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Importance of the Criterion as a Part of MCDM Analysis: Case Study on the Slovak District Towns

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Abstract: Selection of suitable criteria for subsequent application in multi-criteria analysis requires deep knowledge of the specific issue. Subsequent determination of the importance of selected criteria, which directly determine the results of the entire analysis, is no less important. The objective of this article is to identify the differences between various methods of determination of the importance of criteria. A total of 71 local government subjects (district towns) in the Slovak Republic were selected, which were assessed on the basis of 5 criteria. Total debt, debt service and current account balance can be included among these criteria. The importance of the criteria is gradually assessed using 3 objective methods and the obtained results are compared to each other. We state significant heterogeneity of the results depending on the method used. Approaches in one group of methods result in varying importance of criteria, which subsequently gives different results of multi-criteria analysis. The requisite attention and time need to be devoted to selection of a specific method and the results also need to be interpreted in the context of any limitations.

Keywords: municipality; Slovakia; weight of criterion; objective approach

JEL Classification: B23; E69; H11

1. Introduction

At a time of increasing global competition, which we can also identify the 21st as, we need to devote increasing attention to effective expenditure of funds (Hsieh & Fu, 2014; Pevcin, 2014) or identification of alternative sources of funds (Wu et al., 2013). Decisions made on the basis of multiple criteria are gaining popularity and application of this method can be found in various areas of the public and private sectors. The performance evaluation of local self-government entities is very difficult as their primary goal is not to make a profit, but to provide services to their residents that will contribute to an increased quality of life. In this context, it is necessary to evaluate their activity from the viewpoint of several and available criteria, for which it is possible to find relevant and recognised sources.

In general, it can be stated that the result of application of the multi-criteria method (MCDM) is directly determined by the individual making the decision. Pekár and Furková (2014, p. 147) consider the process of determining the importance of the criteria being analysed very important, because the "weights affect the final order and incorrect determination of weights can result in changes to the order and preference of other alternatives". Also by the way they select an approach or a method for determining the importance of individual criteria. Liu and Yin (2019) offer a method for classifying these methods, whereas they identify two groups of methods. Dutta et al. (2021) work with three groups, whereas Keršuliene et al. (2010)

use four groups of methods for determining weights, which represent expansion of the previous classification methods, during which time the groups in question are:

- subjective,
- expert,
- objective,
- integrated.

Subjective methods reflect the personality of the individual making the decisions and his/her individual preferences (the weight of the indicator is determined on the basis of subjective opinion). Expert assessment is carried out by a smaller number of experts in the given field, during which time application of this method in the past is presented by Kendall (1970) or Fisher and Yates (1963). Use of a group of experts and the method of pairwise comparison of criteria (e.g. using the Fuller triangle method) can be found in research by Cambazoğlu et al. (2019); Diaz and Cilinskis (2019) or Polikarpov et al. (2019). The third group, i.e. the group of objective methods, assigns weights to individual criteria on the basis of a previously determined mathematical model, which is unique for each method. The decision-maker therefore has no direct influence on determination of the importance of criteria, but selects according to preference of the properties of the used data, e.g. depending on variability or relations between criteria. This group includes methods such as the Mean Weight method (Paradowski et al., 2021), Standard Deviation method (Ouerghi et al., 2018), Mahalanobis-Taguchi System Method (Yuan & Luo, 2019), λ bi-capacity model (Zhang et al., 2020), Coefficient of Variance method (Vavrek & Bečica, 2022) and others (e.g. Singla et al., 2018; Yalcin & Unlu, 2018). The last group is the integrated methods, which represent a combination of the methods described above.

The presented research works with three approaches to determining the importance of the analysed criteria from the group of objective methods, specifically the MW (mean weight), CV (coefficient of variance) and SD (standard deviation) methods. These approaches are gradually introduced, together with identification of their use in research by various authors. The results of application on real data from the local government area in the Slovak Republic are presented in the last section.

2. Methodology

The goal of the paper is to identify the differences arising from various methods for determining the importance of criteria. For this purpose, three objective approaches to determining the importance of criteria are selected and applied to data from 2020, in a structure recommended by INEKO (2022), which is also used by Vavrek (2019):

- K1 – Total debt,
- K2 – Debt service,
- K3 – Current account balance,
- K4 – Obligations past their due date,
- K5 – Obligations at least 60 days past their due date.

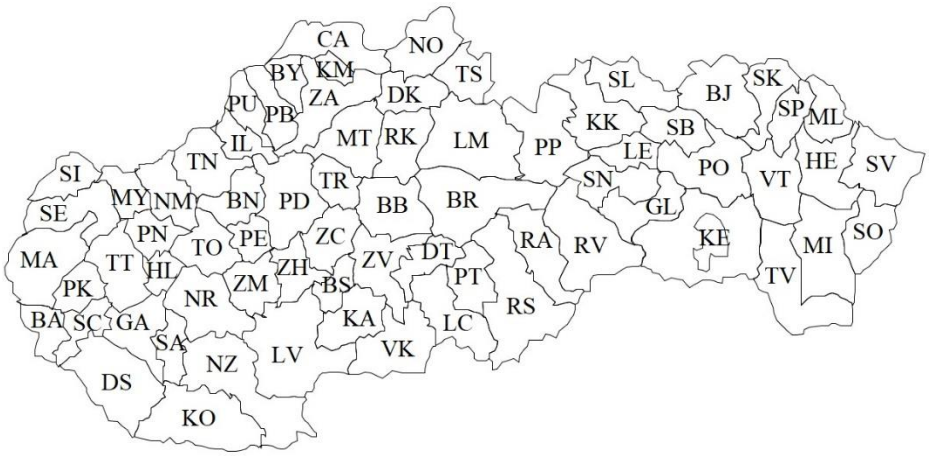

Figure 1. Local administrative division of Slovakia (districts)

Within the meaning of Act No. 221/1996 Coll., on the territorial and administrative organisation of the Slovak Republic, as amended, the territory of the Slovak Republic is divided into eight regions and 79 districts (Figure 1). Only 69 of the 79 districts have district towns, with the exception of five districts in the self-governing Bratislava region (Bratislava I district, Bratislava II district, Bratislava III district, Bratislava IV district, Bratislava V district) and five districts located in the Košice self-governing region (Košice I district, Košice II district, Košice III district, Košice IV district, Košice-surrounding area district). In addition to these 69 district areas, INEKO assesses the financial health of the municipal authority of the capital city of Bratislava and the city of Košice, i.e. the total number of assessed subjects within the terms of the presented research is 71.

2.1. Procedure for Using Objective Methods to Determine the Importance of Criteria

The 1st method (MW method) considers the individual criteria to be equally important (equal), during which time the weight of each criterion is calculated using the following formula:

$$w_j = \frac{1}{n} \tag{1}$$

where: n – number of criteria.

The 2nd approach (CV method) is a representative of the objective methods of determining the importance of criteria, working with their variability in relative terms. Its use in research is various, moment characteristics (Sangnawakij & Niwitpong, 2017; Mokrá et al., 2021) and CV graph (Tran et al., 2019) are supplemented by a parameter for determining importance. In this method, the importance of the assessed criteria is determined on the basis of the coefficient of variance (Coefficient of Variance method – CV) using the formula:

$$w_j = \frac{CV_j}{\sum_{j=1}^{n} CV_j} = \frac{\frac{\sigma_j}{\bar{x}_j}}{\sum_{j=1}^{n} \frac{\sigma_j}{\bar{x}_j}} \tag{2}$$

where: CV_j – variation coefficient of j-th criterion; n – number of criteria; $\bar{x}_j$ – average value of j-th criterion.

The 3rd approach (SD method) is also a member of the objective group of method working with variability, but in absolute terms. The importance of the assessed criteria is determined on the basis of a determinant deviation (i.e. the Standard Deviation Method – SD) using the formula:

$$w_j = \frac{SD_j}{\sum_{j=1}^{n} SD_j} \quad (3)$$

where: SDj - standard deviation of j-th criterion; n – number of criteria; $\bar{x}_j$ – average value of j-th criterion.

All analyzes are processed in MS Office Excel, Statistica and Statgraphics.

3. Results and Discussion

The first of the applied approaches is also the simplest, in the case of which all input criteria are equal. In such case, none of the criteria can be identified as more or less important, i.e. there is no option of assessing dominance or determining the order of importance (see Figure 2).

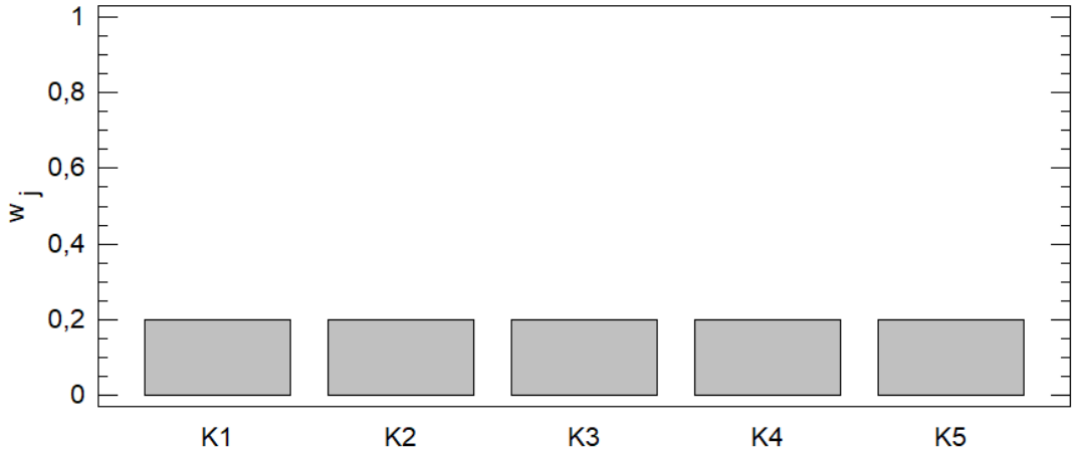

Figure 2. The importance of input criteria from the aspect of the MW method

The principle of the second method of determining the importance of criteria is based on measuring their relative variability by means of a specific moment characteristic, i.e. coefficient of variance. Majority importance is assigned to the last criteria (w_5 = 0.550), during which time the three criteria with the lowest weight are very balanced and oscillate around 5% (Figure 3).

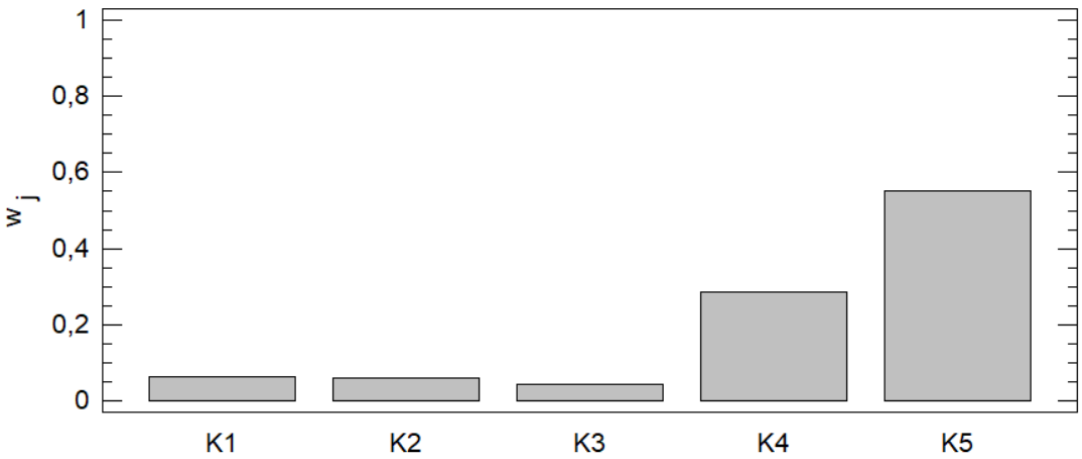

Figure 3. The importance of input criteria from the aspect of the CV method

The principle of the third method used to determine the importance of criteria is based on measuring their absolute variability by means of one of the moment characteristics of variability, specifically the determinant deviation. This method assigns the greatest importance to the first of these criteria, i.e. Total debt (w_1 = 0.602). This is followed by two criteria of an importance on the level of 15.21%, or 21.32%. From this viewpoint, the importance of the remaining two criteria is minimal and does not exceed 2% in both cases.

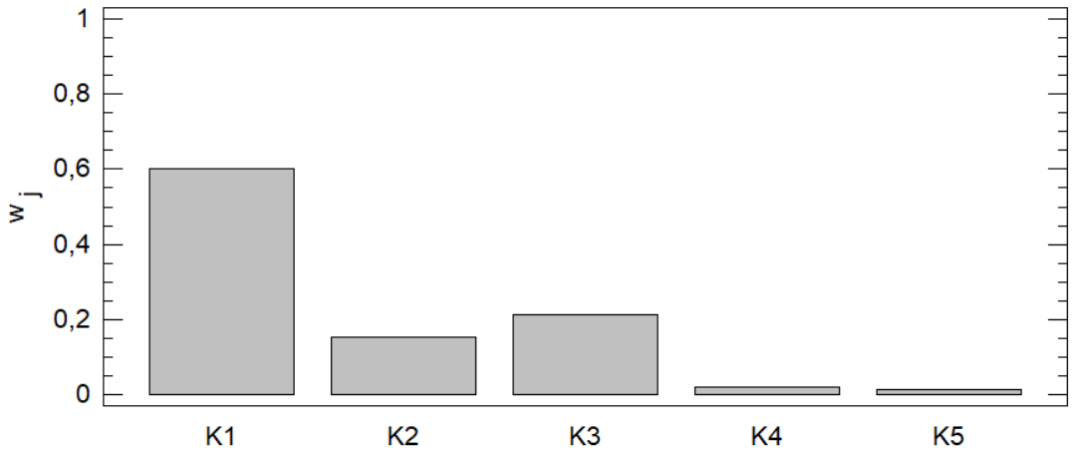

Figure 4. The importance of input criteria from the aspect of the SD method

On the basis of the above, it is possible to identify significant differences arising from application of three simple objective methods for determining the importance of criteria.

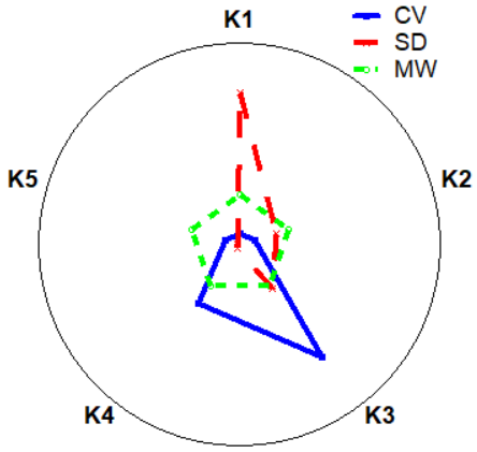

Figure 5. Comparison of the importance of input criteria from the aspect of individual methods

The first of these methods views the individual criteria as equal, which is also reflected in the graph above (Figure 5). During application of the other two methods, we observe significant differences in the obtained results. In both cases, one of the criteria is significantly dominant. On the basis of relative variability, it is possible to identify the most important criterion as K3 - Current account balance (w_3 = 0.550). In the case of absolute variability, this criterion is Total debt, i.e. criterion K1 (w_1 = 0.602). There was absolutely no consistency in the order of the criteria.

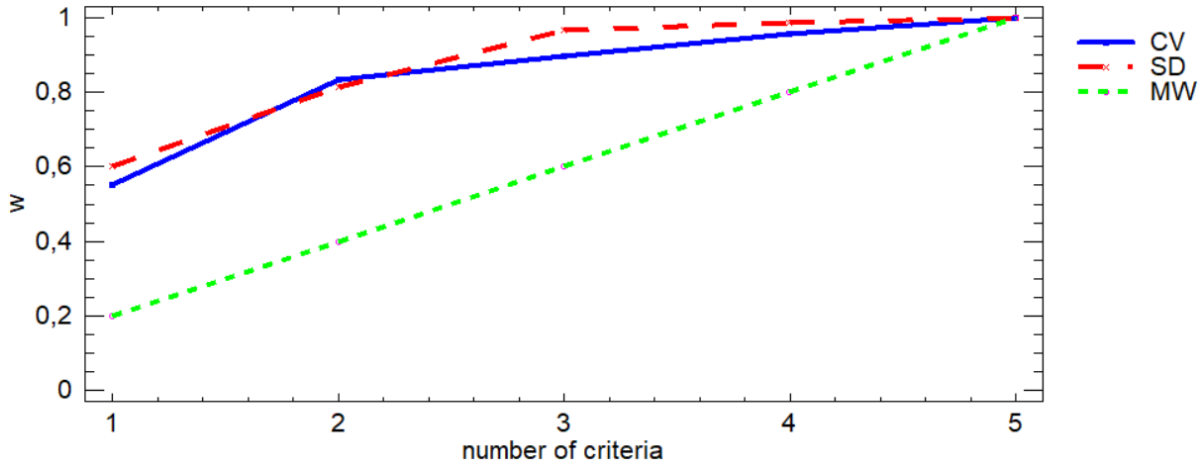

Figure 6. Comparison of the accumulated importance of the input criteria from the aspect of individual methods

The accumulative weight of the criteria is a linear function in the case of the MW method, during which time this grows constantly with the rise of the number of the criteria. In the case of use of the CV method and also the SD method, majority importance is assigned to the two most important criteria (CV: K3 + K4; SD: K1+K3). In both cases, this represents more than 80%. The least important criterion has minimum effect on the results of potential multi-criteria analysis, because the weight assigned to it does not exceed 5% (CV: K1 – 4.36%; SD: K5 – 1.30%).

4. Conclusions

As a result, the multi-criteria evaluation of territorial self-government subjects (in our case, district cities) proved to be highly applicable. In the preceding sections we devoted attention to the importance of input criteria from the aspect of individual methods for determination of such importance, i.e. from the aspect of the MW, CV and SD methods.

Currently, in the conditions of municipalities, single-criteria methods are sporadically used. Many different approaches evaluate a selected group of self-government subject using a different number of criteria, starting with 5 and ending with a group with over 100 criteria. Selection of the method for determining the importance of input criteria has a substantial impact on the results of multi-criteria analysis. The presented research on a simple example confirms this assumption. When selecting a method, even within the terms of one group, a homogenous result cannot be expected. Each of the presented options has its own advantages and disadvantages, which should be taken into consideration when making the final choice.

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Conflict of interest: none.

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