
Analysis of the Links between Selected Socio-economic Indicators and Waste Management at the Regional Level in the Slovak Republic

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Abstract

Problems of continuous increase in waste production and currently still absenting technologies for their effective environmental disposal with positive economic benefits represent one of the global societal challenges which must be addressed primarily at the local level. The paper is focused on analysis of the current state and development in waste production at the regional level in the SR for the period of last ten years. Specifically we are interested in waste separation as the primary basis for the efficient recovery of waste. We verify causal link between the economic efficiency of regions and the rate of waste production as well as we observe if educational structure is related to the rate of waste separation. We observe continuous changes over time, as well as changes in relations between beginning and end of decade.

Key words: Waste management, Waste separation, Regional GDP, Educational structure, Correlation analysis

JEL Classification: O13, Q 56, R10

1 Introduction

Recently the waste represents one of the key problems of pollution of the human environment (Baranova, Fazekasova, Manko, 2013; Chovancova, Huttmanova and Starostka-Patyk, 2012). With the rapid growth of production not only over-exploitation of natural resources consumption is rising, but also the amount of waste inserted into the environment. Production rate is greater than its treatment.

Waste is virtually generated by every human activity; in manufacturing and consumer sector. Its formation and accumulation represents a significant impact on the environment, especially quality of water, air and soil, and it is possible factor of reducing the region's prosperity (Kotulic 2008; Ciekanowski 2013b). It penetrates into the plants and via the food chain endangers the health and life of animal and human population. Proper treatment and waste management therefore becomes such an important problem as the provision of basic necessities of life. Inappropriate waste treatment leads inter alia to reduce the production potential of soils (Vilcek, 2013) via a set of different negative externalities.

Economic growth of countries and regions leads to higher consumption (Kotulic, 2007; Tej, 2002; Ciekanowski, 2013a), which implies a higher waste production. On the other hand, the advancement of the regions associated with awareness of environmental issues (Hronec,

Huttmanova and Chovancova, 2009, can be a useful inhibitor of waste production in general, as well as inhibitor of further untreated waste. Therefore financial instruments (Tej, 2008) may not be the sole determinant influencing the positive trends in waste management. In this paper we analyze the relationships between the factors referred above - waste production - economic level - educational structure.

The regional waste management plans hold a key role within the development of a sustainable waste management. Their main objective is to present the waste flows and the options available in their management (Albu, Chitu, 2011).

Eastern countries appear to be performing generally quite well, thus benefiting from EU membership and related policies in terms of environmental performance. Although absolute delinking is far from being achieved for waste generation, there are some first positive signs of an increasing relative delinking for waste generation and robust landfill diversion, and varying evidence of a significant role of the EU waste policies implemented behind 1990. Waste prevention must be the next objective of waste regulation efforts. (Mazzanti, Zoboli, 2009).

Increasing per capita income results in the generation of more solid waste. An increase in the cost of residual waste collection, changing from weekly to an every other week residual waste collection and introducing separate curbside collection of organic waste increase a municipality's chance of reaching the goal. (Gellynck., Jacobsen and Verhelst, 2011).

Increasing per capita income in correlation with increasing solid waste as science and empirical results are supports with earlier findings on municipal level (Gellynck, Verhelst, 2007; Kinnaman, Fullerton, 1997; Podolsky, Spiegel, 1998).

2 Materials and Methods

Data for analysis were gained from publicly available sources of the Statistical Office of the Slovak Republic, databases REGDAT and census of people and households. Data were collected for a time period of 10 years: 2002 to 2012 (except for some cases). All data were collected at regional level of Slovakia. The factors used for partial analyzes include:

- regional GDP,
- production of municipal waste in regions,
- share of separated waste,
- educational structure.

Selection of parameters partially reflects the work of other authors mentioned in previous parts - especially economic indicators. Comparison represents an original analysis of correlations realized by authors of this paper.

Average number of the population-as the basis for calculation of other parameters per capita of region-was based on the mid-year population to 1st of July of respective year. Regional GDP is expressed in current prices, per capita of region.

Waste production in tones per capita of region was converted from the raw data of total waste production at the regional level. In addition to the total production of municipal waste were

calculated also separated components of municipal waste and other waste fraction, but because of necessity of deeper analysis they weren't used in this contribution.

Share of separated waste was calculated as the ratio between the quantity of separated waste and total municipal waste at the regional level. Following data were obtained or calculated for each year of the period 2002 -2012, with the exception of regional GDP. Official data of economic performance of regions measured by regional GDP in 2012 are absent for now.

The last parameter for the analysis is the educational structure. In its quantification at the regional level we used the methodology for calculating the index of education (Regional Operational Programme for NUTSII Central Bohemia. Socio-economic analysis), where:

$$\text{Education index} = 2 \cdot p_1 + p_2,$$

where:

p_1 - the share of the population above 15 years with university education

p_2 - the proportion of the population above 15 years of upper secondary education

Educational structure of the population at the regional level was calculated from the nationwide censuses conducted in 2001 and 2011. This parameter – unlike before mentioned parameters - is not a continuous parameter monitored throughout the period, but discrete values between 2001 and 2011.

Analysis of links we conducted using parametric Pearson correlation coefficient, whereas the testing normality of most parameters (Kolmogor-Smirn test) did not lead to the rejection of hypotheses about the normal distribution of individual parameters analyzed.

The normality of distribution was not confirmed in the index of education and regional GDP, in both cases, the inter-regional comparisons (between regions) in both studied years, i.e. 2001 and 2011.

3 Results

The first part of analyses addressed the relationship between economic development of the region and the production of municipal waste (both parameter per capita of region). We analyzed relationship between regional GDP and production of municipal waste separately for each of the regions of the SR for the particular years from 2002 to 2011.

Tab. 1 Analysis of the relationship between regional GDP and municipal waste production for the years 2002-2011

Region ¹	Correlation coefficient	p-value
BA	0,8698	0,001
TT	0,8952	0,000
TN	0,9715	0,000
NR	0,9146	0,000
ZA	0,0039	0,992
BB	0,0757	0,835
PO	0,8973	0,000
KE	0,8637	0,001

Source: Own research

¹BA – Bratislava region, TT – Trnava region, TN – Trenčín region, NR – Nitra region, ZA – Žilina region, BB – Banská Bystrica region, PO – Prešov region, KE – Košice region

With the exception of BB, in all other regions was found highly significant correlation between the level of regional GDP and production of municipal waste. In those regions the GDP growth has not been accompanied by a clear increase of municipal waste, which is evident from the graph.

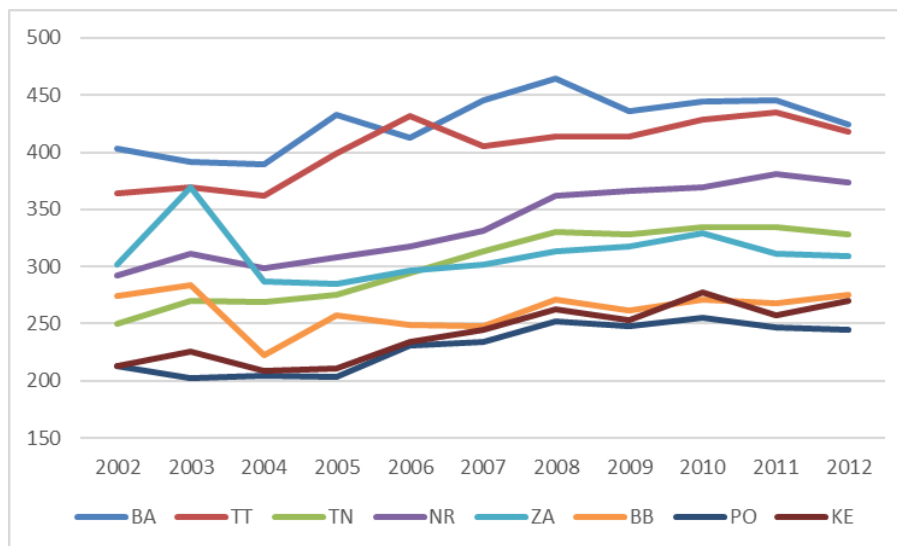


Fig. 1 Municipal waste production in tones per capita of region

Source: Statistical Office of the Slovak republic

In other regions, in addition to high significance of results can be seen high levels of correlation coefficients, therefore we can state that the annual change of regional GDP is tightly linked with annual change of municipal waste production - increase of regional GDP is accompanied with increase of municipal waste production.

This analysis, however, follows the relationship only at the regional level, i.e. within a relatively homogeneous structure (if we do not presume significant annual change of dominant features of a region), ignoring the inter-regional comparison. So we realized the analysis one more time, but we followed the relations between the same parameters in discrete periods (2001 and 2011), though not in inter temporal comparisons but in interregional.

Since testing of parameters normality does not allow adopting conclusions on the normal distribution (extreme values of regional GDP of BA region), we conducted a correlation analysis with the use of nonparametric Spearman's correlation coefficient.

Tab. 2 Analysis of the relationship between regional GDP and municipal waste production between regions of the SR

Year	Correlation coefficient	p-value
2002	0,547619	0,160026
2011	0,976190	0,000033

Source: Own research

Until 10 years ago, the relationship between municipal waste production and regional GDP was ambiguous; the latest available data declare clear relation between these parameters. Thus while in 2002 it was not possible to argue that the region, which has a higher regional GDP per capita simultaneously produces more municipal waste per capita, in 2012 this correlation is clear.

Those findings are based on the results of nonparametric tests of correlation analysis, whereas in the case of BA region with the extreme values of regional GDP led to the rejection of normality. However, as can be appreciated from the following graphs, provided for the application of parametric tests of correlation analysis we obtain statistically significant results already in 2002 ($r = 0.756$, p -value = 0.03) and very similar results 10 years later ($r = 0.748$, p -value = 0.033).

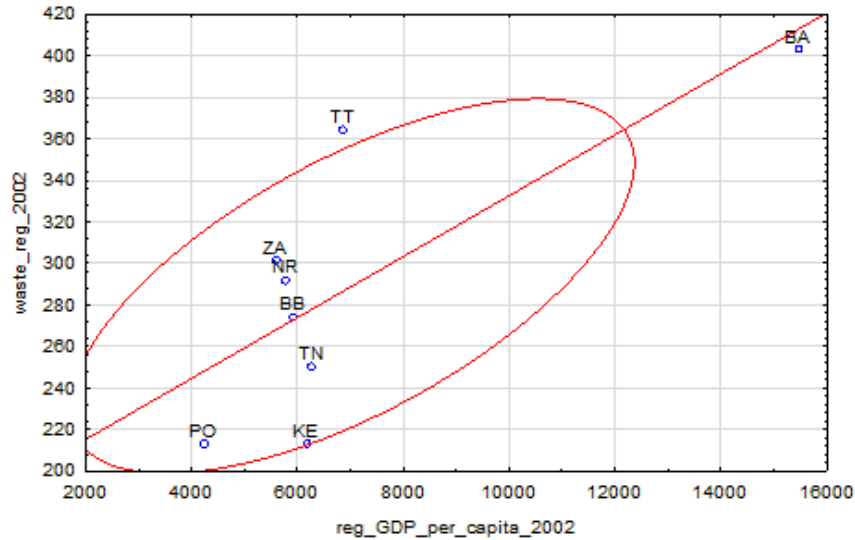


Fig. 2 The relationship between economic development of regions (in EUR per capita) and municipal waste production (kg per capita) in the regions in 2001

Source: Own research

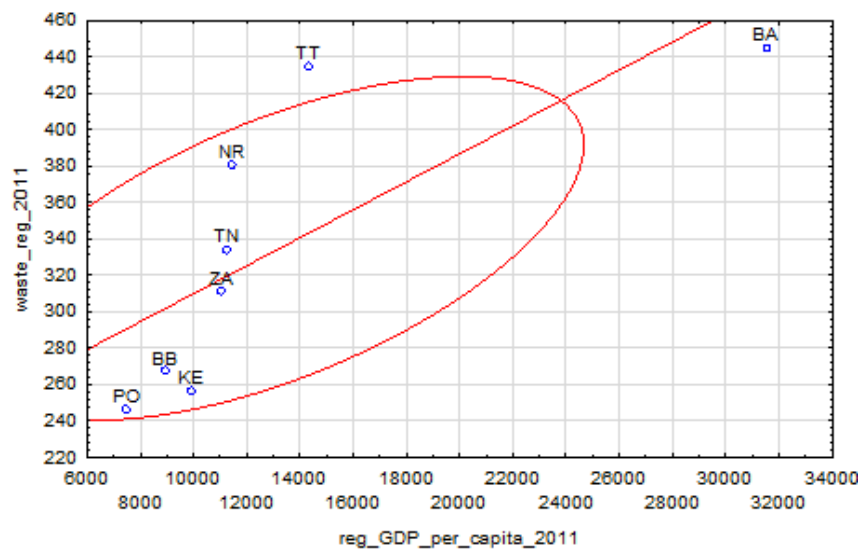


Fig. 3 The relationship between economic development regions (in EUR per capita) and municipal waste production (kg per capita) in the regions in 2011

Source: Own research

The slope of the regression linear axis points out an interesting fact – even though the increase of regional GDP is accompanied with increasing production of municipal waste, it is not a proportional increase. This is evident not only when compared with each other across regions – regions with multiple regional GDP per capita does not reach the same multiple of municipal waste – even regions with approximately the same regional GDP per capita have significantly different waste production per capita.

The lack of proportional increase of municipal waste depending on the growth of regional GDP is even more evident when comparing at the time-during this period the regional GDP doubled at the regional level, but municipal waste production increased by only about 10 %.

The next pair-parameters observed were the share of separated waste and educational level. Since the parameter of the educational level expressed by index of education at the regional level does not support the hypothesis of a normal distribution, the Spearman correlation test was used for testing.

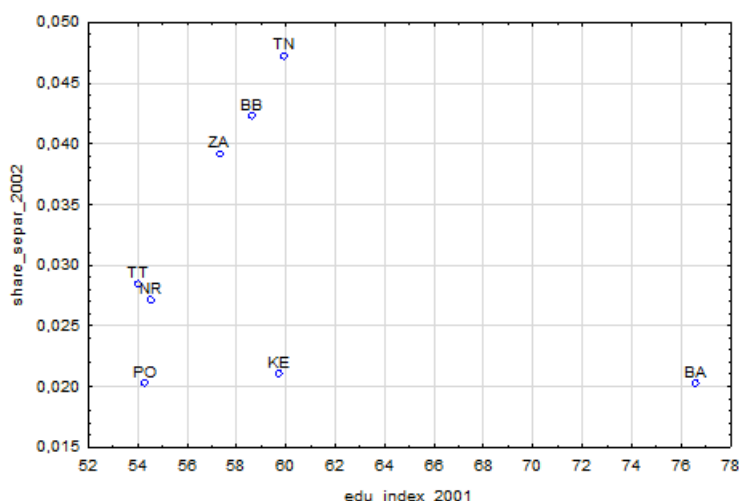


Fig. 4 The relationship between educational level and share of separated waste at the regional level in 2001
Source: Own research

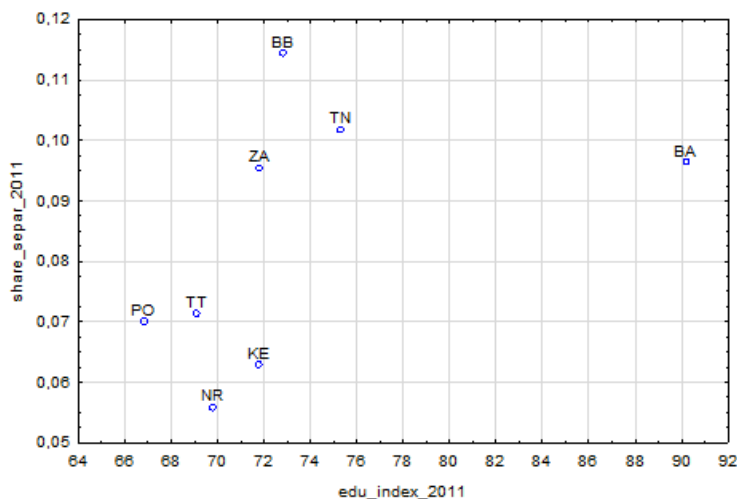


Fig. 5 The relationship between educational level and share of separated waste at the regional level in 2011
Source: Own research

By the visual assessment of values we can make some conclusions:

- for 10 years the educational structure of the population has significantly increased
- for 10 years the rate of separated municipal waste significantly increased
- rate of separated municipal waste is still very low
- visual assessment does not allow a suitable placing appropriate regression curve through the points in the chart.

The results of correlation analysis are summarized in Tab. 3.

Tab. 3 Analysis of the relationship between the educational level and the separated municipal waste in the regions of the SR

Year	Correlation coefficient	p-value
2001	0,142857	0,735765
2011	0,642857	0,085559

Source: Own research

Similarly in conclusive results could be achieved by applying parametric tests. On the basis of these results we can conclude that our assumption - the higher education of population - higher environmental awareness – higher municipal waste separation, was not confirmed. The rate of municipal waste separating is affected by other determinants than is generally quantified educational level.

3 Conclusion

In the present paper we analyzed the relationship between selected socio-economic parameters and production of municipal waste. The obtained results confirm our initial expectations only partially. We identified a significant correlation between regional GDP and production of municipal waste. We assume that the actual increase in production of municipal waste per capita is largely determined by the increase of regional GDP (as independent variable) which assumes increase of consumption of population due to increase of living standards.

The increase in welfare does not reflect the proportional increase of municipal waste, although there is and was identified the correlation between the given parameters. With the increase of regional GDP, the waste production grows too, but not proportionally. The increase of municipal waste production grows milder than regional GDP, which we evaluate very positively. The interesting phenomenon was revealed in regional comparisons - regions act as autonomous units in waste production. Therefore the results of relations between regional GDP and waste production cannot be generalized. We identified regions which have similar GDP and produce different amount of waste.

Higher level of education does not create automatically a more positive attitude towards environment issues. Higher education cannot be associated with a higher environmental awareness, which would alter the position of the cross-cutting issues of environmental protection (Chovancova, Harausova, 2013).

We assume that the municipal waste production at regional level is determined by other important factors which were not the subject of our analysis (for example: consumer behaviour, level of environmental awareness, technical infrastructure available in each region for waste management and etc.).

Analysis of these factors may be important not only for effective waste management at local, resp. regional level, but also at the national level - especially for effectively ensuring long-term sustainability, resp. fulfilling international commitments relating to the protection of the environment as part of management of waste management. We can assume continuous increase of economic level of society and continuous of municipal waste production too. To mitigate the environmental burden will be necessary encouraging more these factors (at

municipal and central level) which can inhibit growth of waste production, resp. their lack of use in the recycling process.

Our initial assumptions about the existence of links between these parameters are therefore only partially confirmed. On the other hand, we can conclude the positive trends in the municipal waste production, as well as in its efficient use. For the continuation of current trends it will be appropriate to identify relevant factors that determine these dominant processes and encourage their implementation in the all-society level.

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