Additives such aids are used to reduce the adhesion and toughness for recycling and improve flowability, better mixing and smoothness of the upper surface of the product. [2]

5 Potential system for managing waste PET packaging

The main objective in managing PET packaging waste is to keep the material in the life cycle as long as possible, and only with the impossibility of further mechanical recycling applied chemical and thermal processes.

Basic phases of PET packaging waste are: collection, transport, sorting and storage, processing and depositing the rest.

Packaging waste management system in the Federation of Bosnia and Herzegovina is based on the shared responsibility of all stakeholders (producers, importers, fillers, packers, distributors and final suppliers) on the principle of "polluter pays". This means that the manufacturer is responsible for the packaging waste generated after use of packaging placed on the market. Manufacturer have their responsibility, or obligation, performs payment of compensation to the Fund for Environmental Protection or an authorized operator, according to the contract signed. The system operator is a legal entity authorized by the Ministry, which deals with the activities of packaging and packaging waste. The operator of the system as a non-profit organization all their profits should invest in building infrastructure for the management of packaging waste and its primary objective is to meet the legal requirements.

To PET bottles waste could be recycled by the "bottle to bottle" it is necessary to organize a good collection systems and training and discipline of consumers.

Good organization collecting waste PET bottles should be achieved by:
- extraction of large quantities of waste PET bottles,
- better separation of waste PET bottles from other types of plastics,
- a high degree of purity of waste PET packaging,
- ensure minimum transport costs, etc

Taking into account the experience of neighboring countries as well as countries of the European Union, a combination of the two systems of collection are recommended:

- system container in certain locations (green islands) and

- deposit system.

Green islands are special places for separate waste collection. The waste separated at source is particularly disposed in separate containers. The vessels within the green islands are specially marked to accept certain types of waste such as, PET bottles, paper, glass and mixed waste. This type of collection is achieved by a low percentage of collection, a high degree of contamination of other wastes, mixing

PET bottles waste with other types of plastic, high transportation costs due to the large volume in relation to ground. Also, in this case it is necessary to subsequently sorting PET bottles waste. The collection system is not acceptable for relatively ″pure″ PET wrapping materials (bottles from water, juice, milk), while it is acceptable for packaging that would receive significant purification before recycling such as a bottle from detergents, oils, chemicals and various . This collection method requires relativity small financial investment and a high level of environmental awareness.

The best motivation for the return of PET bottles waste is achieved through a system of bail (deposit). Collection system works in a way that PET packaging waste back to the place where the device is set to return, usually at a dealer. Consumer deposited PET bottle in the machine for the return of the deposit which are scanned packaging and identification using bar code, color, brand, shape, etc., that is compared with the data from the database. If the bottle is not positively identified, after scanning, is expelled from the machine and returned to the consumer, which means that it is not the system of bail (deposit). If the bottle is positively identified forwards into the container for collection. Depending on the type of device, PET wrapping materials can be, before storage, calender or chop the use of certain equipment, which reduces the volume waste PET packaging.

This system of collecting PET bottles waste is carried out its procurement of final users. Refunds can be done in several ways [6]:

- in the form of a voucher that changing money and can be used in specific stores or for specific products,
- in the form of a coupon for a discount on a product,
- as a ticket for the prize draw,
- as a donation to charity, etc.

Using this system, the experience of countries that apply it, and the return of waste PET wrapping materials even up to 90%.

Deposit system would be applied to relatively ″clean″ PET wrapping materials (bottles of: water, juices, milk), while the packaging, which should be subject to significant cleaning before recycling used green islands. Deposit system would be used mainly for household and industrial buildings, service sector, public institutions and with the handling of public events performed to extract the waste PET bottles in special containers, and the same would be sold to authorized collectors.

Granted, road network, traffic density, distance of some municipalities of landfills and the amount of municipal waste in the region with which the waste is disposed of at the Regional landfill "Moscanica" it would be justified to form three mini region. (Figure 1). Mini region first would cover the area of the municipality of Zepce and Zavidovici, 2 mini-region area municipalities Kakanj and Visoko and 3 mini-region area of the municipality of Travnik, Vitez and Novi Travniik, while the waste from the Municipality of Zenica and Busovaca transported directly to the Regional Landfill "Moscanica" (Figure 1).

All amounts of municipal waste to the existing system of collection and transportation in each mini region transported to the transfer station with sorting in the mini region. At the sorting would be allocated useful components from waste (eg, paper, glass, plastic, PET, etc.), And the rest of the useless waste would be loading on to the district transportation to regional landfill "Moscanica". Sorted PET packaging to transfer stations and in green containers would be sold through waste market in Bosnia and Herzegovina or abroad.

On the basis of these influencing factors and applicable laws and regulations in the Federation of Bosnia and Herzegovina in the field of municipal waste management in Figure 2 provides a potential management system for waste PET packaging in the region Regional landfill "Moscanica".

6 Conclusion

Packaging waste management system in Bosnia and Herzegovina has not been established as in developed European countries, particularly in relation to primary waste PET bottles. Selective separation of waste PET bottles wasteare almost non-existent. Final users of products and PET bottles have not motives to be separated at source. The proposed management system for PET packaging waste in the region Regional dponije "Moscanica" was the largest producers of packaging, citizens, were integrated into the system. Citizens would be motivated by the introduction of the deposit system to return PET bottles waste and not, as now, deposited in the waste container, where a small portion of the packaging stand street collectors and workers at the landfill. The proposed system would be achieved by:

- Technological advantages: PET packaging waste is separated from other types of plastics, has a high degree of purity, separated by color and reduced its volume,
- Environmental benefits: a large percentage of return packaging, saving landfill space, saving primary resources, lower consumption of electricity and water, lower air emissions from transport vehicles and
- Financial income: higher price of pure PET, lower transport costs and cost savings of the deposit, job creation and others.

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Appendix:

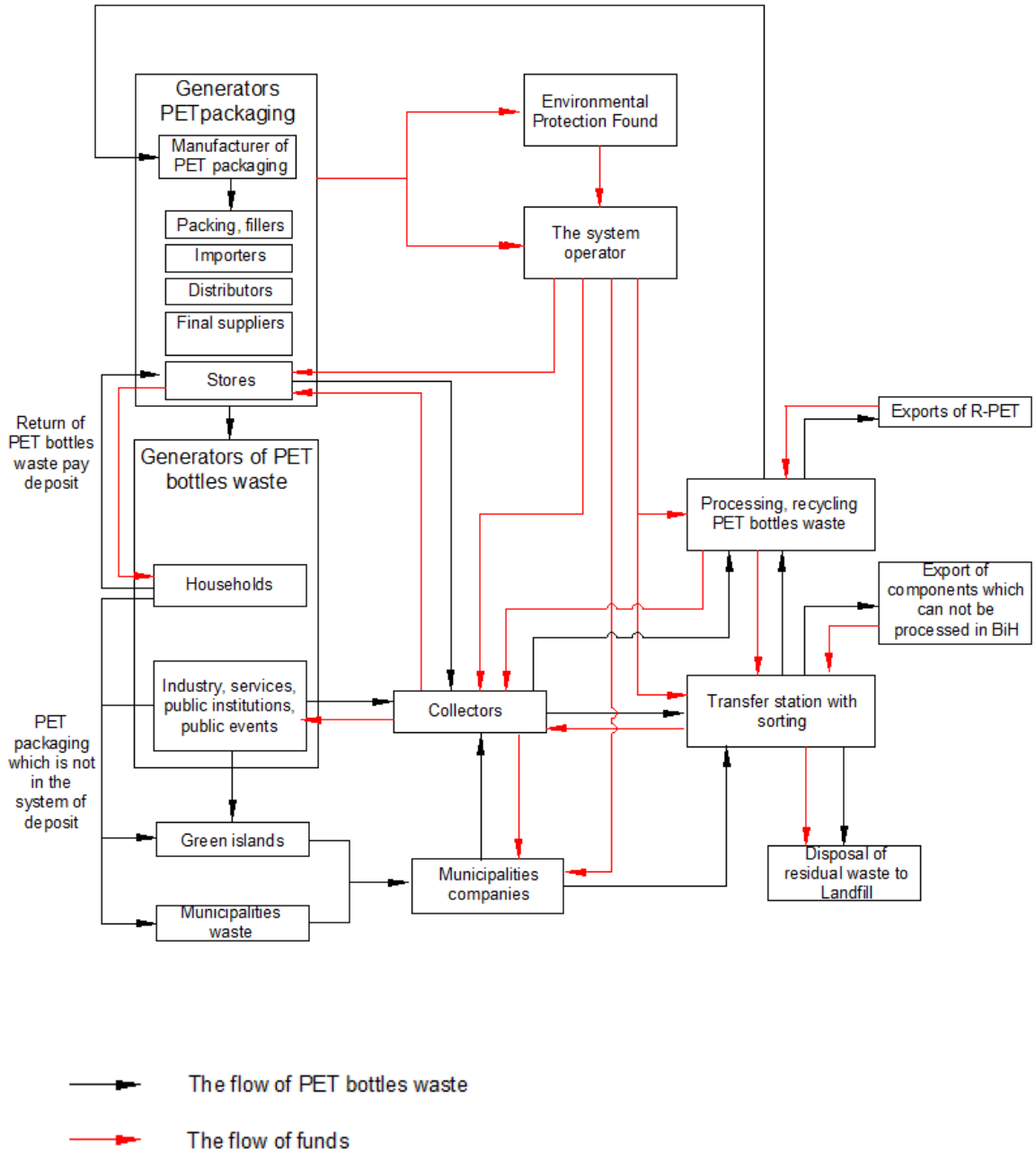

Figure 2. Proposed management system waste PET packaging in the area of Regional landfill "Moscanica"

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