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ANALYTICAL STUDY OF SELECTED ECONOMIC-ENVIRONMENTAL INDICATORS OF WASTE MANAGEMENT SYSTEM IN SLOVAKIA

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ABSTRACT: The main objective of the paper was to visualize and analyze the relationships between selected economic and environmental indicators in the waste management system of Slovakia, i.e., the amount of fees for municipal waste in individual districts of Slovakia in 2019 and the amount of average monthly wage and unemployment in Slovakia in the same year. Data were visualized and analyzed on a thematic map and in a boxplot, and subsequently, they were subjected to statistical testing. Based on the performed analysis, we can confirm the statistical relationship between the average wage and the amount of fees for municipal waste collection and the statistical relation between the municipal waste fee and the unemployment rate in individual districts of Slovakia.

KEYWORDS: environmental indicators, economic indicators, municipal waste fee, wage, unemployment

Introduction

We are currently witnessing many activities at the local or global level, the aim of which is not only to increase general public interest in the environment, but to provoke efforts to take concrete measures to improve its current state. A key aspect is its deteriorating condition. In addition to the economic and social sphere, the environment is one of the pillars of sustainable development. There is a lot of evidence of the nonecological use of natural resources. Everything that threatens the environment also threatens such development. One of the biggest dangers for the environment is waste (Bosak et al., 2016). Waste generation has adverse effects on health, the environment, socio-economic conditions, and contributes to climate change. Therefore, it is important to examine the links between economic growth, waste production, and environmental degradation (Uddin et al., 2017).

In the European Union, the amount of municipal waste generated per person in 2018 amounted to 492 kg, a decrease of 5% compared to a maximum of 518 kg per person in 2008, which is roughly comparable to the 490 kg recorded in 2017. In total, the European Union generated 220 million tonnes of municipal waste in 2018. Although this was slightly higher than in 2017 (218 million tonnes), it was less than in 2008 (227 million tonnes) (Statistical Office of the European Communities, 2020). Economic and fiscal instruments, together with regulatory frameworks, play a key role in addressing these challenges as drivers of improving waste management (Nicolli and Mazzanti, 2013). Municipal waste charges are one of the instruments that are widely recognized as crucial for local waste management (Puig-Ventosa and Sastre Sanz, 2017). These charges must be paid by all entities using the environment in the field of waste generation. At the same time, a uniform rule applies to their collection (calculation and transmission) (Małecki, 2020).

The National Council of the Slovak Republic adopted the Act No. 582/2004 Coll. on Local Taxes and Local Fee for Municipal Waste and Minor Construction Waste, which is valid since 1 November 2004 and in force since 1 July 2020. The aim and subject of this law are to establish a local tax and a local fee for municipal waste and small construction waste. The National Agency for Network and Electronic Services (2013) states that the municipal waste fee is paid for the waste that is generated on the territory of a given municipality of the Slovak Republic. The taxpayer is responsible for the payment of this fee, who is considered a natural person with a permanent, resp. a temporary stay in the municipality or a person who is an authorized user of a residential space, garden, orchard, building construction, or who does business in the territory of the municipality. In addition to the individuals, the taxpayer for municipal waste can also be a legal person who is authorized to use

real estate in the municipality for another purpose, such as business activities, as well as a legal entity using the object in the territory for business activities. The taxpayer is not a person who uses the territory of the municipality for temporary housing in facilities such as hotels. The taxpayer is not a person hospitalized in a health centre due to the provision of health care. Each municipality, which determines the amount based on the frequency of waste treatment, is responsible for determining the amount of the municipal waste fee. The tax period for this fee is specified for the period of one calendar year. The decisive factor for determining the amount of the municipal waste fee is to look at the last period and the last determined fee (annual fee). If the resident is not present on the territory of the municipality for more than 90 days in a calendar year and proves this by verified documents, the municipality has the option to waive or reduce the municipal waste fee to the payer to the lowest possible fee, which means 0.01 euro/day, i.e. a fee of 3.65 euro/year. According to Collection of Laws of the Slovak Republic, in particular, Act No. 79/2015 Coll. on waste, collected funds must be used by the municipality specifically for the collection, transport, recovery, and disposal of municipal waste and small construction waste.

The management of municipalities is subject to increasing control by the public, the state and the municipalities themselves, and these local authorities around the world are being forced to deal more and more with waste management (Budică et al., 2015; Vavrek, Adamisin and Kotulic, 2017). Municipal waste management has become a challenge for local government authorities in both small and large municipalities (Starkowski and Bardzinski, 2018). Cheng et al. (2020) state that local and regional specific conditions should be taken into account when modelling the economic and environmental impacts of waste generation. Recent findings also suggest that different regional economic environments significantly affect the link between economic growth and environmental quality (Gardiner and Hajek, 2020a). For example, an increase in production factors (employment and capital) contributes not only to production and consumption but also to industrial pollution (Alam et al., 2011). The unemployment rate is another factor that is significantly correlated with solid waste generation (Namlis and Komilis, 2019). Khajevand and Tehrani (2019) also agree and state that it is essential to include an economic factor, such as the unemployment rate, in the waste disposal model, especially during economic downturns, when economic factors may outweigh the effects of population change on waste generation and thus also for its disposal. The research by Talalaj (2017) found the lack of a significant statistical relationship between the average monthly wages and the quantity of waste generated, that is contrary to the results of a study by Minelgaitėa and Liobikienė (2019), that indicated that the level of waste gen-

eration in the European Union countries significantly depends on indicators of economic development, and the results of the study carried out by Gardiner and Hajek (2020b), that provide empirical support for the existence of short-term and long-term bidirectional causality between waste generation and economic growth in EU regions. Malinowski et al. (2019) examined the relationship between the efficiency of waste segregation and fee rate imposed on residents for generated municipal solid waste and found that in those municipalities where the fee increased, the growth of segregation efficiency was hampered. Based on the results of multi-year research conducted by Bosak et al. (2018), the average fee for municipal waste and small construction waste is gradually increasing as we move from the eastern Slovakian districts to the west. At the same time, the amount of the fee depends not only on whether it is paid in the municipality or in the city, on the number of inhabitants, or on the company that collects the waste but also on the region in which the municipality is located. Assessing the dependence of various economic and environmental variables is commonly used by various researchers, e.g., Chovancová and Vavrek (2020) or Fura (2020).

Research methods

The paper visualizes and analyzes data on municipal waste fees and the average wage on a thematic map and in a boxplot, and subsequently examines the relationship between the amount of fees for municipal waste in 2019 and the average monthly wage and unemployment in individual districts of Slovakia in the same year.

Currently, the value of the fee for municipal waste collection in Slovakia depends on the following factors:

- Act no. 17/2004 Coll., Annex no. 1 Landfill fees,
- inflation, i.e., a generally constant rise in the price level,
- deflation, i.e., a general decline in the price level,
- consumer price index.

The amount of the fee for municipal waste collection is also calculated on the basis of the formula:

$$R = Q \times A \times CPI, \quad (1)$$

where:

R – contribution to the creation of a special-purpose financial reserve in €/Year,
Q – the amount of deposited waste per year in m^3,
A – the amount of fee per unit of waste calculated at the beginning of the creation of the special-purpose financial reserve,
CPI – consumer price index (amount of inflation in a given year).

The amount of the levy per unit amount of waste, which is calculated once at the beginning of the creation of the special-purpose reserve, is calculated according to the formula:

$$A = CN / K, \quad (2)$$

where:

A – the amount of fee per unit of waste calculated at the beginning of the creation of the special-purpose financial reserve,

CN – the investment costs estimated by the project documentation intended for closure, reclamation and operating costs for monitoring the landfill in €,

K – is the free capacity of the landfill at the beginning of the creation of the special-purpose financial reserve at the time of calculation in m^3.

The initial basis for the analysis and subsequent visualization was secondary data from the Statistical Office of the Slovak Republic (2020). Thematic maps were processed in the MapInfo Professional 16.0 software. Software Statistica 13.5 was used to test the relationship between variables.

Results of the research

Table 1 contains data presenting the amount of the average annual fee for municipal waste collection in Slovakia in 2019 sorted by individual districts. At the same time, it is the input data of the attribute table for the visualization of this indicator in the MapInfo Professional software.

Table 1. The average annual fee for municipal waste in individual districts of Slovakia in 2019

Bratislava Region	Average fee/year	Trnava Region	Average fee/year	Nitra Region	Average fee/year	Trenčín Region	Average fee/year
Malacky	20.18 €	Dunajská Streda	15.13 €	Komárno	13.66 €	Bánovce nad Bebravou	13.85 €
Pezinok	20.58 €	Galanta	16.19 €	Levice	11.46 €	Ilava	15.33 €
Senec	16.26 €	Hlohovec	14.56 €	Nitra	16.37 €	Myjava	13.19 €
BA I.	19.11 €	Piešťany	15.03 €	Nové Zámky	12.47 €	Nové Mesto nad Váhom	15.72 €
BA II.	19.11 €	Senica	16.16 €	Šaľa	14.17 €	Partizánske	12.84 €
BA III.	19.11 €	Skalica	15.54 €	Topoľčany	14.12 €	Považská Bystrica	17.49 €
BA IV.	19.11 €	Trnava	15.21 €	Zlaté Moravce	13.86 €	Prievidza	16.12 €
BA V.	19.11 €	**Average for region**	**15.40 €**	**Average for region**	**13.73 €**	Púchov	18.86 €
Average for region	**19.07 €**					Trenčín	17.24 €
						Average for region	**15.63 €**
Žilina Region	**Average fee/year**	**Banská Bystrica Region**	**Average fee/year**	**Prešov Region**	**Average fee/year**	**Košice Region**	**Average fee/year**
Bytča	14.86 €	Banská Bystrica	16.92 €	Bardejov	8.24 €	Gelnica	11.48 €
Čadca	14.72 €	Banská Štiavnica	11.74 €	Humenné	6.78 €	Košice - okolie	13.49 €
Dolný Kubín	13.14 €	Brezno	13.53 €	Kežmarok	10.44 €	Michalovce	8.25 €
Kysucké Nové Mesto	14.83 €	Detva	13.37 €	Levoča	11.05 €	Rožňava	10.13 €
Liptovský Mikuláš	13.36 €	Krupina	11.86 €	Medzilaborce	6.30 €	Sobrance	9.33 €
Martin	15.21 €	Lučenec	9.95 €	Poprad	12.50 €	Spišská Nová Ves	10.25 €
Námestovo	13.24 €	Poltár	10.90 €	Prešov	9.09 €	Trebišov	7.99 €
Ružomberok	15.12 €	Revúca	10.99 €	Sabinov	8.94 €	KE I.	31.35 €
Turčianske Teplice	13.25 €	Rimavská Sobota	10.45 €	Snina	7.57 €	KE II.	31.35 €
Tvrdošín	14.81 €	Veľký Krtíš	9.82 €	Stará Ľubovňa	11.81 €	KE III.	31.35 €
Žilina	14.74 €	Zvolen	14.58 €	Stropkov	7.19 €	KE IV.	31.35 €
Average for region	**14.42 €**	Žarnovica	14.50 €	Svidník	7.40 €	**Average for region**	**17.85 €**
		Žiar nad Hronom	14.77 €	Vranov nad Topľou	7.55 €		
		Average for region	**12.57 €**	**Average for region**	**8.84 €**		

Source: author's work based on slovak.statistics.sk [26-09-2020].

Figure 1 shows a thematic map that visualizes the amount of the average annual fee for municipal waste within the districts of the Slovak Republic in 2019. Based on the data analysis, the highest amount of municipal waste fee is in Košice and Bratislava. On the contrary, the lowest fee is paid by residents in the northeast parts of Slovakia.

Figure 1. The average annual fee for municipal waste in individual districts of the Slovak Republic (2019)

Source: author's work based on slovak.statistics.sk [26-09-2020].

In the analysis of the obtained data on the average fee for municipal waste and the average wage, we visualized the variance of values using descriptive statistics. The following graphs (figures 2 and 4) show the analyzed data on the average fee for municipal waste and the average monthly wage in Slovakia in 2019.

The thematic map (figure 3) shows the average wage in individual districts of Slovakia in 2019 (regardless of gender). If we look at the amount of the average wage from the point of view of particular regions, the average wage in the Bratislava region relatively highly exceeded the average of the whole country and reached almost the amount of 1,500 euro. The lowest value was recorded in the Prešov region.

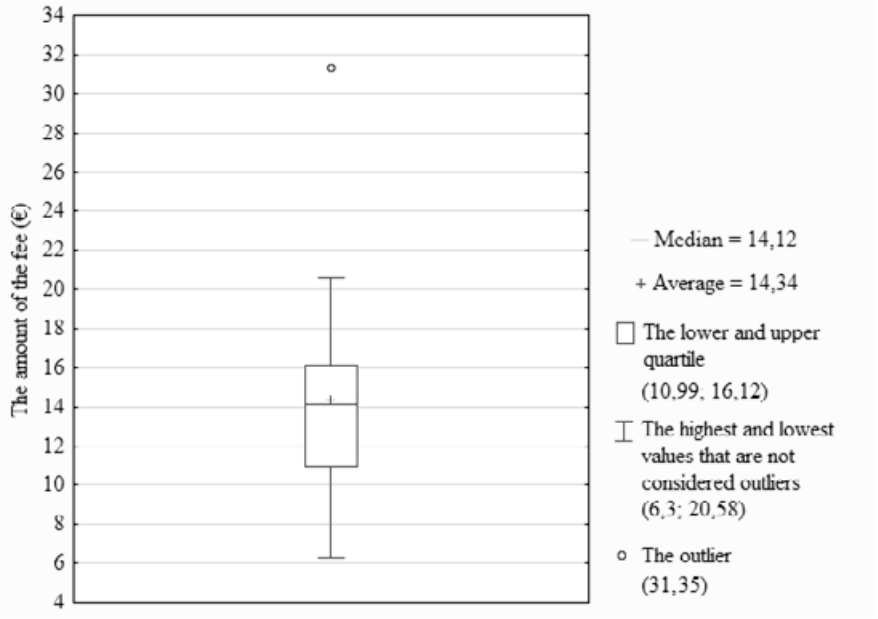

Figure 2. The average municipal waste fees in Slovakia in 2019

Source: author's work based on slovak.statistics.sk [26-09-2020].

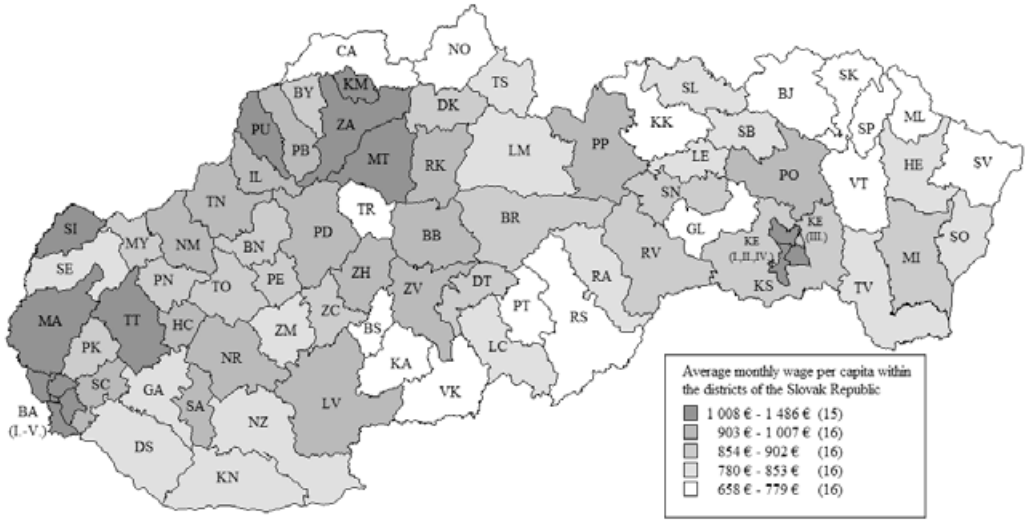

Figure 3. The average monthly wage per capita in individual districts of the Slovak Republic (2019)

Source: author's work based on slovak.statistics.sk [26-09-2020].

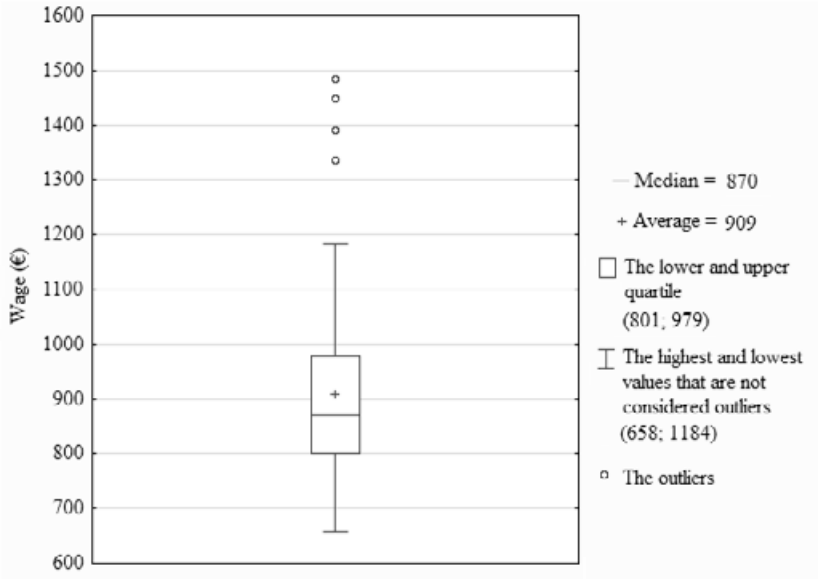

Figure 4. The average wage in Slovakia in 2019

Source: author's work based on slovak.statistics.sk [26-09-2020].

The data on unemployment rates in individual districts of Slovakia were also obtained from the Statistical Office of the Slovak Republic, which is the central body of the state administration of the Slovak Republic for the area of state statistics.

Based on the processing of secondary data, we performed a correlation analysis and verified the statistical relationship of the selected variables.

The statistical test verifies the assumption that there is no statistically significant relationship between the average monthly wage and the amount of fee for municipal waste collection in individual districts of the Slovak Republic in 2019.

H0: ρ (correlation coefficient) = 0

H1: ρ (correlation coefficient) ≠ 0

Table 2. Testing the statistical relation of the hypothesis H1

Correlation	
corr (wage, fee)	0.57439145
p-value	0.0000

Source: author's work based on slovak.statistics.sk [26-09-2020].

We reject the hypothesis H0, a linear relationship exists.

At the significance level α = 0.05, there is a relationship between the average wage and the amount of fee for municipal waste collection. Based on the value of the correlation coefficient ρ = 0.5744, we confirm that the relationship between the variables is significant.

We further assume that there is no statistically significant relationship between the amount of fee for municipal waste collection and the unemployment rate in individual districts of the Slovak Republic in 2019.

H0: ρ (correlation coefficient) = 0

H1: ρ (correlation coefficient) ≠ 0

Table 3. Testing the statistical relation of the hypothesis H2

Correlation	
corr (unemployment, fee)	-0.60482345
p-value	0.0000

Source: author's work based on slovak.statistics.sk [26-09-2020].

We reject the hypothesis H0, a linear relationship exists.

At the level of significance α = 0.05, there is a relationship between the fee for municipal waste collection in the districts of Slovakia and the unemployment rate in individual districts of Slovakia. Based on the absolute value of the correlation coefficient ρ = | 0.6048 |, we confirm that the relationship between the given variables is significant.

Conclusions

The paper aimed to visualize and analyze the relationships between selected economic and environmental indicators in the individual districts of Slovakia. Selected indicators included: municipal waste fee, an average monthly wage, and unemployment in the districts of Slovakia in 2019. Data were visualized and analyzed on a thematic map and in a boxplot. Based on the statistical testing, we can state that:

- there is a statistical relationship between the average wage and the amount of fee for municipal waste collection in the individual districts of the Slovak Republic,
- there is a statistical relationship between the municipal waste fee and the unemployment rate in the individual districts of the Slovak Republic.

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The contribution of the authors

Martin Rovnak – 65% (conception, data analysis, interpretation, discussion).
Roman Novotny – 25% (literature review, data analysis, language correction).
Matus Bakon – 10% (literature review, data collection).

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