International Journal on Emerging Technologies **10**(2a): 28-33(2019)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

Multi–Criteria Evaluation in Terms of Slovak Local Government-Case Study of Trencin Region

***Askar Nailevich Mustafin*[1] *and Roman Vavrek*[2]**
[1]*Institute of Management, Kazan Federal University Russia.*
[2]*Faculty of Management, University of Prešov. Russia.*

(Corresponding author: Askar Nailevich Mustafin)
(Received 05 May 2019, Revised 16 July 2019 Accepted 25 July 2019)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: If entities want to survive and prosper in the public sector under the current global and competitive environment, they have to change their way of thinking and managing. Efficiency evaluation based on multiple criteria is a more complicated option, but on the other hand, this evaluation gives more insight into the real state of public sector efficiency. The manuscript focuses on usage of one of MCDM methods - TOPSIS technique - as a tool for comprehensive evaluation in self-government in Slovakia. This method is applied on a sample of 276 municipalities of Trencin self-governing region. 8 criteria are used and their weight was calculated based on Equal importance method and Fuller triangle method with 25 experts from public sector. One of the results achieved is a fact that this kind of evaluation really depends on each indicator used (municipalities cannot focus only on one of them). It is possible to recommend TOPSIS technique for usage not only in public sector, but also in private sector as well. Its use is also conditioned by the appropriate selection of monitored indicators and also by weight determination, which significantly determines overall results.

Key words: Effectiveness, MCDM methods, TOPSIS technique, Trencin region

I. INTRODUCTION

Definition of the public administration is a topic of many scientific studies, agendas of discussions between representatives of business and government. This process is accompanied by both positive and negative phenomena for society. One of which is an increase in regional disproportions between the regions of the country (Mustafin *et al*. 2019). The possible reason is the fact that administrative law, with its jurisdictional approach and the narrow perspective, is not able to comprehensively deal with such a complex phenomenon as public administration. In figure 1 we can consider the public administration in a narrower sense (Siegl *et al*. 2011).

According to Prucha (2007), the public administration is widely understood as a public affairs administration carried out under the executive power within the state. The public administration, apart from the above, can therefore be viewed in a broader sense as a structure and hierarchy of power within the state.

Local self-government is a part of the public administration. Prucha (2007) refers to self-government as "residual public power" and considers it to be derived from the state's power. However, local self-government cannot be in conflict with the public administration. In this regard, the issue of trust is very important (Khafizov and Mustafin, 2017). It is therefore a form of public administration carried out by other bodies than state bodies and can be understood as a manifestation of the decentralized power of the state.

Heger (2012) claims that the local self-government has to have clearly defined territorial boundaries within which it can act. An important component is also the personnel potential of a territory (Seliverstova *et al.* 2018).

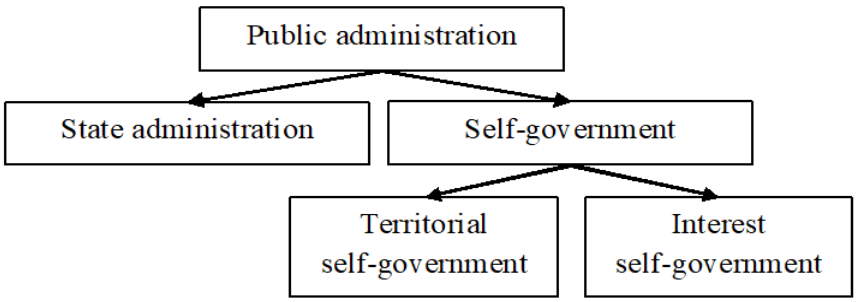

Fig. 1. Public administration in a narrower sense.

From the state's point of view, the structure of individual local authorities and the coordination of their competencies play an important role within the local government.

Literature outlines several options to measure efficiency in the public administration. The breakdown follows the complexity of the methods used and identifies 5 categories of methods: evaluation methods based on one criterion, assessment methods based on a number of criteria, comparative methods, management evaluation methods, other selected evaluation methods (Vavrek, 2018). Efficiency evaluation based on multiple criteria is a more complicated option, but on the other hand, this evaluation gives more insight into the real state of public sector efficiency.

II. METHODS

Multiple-criteria decision making (MCDM) supports decision makers with a comprehensive collection of approaches to address complex, poorly defined problems with multiple and interrelated criteria. MCDM refers to making decisions in the presence of multiple, usually conflicting, criteria. Each different criterion may have different units of measurement, quality characteristic, and relative weight. It is possible that some criteria can be measured numerically and other criteria can only be described subjectively (Zavadskas *et al.* 2016). According to Yue (2011), the objective of the MCDM is to find the most desirable alternative(s) from a set of available alternatives versus the selected criteria. One of these methods is TOPSIS technique (Technique for Order Preference by Similarity to Ideal Solution) which by considering both the above distances, tries to choose solutions that are simultaneously close to the ideal solution and far from the nadir solution.

TOPSIS technique allows a decision-maker to solve and analyze the problem, compare alternatives and establish their rank based on the selected criteria (Shih et al. 2007). A relative advantage of its usage is the ability to identify the best alternative quickly (Paxkan and Wu, 1997). The range of selected data is not determinative for its use, i.e. it is possible to use data of any extent. As another pros of this method could be mentioned an ability to work with all types of criteria, directness of calculation or concept enables to illustrate the best alternative by mathematical calculation (Bhutia and Phipon, 2012).

In case of the TOPSIS technique usage, the authors differentiate between 5 steps (Wu *et al.* 2013) and to 9 steps (Zolfani and Antucheviciene, 2012). Based on the literature research we use the procedure used by (Vavrek *et al.* 2015). According to Olson (2004), TOPSIS technique is attractive in that limited subjective input is needed from decision makers. The only subjective input needed is weights.

Indicators used and weight determination. The identification of individual criteria for TOPSIS calculation was based on personal consultations with government employees of the Financial Control and representatives of municipalities. The common goal was to jointly identify a set of core indicators that best reflect the real status of a particular municipality's economy and that would offer an alternative to the currently valid law-based evaluation. After several meetings, the set was minimized into the following group of monitored indicators:

R1 – total expenditures per capita,
R2 – share of foreign resources on the total assets of the municipality,
R3 – total income of the municipality per capita,
R4 – profit per inhabitant of the municipality,
R5 – return on assets,
R6 – current expenditures per inhabitant of the municipality,
R7 – foreign sources per inhabitant of the municipality,
R8 – current income per capita of the municipality.

The set of indicators, in our opinion, meets the requirements imposed on such a set by Fotr *et al.* (2004), i.e. completeness, operability, non-redundancy and minimum scope. The weight of each indicator is determined by Fuller triangle method (Alternative 1 – modified weights) and Equal importance method (Alternative 2 – same weights).

Table 1: Weights of criteria used in two alternatives.

Criterion	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
Weight – alterative 1 (M)	0,161	0,113	0,150	0,123	0,09	0,144	0,106	0,113
Weight – alterative 2 (S)	0,125	0,125	0,125	0,125	0,125	0,125	0,125	0,125

The results of TOPSIS technique are complemented by a set of mathematical and statistical methods, namely Dean Dixon test, Kendall rank coefficient, Kolmogorov-Smirnov test, Kruskal-Wallis test, Levene test, Mann-Whitney test, Moran index, Regression analysis, and Shapiro-Wilk test as well (Andel, 2007). The research focused on data from 2017. The whole process of statistical analyzes was carried out in MS Excel, Statistica 13.1 and Statgraphics XVII.

Application of TOPSIS technique in Trencin region. Trencin region (here in after "TSK") is a small region of Slovakia and its area reaches only two thirds of the average value. As for the population, this region ranks among those less populous with uneven distribution of inhabitants.

TSK has 276 municipalities (one of them is erased from the analysis due to unavailable data) the majority of which are small ones (Q3 = 1534.5). 25 % of municipalities has no more than 457.5 inhabitants. The largest city is the county seat of Trencín (55857 inhabitants), followed by Prievidza and Povazska Bystrica. The smallest statistical unit is the municipality of Trebichava with 39 inhabitants.

Fig. 2. Districts of Trencin region.

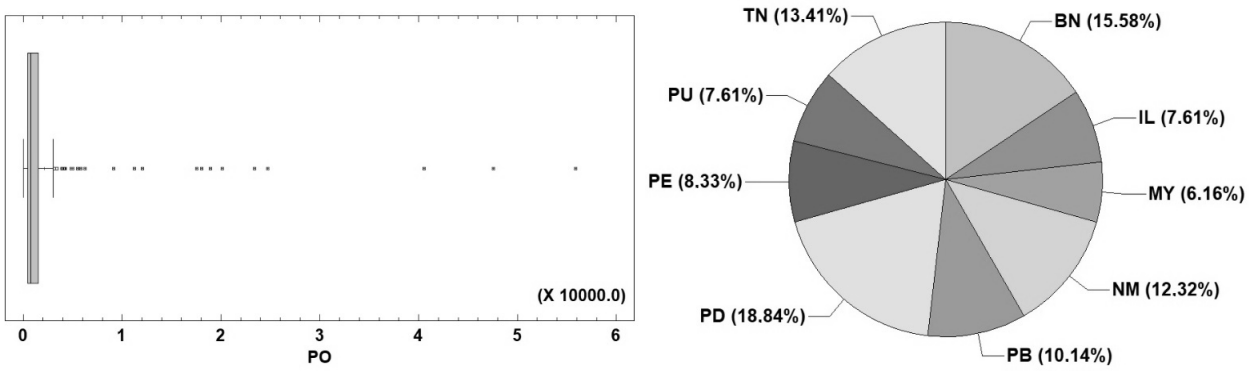

Fig. 3. Districts of Trencin region.

Results of TOPSIS method and statistical processing. Table 2 shows the ranking of selected municipalities, including values of the individual indicators and also the correlations between overall result and each indicators used. It is possible to see the domination of the best evaluated municipality (Cerenany) which achieved the highest overall score (relative distance from PIS).

Table 2: Ranking of municipalities based on TOPSIS method.

S	M	District	Muni	c_i*	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
1	1	PD	Cerenany	0.893	521	9	537	1137	0.36	421	281	467
2	2	PB	Sadocné	0.730	279	0,71	811	499	0.25	279	14	302
3	4	PD	Radobica	0.671	408	7	396	244	0.33	380	53	396
4	3	PD	Lipník	0.667	370	19	419	429	0.16	370	518	415
5	5	TN	Stvrtok	0.637	398	1	459	265	0.18	388	25	431
...	...	...	...	...	...	...	...	...	...	...	...	...
271	272	PB	Slopna	0.412	2623	63	494	-11	0	461	2143	476
272	270	PD	Malinova	0.411	345	4	371	-173	-0.16	308	43	352
273	274	PB	Podskalie	0.366	4420	66	460	4	0	392	4017	460
274	275	PB	Durdove	0.360	4824	64	684	-1	0	581	4200	684
275	273	NM	Ockov	0.316	406	1	378	-659	-0.32	309	22	378
Correlation of results with individual criteria												
same indicator weights (r_K)					-0.10	-0.15	-0.08	0.11	0.16	-0.07	-0.16	-0.06
p-value					<0.01	<0.01	0.03	<0.01	<0.01	0.06	<0.01	0.122
modified indicator weights (r_K)					-0.13	-0.15	-0.10	0.11	0.16	-0.09	-0.17	-0.08
p-value					<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.037

S – rank based on the same weights of selected indicators S – rank based on the same weights of selected indicators
M – rank based on the modified weights of selected indicators
* - relative distance from PIS

Majority of rank correlations are not statistical significant or these correlations could be classified as small. In that fact if the municipality wants to improve their rank it is not sufficient to focus only on one or two indicators. It is necessary to follow each indicators at the same time. For the purposes of further analysis, outliers (municipalities) identified by the Dean Dixon test were removed.

Table 3: Outliers (municipalities).

District	Statistical unit
Banovce nad Bebravou	Banovce nad Bebravou
Ilava	Dubnica nad Vahom, Ilava, Nova Dubnica
Myjava	Brezova pod Bradlom, Myjava
Nove Mesto nad Vahom	Cachtice, Nové Mesto nad Vahom, Stará Tura
Partizanske	Bosany, Partizanske
Povazska Bystrica	Povazska Bystrica
Prievidza	Handlova, Prievidza
Puchov	Belusa, Lednicke Rovne, Puchov
Trecin	Nemsova, Trencin

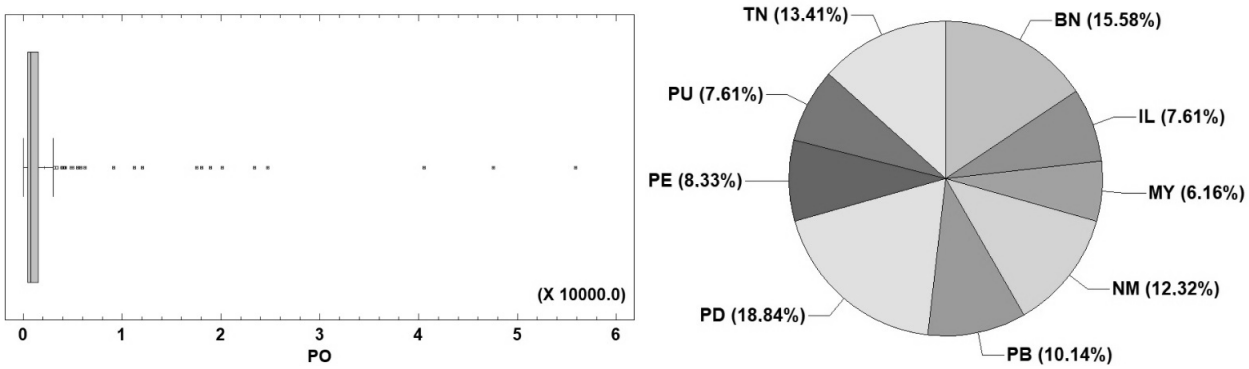

Fig. 4. Comparison of distribution functions of results.

Kolmogorov-Smirnov do not confirm any match of the results' distribution functions (K-S = 0,242, p < 0.01). Based on its result we can say that the weights of indicators used significantly affects structure of the results. Nevertheless, the high rank correlation of Kendall coefficient is confirmed (rK = 0,924, p < 0.01).
WS - distribution function of results of TOPSIS technique with same indicator weights; WM - distribution function of results of TOPSIS technique with modified indicator weights
The rank correlation between the result of TOPSIS method and the number of inhabitants is tested by Kendall coefficient too, which do not identified any negative rank correlation (r_{KS} = -0,024, p < 0.55; r_{KM} = -.0.042, p < 0.30). Testing of all requirements of regression analysis is outlined in Table 4.

Table 4: Residues requirements.

Requirement	Test (S)	Test (M)	
$\varepsilon_i \sim N(0; \sigma_\varepsilon^2)$	SW = 0.765, p < 0.01	SW = 0.735, p < 0.01	unfulfilled
$E(\varepsilon_i) = 0$	$E(\varepsilon_i)$ = 0.009	$E(\varepsilon_i)$ = 0.009	fulfilled
cov (ε_i ε_j) = 0	Moran I = 0.040	Moran I = 0.025	fulfilled
$D(\varepsilon_i) = \sigma_\varepsilon^2$	L_E = 10/10	L_E = 10/10	fulfilled
outliers	Dean Dixon test	Dean Dixon test	fulfilled

The dependence between the number of inhabitants and the results is expressed by the regression functions, whose predictive value is expressed by high coefficient of determination (97.5 %). Since not all requirements were met, this conclusion cannot be generalized for sure:

$$W_S = 0.0769848*\ln(PO), \text{ or } W_M = 0.0783829*\ln(PO) \quad (1)$$

Districts of Trencin region. The change of weights of monitored indicators could affect each attribute of the results. As we can see (Table 5), the districts of TSK can be divided into 2 groups: First of them consists of 2 districts - the district of Povazska Bystrica and Prievidza. Based on the change of weights, the mean value of relative distance from PIS is significantly different (F-ration$_{PB}$ = 4.51, p = 0.038; W_{PD} = 1617, p = 0.011). The results in other district are not affected by weights of indicators used in TOPSIS technique procedure. Homoscedacity is confirmed in each district. Fig. 5 shows the difference between districts each other, whose evaluation is a little bit different. The best average score is obtained by the district of Prievidza in both of analysis realized. But the differences between first and second place are really small (<1%). Due to the change in monitored weights the evaluation of each district improved by 1.8 % on average.

Table 5: Selected characteristics of regions.

District	Normality	Homoscedasticity	Identical mean value
Bánovce nad Bebravou	no	yes	yes
Ilava	yes	yes	yes
Myjava	yes	yes	yes
Nové Mesto nad Váhom	yes	yes	yes
Partizánske	yes	yes	yes
Považská Bystrica	**yes**	**yes**	**no**
Prievidza	no	yes	no
Púchov	no	yes	yes
Trenčín	no	yes	yes

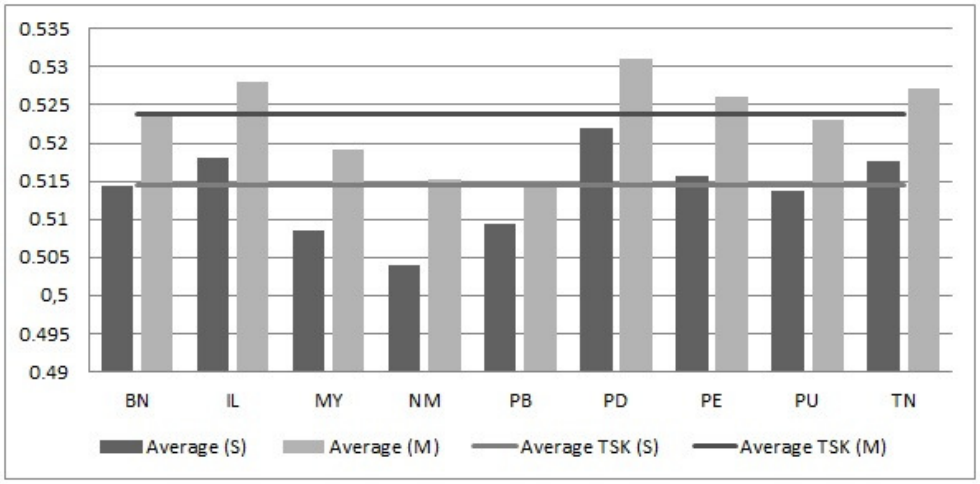

Fig. 5. Average evaluation of municipalities' management in districts of TSK.

Kruskal-Wallis test confirm a statistically significant difference between the districts of TSK (KWS = 4.39, p = 0.819; KWM = 4.46, p = 0.812). In both cases, Levene test also do not confirm the homoscedasticity of the results.

III. CONCLUSION

Rating based on multiple criteria, i.e. multi-criteria analysis, offers the possibility of a comprehensive evaluation of a set of units based on several indicators. Many factors have to be taken into account when choosing them since the inclusion or non-inclusion of the indicator in the analysis will significantly affect its results. The second significant factor influencing the overall result is the weighting determination which could statistical significantly influence the results obtained. Based on a theoretical search capturing diverse approaches to assessing the efficiency in public sector, we have selected 8 indicators whose importance was determined by two methods - Equal importance method and Fuller triangle method. These data were evaluated using TOPSIS technique in 2017.

IV. SUMMARY

Based on the statistical analysis of the results obtained, we note that:

(a) The overall score of municipality is effected by more than indicator used. In that fact if the municipality wants to improve their rank it is not sufficient to focus only on one or two indicators.

(b) The change of weights used leads to difference average/median score in 2 districts, each district variance is unaffected.

(c) The territory of TSK can be considered homogeneous from the point of view of municipal evaluation.

ACKNOWLEDGEMENTS

The work is carried out according to the Russian Government Program of Competitive Growth of Kazan Federal University.

This article was elaborated as a part of grants GaPU 44/2019, KEGA 038PU-4/2018 and VEGA 1/0578/18.

REFERENCES

[1]. Andel J., (2007). Zaklady matematicke statistiky. Prague: Matfyz. ISBN 978-80-7378-162-0.

[2]. Bhutia P.W., Phipon R. (2012). Application of AHP and TOPSIS Method for Supplier Selection Problem. *Journal of Engineering*, *2*(10), 43-50.

[3]. Fotr J., Dedina J., Hruzova H. (2000). *Manazerske rozhodovani*. Prague: Ekopress. ISBN 80-86119-20-3.

[4]. Heger V. (2012). *Komunikace ve verejne sprave*. Prague: Grada Publishing. ISBN 978-80-247-3779-9.

[5]. Khafizov M.D, Mustafin A.N. (2017). Development of small and medium entrepreneurship: Evidence from Russia. *International Journal of Economic Perspectives*, *11*(3), 1529-1534.

[6]. Mustafin A.N., Shlyakhtin A.E., Kotulič R. (2019). *Role of public management in elimination regional disparities. Polish Journal of Management Studies*, 19.

[7]. Olson D.L. (2004). Comparison of weights in TOPSIS models. *Mathematical and Computer Modelling* (40), 721-727.

[8]. Paxkan C., Wu M.L. (1997). On the equivalence of operational performance measurement and multiple attribute decision making. *International Journal of Production Research*, 35, 2963-2988.

[9]. Prucha P. (2007). *Spravni pravo, obecna cast.* Brno: Bmo – Doplnek. ISBN 978-80-210-427.

[10]. Seliverstova N.S, Mustafin A.N, Benková E. (2018). Analysis of the factors affecting the choice of information systems by economic subjects of Russian Federation. *Journal of Social Sciences Research* (5), 46-51.

[11]. Shih, H.S., Shyur, H.J., Lee, E.S. (2007). An extension of TOPSIS for group decision making. *Mathematical and Computer Modelling* (45), 801-813.

[12]. Siegl M., Stejskal J., Stanska Kotatkova P. (2011). Management verejneho sektoru. Pardubice: Univerzita Pardubice. ISBN 978-80-7395-415-4.

[13]. Vavrek, R. (2018). Efficiency and inefficiency of public administration. *Journal of Economic Development. Environment and People, 7*(1), 6-14.
[14]. Vavrek, R., Kotulič, R., Adamisin, P. (2015). Evaluation of Municipalities Management with the Topsis Technique Emphasising on the Impact of Weights of Established Criteria. Lex Localis. *Journal of Local Self-Government, 13*(2), 249-264.
[15]. Wu. Ch., Hsieh Ch, Chang K. (2013). A Hybrid Multiple Criteria Decision Making Model for Supplier Selection. *Mathematical Problems in Engineering*, 1-8.
[16]. Yue, Z. (2011). *A method for group decision-making based on determining weights of decision makers using TOPSIS*. *Applied Mathematical Modelling*, *35*(4), 1926–1936.
[17]. Zavadskas, E.K., Mardani, A., Turskis, Z., Jusoh, A., Nor K., 2016. Development of TOPSIS Method to Solve Complicated Decision-Making Problems: An Overview on Developments from 2000 to 2015. *International Journal of Information Technology & Decision Making*, *15*, 645-682.
[18]. Zolfani S.H., Antucheviciene J. (2012). Team Member Selecting Based on AHP and TOPSIS Grey. Engineering Economics, *23*(4), 425-434.