

# Comparing Regions' Ranking by MCDM methods: the Case of Visegrad Countries

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*Abstract:* - The paper solves the problem of an alternative access to quantitative evaluating of differences in the level of socio-economic development of regions in Visegrad Four countries (V4). The aim of the paper is to define the position of NUTS 2 regions in the period 2000-2010 by utilizing methods of Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW) and Technique for Order Preferences by Similarity to an Ideal Solution (TOPSIS). The sense of applying the methods will be setting the rank and mutual positions of NUTS 2 regions reflecting their socioeconomic development reached for the year 2000, 2005, 2010 based on selected regional data (criterion). The AHP, SAW and TOPSIS are concrete multicriteria decision-making methods (MCDM) which use the hierarchy of elements and ranking the alternatives according to utility and distance functions. Based on the application of methods we can gain detailed view on the regional development of regions by way of quantitative multidimensional characteristics which can lead to more precise evaluation of the socioeconomic disparities among NUTS 2 regions.

*Key-Words:* - AHP, Cohesion policy, Multicriteria decision-making methods, Pairwise comparison, Regional disparities, SAW, TOPSIS, Visegrad Four

## 1 Introduction

In spite of the fact that European Union (EU) is one of the wealthiest parts of the world, many European countries are facing the problem of regional disparities when the level of economic, social and territorial development of particular regions is obviously different. In 2004, EU expanded with 10 new countries (Estonia, Lithuania, Latvia, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Malta and Cyprus) that increased the population and the area of EU by one third, while wealth increased only by five percent [34]. This integration represents a challenge for the EU internal cohesion and competitiveness at a global level. The socio-economic differences among territorial units in European countries became a primary interest of economists as well as politicians. There is a general belief that the difference in the level of the majority of economic indicators should be kept in sustainable limits for the welfare of each country as a whole EU. European countries supported by the EU take actions aimed to reduce or eliminate the differences in economic and social development among the regions [9]. The main role in the regional development plays the EU cohesion policy (EU regional policy). Through the EU cohesion policy, the European Union aims to reduce the economic,

social and territorial disparities and support lagging states and their regions so that they can catch up with the rest of the EU member states. In the period 2007–2013, cohesion policy focuses on the support of regional growth, innovation and job creation through multi-annual development programmes co-financed by EU Structural funds (European Regional Development Fund, European Social Fund) Cohesion fund and national budgets.

Given the data about actual state of development, the financing from the EU cohesion policy and member states' budgets may be more rational and effective [10]. Therefore, the quantitative analysis of regional disparities indicators can serve as the basis for the regional development policy and regional planning because it brings important information about the key problematic issues in the region and its development potential. However, the evaluation of regional disparities is related to the problem of lack of uniform methods or an aggregate index. Currently used approaches (i.e. gross domestic product per region inhabitants) are either not sufficiently complex or are unsuitable for quantitative evaluation of economic and social development of the particular state's regions. Multi-criteria (multi-attribute) approaches may be more efficient in solving this problem [9].

The aim of the paper is to define the rank and mutual positions of NUTS 2 regions in Visegrad Four countries reflecting their socioeconomic development in the period 2000-2010 by utilizing MCDM methods. The Visegrad Four (the Czech Republic, Hungary, Poland and Slovakia) belongs to central European states that in the nineties of 20th century underwent an essential economic restructuring. However, since this time the states have been involved in free market, they have faced with the problem of insufficient regional development, which, if not solved, may give rise to a number of complicated economic and social problems. Economic development of V4 countries of the last 10 years has been strongly linked to European funding. Although the regional disparities have been reduced in V4 with contribution of EU cohesion policy, disparities have still persisted especially between regions of capital cities and regions that are more distant from capital city, see e.g. [12], [23]. Based on multicriteria approach, the paper provides an alternative view on quantitative evaluating of differences in the level of socio-economic development of regional unit.

The rest of this paper is organized as following. Basic concepts of regional development evaluation are introduced in Section 2. In Section 3 methods of Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW) and Technique for Order Preferences by Similarity to an Ideal Solution (TOPSIS) are reviewed. Section 4 illustrates an empirical case for evaluation of socio-economic development of regions and regional disparities. In Section 5 conclusions and remarks are provided.

## 2 Evaluation of regional development in the EU

Generally, the term “development” can be defined as the process of positive quantitative or qualitative changes. Regional development is a complex of processes taking place within the regions that affect economic, social, environmental and other changes of a region. Regional economic and social development may be described from various perspectives using different criteria, often oriented in different directions. In many cases, the level of region’s development is measured by gross domestic product (GDP) that defines economic growth (increase of overall output of the region during a given period). In fact, regional development is a wider and more complex concept. Regional development involves economic as well as social and ecological development providing good conditions for increasing regional cohesion and

competitiveness. This shows that the evaluation of region’s development is a complicated problem to be addressed by complex approaches [9].

Regional development is a broad term that can be also seen as a general effort to reduce regional disparities by supporting (employment- and wealth-generating) economic activities in regions [18]. The quantification of regional disparities falls into important spheres of a regional policy at state and European level. The central authorities at national level as well as European Commission at the EU level should enable balanced development of a member state, and should support the balancing of differences among the levels of particular regions. This is the reason why it is necessary to create a suitable methodology that will enable a measurement of the regions’ current socio-economic level, and will consequently change this level after the implementation of the projects that focus on the improvement of a situation in a region.

### 2.1 Role of regions in the EU

Since the eighties and nineties of 20th century, the term “region” has become one of the most frequent words in the global, European and social science discourse. To find the uniform or universally accepted definition of “region” is almost impossible. In EU conditions, we are mostly talking about the regions from the perspective of the geographical concept and in the context of cohesion policy. Geographically, the region is a part of the area that is characterized by a set of similar natural and socio-economic elements and relations which differ from the other territorial units. Region represents important historical, political, economic, social or cultural units that have undoubtedly become an integral part of the multi-level model of governance, which has been promoted in democratization, decentralization processes since seventies of 20<sup>th</sup> [4]. The growth of regions’ importance can be interpreted as a reaction to social developments; in particular, the crisis of the nation state, which reinforces the importance of global and regional or local level, and the crisis of the welfare state resulting from the increasing differentiation and plurality of social values, norms and lifestyles. From the perspective of the economic dimension, regions have become an important subject due to globalization and internationalization of the economy. Strategic importance has local and regional embedding of economic activity, which results in the creation of regional clusters. The regions are also important as political-administrative units. We are talking about the need of subsidiarity, decentralization and transfer of competences.

Currently, the European Union can be seen as a mosaic composed of more than two hundred different regions. Economic, social, cultural and historical diversity of the regions represents a specific competitive advantage, but to some extent also shows the weakness for balanced development. Over time, the regions have seen their influence increased at the EU level. Incorporating the principle of subsidiarity in EU law and creation of the Committee of the Regions showed that regions were given much more important role in EU policy making. After the Maastricht Treaty (1993) came into force, regional authorities have received more competences in the areas of regional policy, social policy, transport, environment, research, technological development, culture, employment, tourism, energy [21]. At the EU level, the region represents a point of reference between the central and local governments. Regional and local authorities are directly in touch with their citizens. They know about the local circumstances and have direct access to the necessary information about the consequences of political decisions in regions. Through the regional European policy's processes the EU can be brought closer to its citizens. Regions also have a democratic legitimacy, and can bring this legitimacy back into the European governance and policy making process. This can help to retain democratic control of European policy making and reduce democratic deficit [17].

The idea of the EU functioning is based on shared values and principles that are inherent in all member countries. One of such values is solidarity between richer countries (regions) and the poorer or disadvantaged ones. The solidarity represents the main principle of EU cohesion policy and is expressed by (not only) financial support from common budget for those regions which are lagging behind in their development. In this context region, exactly NUTS 2 regions are seen as implementation level of cohesion (regional) policy. The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic EU territory for the purpose of the collection, development and harmonisation of the EU regional statistics. Regions are divided into three territorial levels (NUTS 1, NUTS 2, NUTS 3). Currently, there are 270 NUTS 2 regions in the EU-27.

## 2.2 Evaluation of regional development in the context of EU cohesion policy

In developing an effective development policy one of the most important conditions is the identification of the actual level of region's development. This

problem may be solved if economic, social, political, legislative, and ecological and other factors influencing regional development are taken into consideration [9, p.1]. The assessment of actual state of regional development derives from the quantitative analysis of regional disparities. Generally, the term "disparity" means an inequality, disharmony or difference. In reference to regional problems, it means differences on the socio-economic level of particular territorial units [24].

The existence of disparities between regions, including their elimination, is one of the main aspects of EU cohesion policy and regional development. In this context, we distinguish three types of regional disparities: economic, social and territorial. Economic disparities represent different level of economic convergence of countries and regions that can be measured by economic indicators. Social disparities are related to how people perceive spatially differentiated quality of the life, standard of living or social inequality and they are mostly measured by the indicators of the labour market. Territorial disparities reflect strong inequalities in the EU competitiveness factors. Territory inequality is expressed by significant differences in the economic performance, geographical potential and transport and technical infrastructure, capacity for innovations or quality of environment [16].

In the European concept, the level of disparities can be regarded as a measure of cohesion. By Molle [16] the cohesion can be expressed by such level of differences between countries, regions or groups that are politically and socially tolerable. The level of regional disparities within EU is evaluated by the Cohesion Reports published by the European Commission every 3 years see [1].

### Approaches to regional disparities evaluation

The attitude of the researches to the measurement and evaluation of regional disparities is not uniformed. Therefore, the analysis of regional disparities in the EU countries are still actual and important topics of many discussion and regional research studies, at European level see e.g. [8], [27], [3], [35].

In recent years, the attention has been focused on the measurement of regional disparities that impede well-balanced development and strengthening of cohesion in new EU countries. Matlovič et al. [14], deal with regional disparities in Slovakia, Goshin, Constantin, Roman, Ileanu [11] analyse regional disparities in Romania, regional differences in Visegrad Four countries are analysed by Tvrdon, Skokan [30], Tuleja [29], or Kutscherauer et al.

[12]. Most existing approaches to regional disparities evaluation use several disparities indicators that are processed by different mathematical and statistical methods. The aim is usually to obtain one comprehensive index that represents each of the analysed territory. Most of regional economic inequalities are measured by a variety of indices based on the indicator of GDP – coefficient of variation and Hoover Concentration Index, the Herfindahl index, the Geographic concentration index and the Theil index, see e.g. [31]. From the point of view of low calculation difficulty, high informative level and applicability of the results in practice, following mathematical and statistical methods are often used for disparities' measurement [12]: point method, traffic light method (scaling), method of average (standard) deviation, method of standardized variable, method of distance from the imaginary point.

From the perspective of the practical utilization, the traffic light method can be applied in phase of the identification and quantification of variables, see e.g. [15]. The point method, method of standardized variable and method of distance from the imaginary point are often used in integrated approach based on calculation of synthetic index of disparities or weighted synthetic index of disparities, see e.g. [23], [29]. More sophisticated methods that are very useful in the process of regional disparities evaluation are multivariate statistical methods, especially cluster analysis and factor analysis, see e.g. [27], [28], [34].

Alternative and not broadly extended approach to regional disparities represents multicriteria decision-making methods, see e.g. [32]. One of the most popular techniques dealing with multi-criteria decision making (MCDM) problems in the real world are Simple Additive Weighting (SAW), see [5],[7],[9],[17],[22] or the Technique for Order Preferences by Similarity to an Ideal Solution (TOPSIS) see e.g. [13],[19],[20],[26]. MCDM methods helps decision maker organize the problems to be solved, and carry out analysis, comparisons and rankings of the alternatives.

Simple Additive Weighting which is also known as weighted linear combination or scoring methods is a simple and most often used multi attribute decision technique. An evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria [13, p.112].

TOPSIS is known as one of the most classical MCDM methods. It has been successfully applied to

the areas of human resources management, transportation, product design, manufacturing, water management, quality control, and location analysis [26]. The high flexibility of this concept is able to accommodate further extension to make better choices in various situations. e.g. in the field of regional analysis. MCDM problems involve criteria of varying importance to decision-makers. Consequently, information about the relative importance (weight) of the criteria is required. A number of criteria weighting procedures have been proposed in the MCDM literature. One of the most popular procedures is the pairwise comparison within Analytic Hierarchic Process (AHP) [20].

As presented, there is neither uniform approach to regional disparities analysis nor comprehensive index for disparities evaluation at European and national level. This paper thus responds to the multidimensional problems of regional disparities and presents an alternative method of their evaluation.

### 3 Methodology

Before building an illustrative example of regional development and regional disparities evaluation, following section discusses the optimal ranking methods used by multi-criteria decision-making, AHP, SAW and TOPSIS, as a theoretical basis for the following application. In this paper, AHP is used to derive the weights of criteria that are subsequently inserted to weighted decision matrix in SAW and TOPSIS methods. In using the AHP to model the problem, hierarchy representing the problem is needed, as well as pairwise comparisons to establish relation within the structure [25]. The differences in the level of socio-economic development of regions and their ranking are determined by SAW and TOPSIS methods.

#### 3.1 The method AHP

Analytic hierarchy process is used to derive the criteria weights from paired comparison in four level hierarchic structures. The decision hierarchy structure is created; the goal of the decision is at the top level, subcriteria (group of criteria) at second level followed by the level of criteria (criteria on which subsequent elements depend). The lowest level represents a set of alternatives. Having the hierarchic structure, we compare the comparative weight between the attributes of the decision elements in form of pairwise comparison matrices. The comparisons are taken from fundamental scale that reflects the relative strength of preferences. Table 1 exhibits Saaty's fundamental scale which

indicates how many times more important one element is over another element with respect to property to which they are compared to. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.

Table 1 Fundamental scale for pairwise comparison

Intensity of importance	Definition
1	equal importance
3	moderate importance
5	strong importance
7	very strong importance
9	extreme importance

Source: [25]; own modification

### 3.2 The method SAW

Simple Additive Weighting method is one of the simplest, natural and most widely used multicriteria evaluation methods. It clearly demonstrates the idea of integrating the values and weights of criteria into a single estimating value – the criterion of the method [22, p.1]. Because of its simplicity, SAW is the most popular method in multiple attribute decision making (MADM) problems and the best alternative can be derived by the following equation [32]:

$$A^* = \left\{ u_i(x) \mid \max_i u_i(x) \mid i = 1, 2, \dots, n \right\}, \quad (1)$$

The gaps of alternatives can be improved to build a new best alternative  $A^*$  for achieving aspired/desired levels in each criterion:

$$u_i(x) = \sum_{j=1}^n w_j r_{ij}(x), \quad (2)$$

where  $u_i(x)$  represents the utility of the  $i$ -th alternative and  $i = 1, 2, \dots, n$ ;  $w_j$  denotes the weights of the  $j$ -th criterion;  $r_{ij}(x)$  is the normalized preferred ratings of the  $i$ -th alternative with respect to the  $j$ -th criterion for all commensurable units; The normalized preferred ratings ( $r_{ij}(x)$ ) of the  $i$ -th alternative with respect to the  $j$ -th criterion can be defined as [32]:

$$r_{ij} = \frac{x_{ij} - D_j}{H_j - D_j}, \quad (3)$$

where  $H_j$  is aspired/desired level ( $\max_i x_{ij}$ ) and  $D_j$  is the worst level ( $\min_i x_{ij}$ ). SAW may be used if all the criteria are maximizing. This is a drawback of this method, though minimizing criteria can be

easily converted to the maximizing ones by the formula [22, p.2]:

$$r_{ij} = \frac{H_j - x_{ij}}{H_j - D_j}. \quad (4)$$

According to utility  $u_i(x)$  the alternatives are ranked in descending order.

### 3.3 TOPSIS method

TOPSIS method is based on the determination of the best alternative that comes from the concept of the compromise solution. The compromise solution can be regarded as choosing the best alternative nearest to the ideal solution (with the shortest Euclidean distance) and farthest from the negative ideal solution [25]. TOPSIS is always used for multi-attribute decision making, by ranking the alternatives according to the closeness between the alternative and the ideal alternative. The main advantage of this approach is that its user could directly input judgment data without any previous mathematical calculations and locate both the ideal solution and the negative ideal solution easily [7].

The procedure of TOPSIS method includes the following steps. The first step is to construct the decision matrix. Given a set of alternatives,  $A = \{A_i \mid i = 1, \dots, n\}$ , and a set of criteria (attributes),  $C = \{C_j \mid j = 1, \dots, m\}$ , where  $Y = \{y_{ij} \mid i = 1, \dots, n; j = 1, \dots, m\}$  denotes the set of performance ratings and  $w = \{w_j \mid j = 1, \dots, m\}$  is the set of weights for criteria, the decision matrix can be represented as shown in table 2. Procedure that converts all the criteria so that all of them were either minimization or maximization is often implemented before the execution of TOPSIS method.

Table 2 Information table of TOPSIS Criteria

Alternatives	Criteria			
	$C_1$	$C_2$	....	$C_m$
$A_1$	$y_{11}$	$y_{12}$	....	$y_{1m}$
$A_2$	$y_{21}$	$y_{22}$	....	$y_{2m}$
$\square$	$\square$	$\square$	$\square$	$\square$
$A_n$	$y_{n1}$	$y_{n2}$	....	$y_{nm}$
$W$	$w_1$	$w_2$	....	$w_m$

Source: [32]; own modification

Second step is to calculate the normalized decision matrix according to formula:

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^n y_{ij}^2}}, \quad (5)$$

where  $i = 1, \dots, n$ ;  $j = 1, \dots, m$ . With regard to the defined weight of criteria, the third step of TOPSIS

method is to calculate weighted normalized decision matrix expressed as  $v_{ij} = w_j \cdot r_{ij}$ , where  $i = 1, \dots, n; j = 1, \dots, m$ . The following step includes the determination of the positive ideal solution ( $H_j$ ) and the negative ideal solution that are derived as  $H_j = \max(v_{ij})$  and  $D_j = \min(v_{ij})$ .

Subsequently, the separation from the ideal ( $d_i^+$ ) and the negative ideal solutions ( $d_i^-$ ) between alternatives is calculated. The separation values can be measured using the Euclidean distance, which is given as:

$$d_i^+ = \sqrt{\sum_{j=1}^k (v_{ij} - H_j)^2}, \tag{6}$$

$$d_i^- = \sqrt{\sum_{j=1}^k (v_{ij} - D_j)^2}, \tag{7}$$

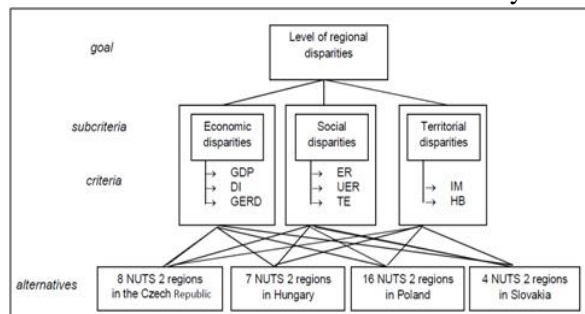
Last step include the calculation of the relative closeness to the ideal solution and rank the alternatives in descending order. The relative closeness of the  $i$ -th alternative  $A_i$  is expressed as:

$$c_i = \frac{d_i^-}{d_i^- + d_i^+}. \tag{8}$$

### 4 Application of MCDM methods for regional development and regional disparities evaluation

In this study, the goal in the hierarchic structure is to assess the level of regional disparities in Visegrad Four countries that reflecting their socio-economic development. As shown in chart 1, the alternatives are 35 NUTS 2 regions (8 Czech NUTS 2 regions, 7 Hungarian NUTS 2 regions, 16 Polish NUTS 2 regions, 4 Slovak NUTS 2 regions).

Chart 1 Hierarchic structure of evaluation system



Source: own elaboration, 2013

These alternatives are evaluated by three types of subcriteria (economic, social and territorial disparities) and eight criteria shown in table 3. The criteria reflecting economic and social development of a region are multidimensional. These indicators are most frequently used indicators of regional disparities monitored within Cohesion reports, see [1] and are available in Eurostat database.

Table 3 Selected criteria (indicators) for disparities evaluation in V4 regions

Criteria	Abbreviation
GDP per capita (PPS)	GDP
Disposable income of households (PPS)	DI
Gross domestic expenditure on R&D (GERD) (% of GDP)	GERD
Employment rate (%)	ER
Unemployment rate (%)	UER
Persons aged 30-34 with tertiary education attainment (%)	TE
Infant mortality rate (%)	IM
Hospital beds (Number/100000 inhabitants)	HB

Source: [1], [2]; own modification 2013

To determine the final weights of criteria, pairwise comparison in the context of AHP is applied to calculate weights of subcriteria with respect to the goal. After that criteria are pairwise compared against the subcriteria importance. The pairwise comparison matrices are shown in Annex, table 1-4. According to final calculated weights of criteria shown in table 4, indicators GDP per capita, disposable income and unemployment rate have the highest importance in the level of region's development, evaluation of disparities among regions and regions' ranking.

Table 4 Weights of criteria

Subcriteria	Weight	Criteria	Weight	Final weight
Economic	0,731	GDP	0,637	0,465
		DI	0,258	0,189
		GERD	0,105	0,077
Social	0,188	ER	0,279	0,053
		UER	0,649	0,122
		TE	0,072	0,014
Territorial	0,081	IM	0,750	0,061
		HB	0,250	0,020

Source: own calculation, 2013

### Empirical results

According to SAW and TOPSIS methods described above, combining with determined weight of criteria by AHP, the methods are applied to rank 35 NUTS 2 regions in V4 on the basis of their economic, social and territorial development in the year 2000, 2005 and 2010. Subsequently, socio-economic disparities among regions are evaluated and compared.

Table 5 calculates the utility  $u_i(x)$  of each alternative and shows the ranking of regions in given year. On the basis of wide range of utility value, the significant socioeconomic differences between regions can be identified. The utility value of the regions with capital city - Praha, Bratislavský kraj, Közép-Magyarország and other Czech region Střední Čechy is the highest, especially regions Praha, and Bratislavský kraj are ranked at the top two positions of alternatives. Their ranking has not changed for whole reference period which implies the significant differences in the level of socioeconomic development of regions with capital cities and other regions. These regions are characterized by high level of living standard (the highest value of economic indicators GDP per capita, disposable income of households) and high support of the research and development (the expenditure on R&D exceed 1 % GDP). These regions are also characterized by high quality structure of labour force (high share of human resources in science and technology and flexible labour market (low level of unemployment and high level of employment). On the contrary, Slovak region Východné Slovensko, Polish regions Warmińsko-Mazurskie, Podkarpackie and Świętokrzyskie are ranked at the bottom positions and evaluated as the worst alternatives for most of the examined period. These regions suffer from low level of living standard (e.g. GDP per capita in PPS in Slovak region Východné Slovensko was 3,5 times lower than GDP per capita of Czech capital city Praha in 2010), low support of the research and development (the expenditure on R&D do not exceed 0,5 % GDP) and high level of unemployment.

For the rest of regions the greater or lesser changes in socioeconomic development are observed during the examined period. Strong positive trend in reducing disparities among regions with capital cities and other regions is recorded by Slovak regions Stredné Slovensko, Západné Slovensko and Polish regions Dolnośląskie since they have achieved better ranking each year. On the other hand Czech region Severozápad, Hungarian regions Nyugat-Dunántúl, Dél-Alföld recorded visible weakening of development and increase in disparities since their ranking is getting worse in each examined year.

Table 6 shows and compares the scores of relative closeness to ideal solution ( $c_i$ ) and the ranks of regions of those three years, which could reveal the trends of regional development and regional disparities.

Table 5 Region's ranking by SAW (2000, 2005, 2010)

Code	Region	2000		2005		2010	
		$u_i(x)$	Rank	$u_i(x)$	Rank	$u_i(x)$	Rank
CZ01	Praha	0,967	1	0,977	1	0,925	1
CZ02	Střední Čechy	0,550	4	0,543	4	0,486	5
CZ03	Jihozápad	0,475	6	0,477	5	0,412	7
CZ04	Severozápad	0,350	11	0,312	13	0,267	18
CZ05	Severovýchod	0,462	8	0,442	7	0,387	8
CZ06	Jihovýchod	0,464	7	0,453	6	0,426	6
CZ07	Střední Morava	0,389	9	0,386	9	0,344	9
CZ08	Moravskoslezsko	0,341	12	0,360	10	0,338	10
HU10	Közép-Magyarország	0,554	3	0,661	3	0,511	4
HU21	Közép-Dunántúl	0,312	13	0,328	12	0,245	20
HU22	Nyugat-Dunántúl	0,375	10	0,350	11	0,273	16
HU23	Dél-Dunántúl	0,206	22	0,228	16	0,143	31
HU31	Észak-Magyarország	0,145	30	0,165	25	0,089	35
HU32	Észak-Alföld	0,140	31	0,181	21	0,103	33
HU33	Dél-Alföld	0,234	17	0,199	18	0,164	30
PL11	Lódzkie	0,217	19	0,195	20	0,280	15
PL12	Mazowieckie	0,479	5	0,411	8	0,518	3
PL21	Małopolskie	0,246	15	0,196	19	0,252	19
PL22	Śląskie	0,237	16	0,219	17	0,313	11
PL31	Lubelskie	0,164	27	0,133	31	0,177	27
PL32	Podkarpackie	0,139	33	0,094	33	0,139	32
PL33	Świętokrzyskie	0,139	32	0,113	32	0,171	29
PL34	Podlaskie	0,155	28	0,153	26	0,182	26
PL41	Wielkopolskie	0,277	14	0,230	15	0,307	12
PL42	Zachodniopomorskie	0,216	21	0,150	27	0,220	21
PL43	Lubuskie	0,147	29	0,142	29	0,192	25
PL51	Dolnośląskie	0,204	23	0,175	23	0,284	14
PL52	Opolskie	0,177	25	0,138	30	0,193	24
PL61	Kujawsko-Pomorskie	0,185	24	0,148	28	0,209	23
PL62	Warmińsko-Mazurskie	0,110	34	0,093	34	0,176	28
PL63	Pomorskie	0,216	20	0,177	22	0,271	17
SK01	Bratislavský kraj	0,737	2	0,836	2	0,893	2
SK02	Západné Slovensko	0,220	18	0,277	14	0,293	13
SK03	Stredné Slovensko	0,168	26	0,172	24	0,211	22
SK04	Východné Slovensko	0,077	35	0,083	35	0,093	34

Source: own calculation, 2013

The shortest relative closeness to ideal solution is achieved by regions with capital city - Praha, Bratislavský kraj, Közép-Magyarország and Mazowieckie. These regions are ranked on the top four positions and their ranking has not changed for whole reference period. In compliance with results of SAW method, for the rest of regions the greater or lesser changes in disparities trends are observed during the examined period. The strong positive trend in reducing disparities is recorded by Czech region Moravskoslezsko, Jihovýchod and Polish region Lubuskie and Dolnośląskie since they have achieved better ranking each year. On the contrary two Czech regions Severozápad, Střední Morava and two Hungarian regions Nyugat-Dunántúl, Dél-Alföld recorded visible weakening of development and increase in disparities since their ranking is getting worse in each examined year. The situation and the ranking of other regions were only slightly changed both in positive or negative sense. For example 13 Polish regions, 4 Hungarian regions and 2 Slovak regions have the largest distance (disparity) to ideal situation and they are mostly ordered in the second half of overall ranking.



Moreover, in comparison with the year 2000 their positions were not positively, significantly changed in the year 2005 and 2010 which indicates the persistence of regional disparities. In positive sense, regions as Střední Čechy, Jihozápad, Severovýchod, Közép-Dunántúl, Małopolskie, Wielkopolskie and Západné Slovensko kept their position in top twenty for most of evaluated period.

Table 6 Region's ranking by TOPSIS (2000, 2005, 2010)

Code	Region	2000		2005		2010	
		$c_i$	Rank	$c_i$	Rank	$c_i$	Rank
CZ01	Praha	0,893	1	0,950	1	0,946	1
CZ02	Střední Čechy	0,429	4	0,388	4	0,333	5
CZ03	Jihozápad	0,352	6	0,346	6	0,285	7
CZ04	Severozápad	0,265	11	0,240	13	0,197	16
CZ05	Severovýchod	0,340	7	0,310	8	0,260	8
CZ06	Jihovýchod	0,338	8	0,324	7	0,296	6
CZ07	Střední Morava	0,279	10	0,266	11	0,233	12
CZ08	Moravskoslezsko	0,249	13	0,272	9	0,241	9
HU10	Közép-Magyarország	0,489	3	0,540	3	0,499	3
HU21	Közép-Dunántúl	0,250	12	0,250	12	0,173	20
HU22	Nyugat-Dunántúl	0,307	9	0,267	10	0,222	15
HU23	Dél-Dunántúl	0,174	17	0,170	16	0,101	32
HU31	Észak-Magyarország	0,143	25	0,139	23	0,058	35
HU32	Észak-Alföld	0,149	23	0,160	19	0,103	31
HU33	Dél-Alföld	0,197	15	0,168	18	0,129	27
PL11	Łódzkie	0,147	24	0,129	24	0,187	18
PL12	Mazowieckie	0,409	5	0,362	5	0,469	4
PL21	Małopolskie	0,173	18	0,141	21	0,176	19
PL22	Śląskie	0,191	16	0,169	17	0,239	11
PL31	Lubelskie	0,122	28	0,101	30	0,124	28
PL32	Podkarpackie	0,115	30	0,078	32	0,099	33
PL33	Świętokrzyskie	0,097	33	0,074	33	0,111	30
PL34	Podlaskie	0,108	32	0,108	26	0,123	29
PL41	Wielkopolskie	0,207	14	0,174	15	0,228	13
PL42	Zachodniopomorskie	0,156	22	0,105	28	0,142	25
PL43	Lubuskie	0,109	31	0,106	27	0,145	23
PL51	Dolnośląskie	0,163	21	0,144	20	0,240	10
PL52	Opolskie	0,133	26	0,104	29	0,142	24
PL61	Kujawsko-Pomorskie	0,130	27	0,097	31	0,146	22
PL62	Warmińsko-Mazurskie	0,078	34	0,066	34	0,130	26
PL63	Pomorskie	0,166	20	0,139	22	0,197	17
SK01	Bratislavský kraj	0,688	2	0,791	2	0,861	2
SK02	Západné Slovensko	0,166	19	0,205	14	0,223	14
SK03	Stredné Slovensko	0,116	29	0,111	25	0,152	21
SK04	Východné Slovensko	0,053	35	0,065	35	0,078	34

Source: own calculation, 2013

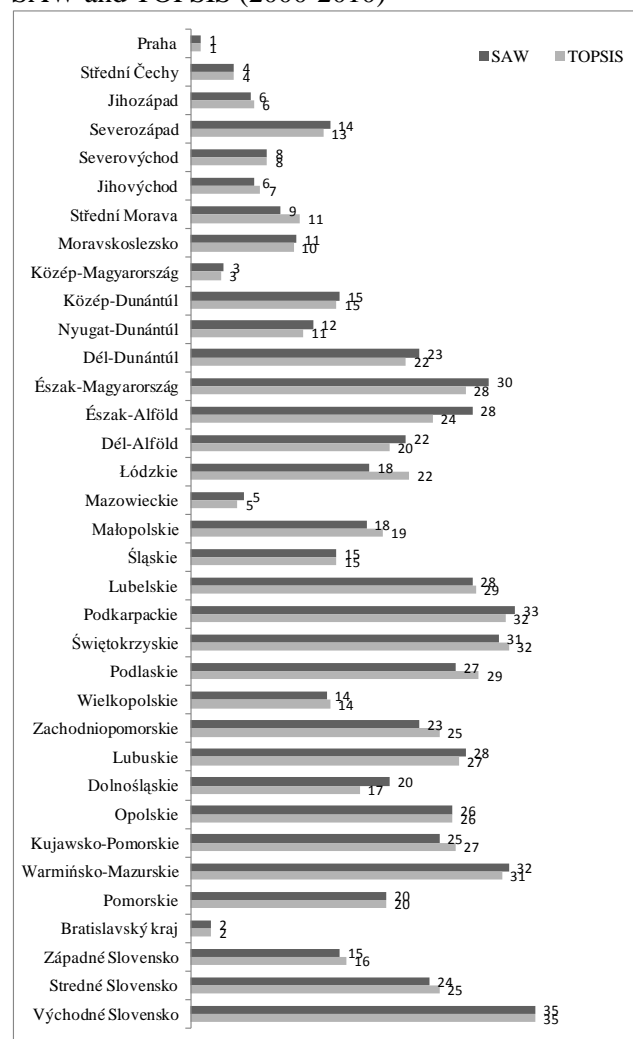
The results showed that SAW and TOPSIS have not an identical rankings of regions overall. We carry on the comparison between SAW and TOPSIS using average ranking for period 2000-2010.

In 37 %, SAW and TOPSIS have identical rankings. In 37 % SAW and TOPSIS have almost identical ranking, the rank of region is better or worse about one position. In 26 %, SAW and TOPSIS have different rankings (rank of region is better or worse about two to four positions).

Figure 1 shows identical average rankings according SAW and TOPSIS which have

particularly the regions of capital cities and Czech regions Střední Čechy. The average ranking of regions on the first five positions again confirmed the differences among metropolitan regions and the rest of V4 regions. SAW and TOPSIS methods also confirmed the worse position of least developed region Východné Slovensko. Different average ranking have regions Střední Morava, Észak-Magyarország, Észak-Alföld, Dél-Alföld, Łódzkie, Podlaskie, Zachodniopomorskie, Dolnośląskie, Kujawsko-Pomorskie. As can be seen in Figure 1, regions Észak-Magyarország, Észak-Alföld, Dél-Alföld, Dolnośląskie are ranked in better positions by TOPSIS. In comparison, Střední Morava, Łódzkie, Podlaskie Zachodniopomorskie, Kujawsko-Pomorskie are ranked in worse positions by TOPSIS.

Fig.1 Comparison of average region's ranking by SAW and TOPSIS (2000-2010)



Source: own calculation, 2013

According to socio-economic development we could divide the NUTS 2 regions into four groups.



First group includes regions of capital city Praha, Bratislavský kraj, Közép-Magyarország, Mazowieckie and Střední Čechy, as we stated above these regions are treated as the developed regions with strong economy. The second group of regions with average ranking from 6th to 14th position (Czech regions Jihozápad, Jihovýchod Severovýchod, Střední Morava, Severozápad, Moravskoklesko, Hungarian region Nyugat-Dunántúl and Polish region Wielkopolskie) can be considered as regions rather converge to best regions and have development potential. The third group of regions from 15th to 30th average ranking (Hungarian regions Közép-Dunántúl, Dél-Alföld, Észak-Magyarország, Észak-Alföld, Dél-Dunántúl, Polish regions Małopolskie, Śląskie, Pomorskie, Dolnośląskie, Łódzkie, Zachodniopomorskie, Kujawsko-Pomorskie, Lubuskie, Lubelskie, Podlaskie, Opolskie and finally Slovak regions Západné Slovensko and Stredné Slovensko) represent the middle situation, regional disparities have rather moderate decrease and their economy is still not strong enough. Polish regions Podkarpackie, Świętokrzyskie, Warmińsko-Mazurskie and Slovak region Východné Slovensko can be considered as least developed group compared to others and they are ranked in last position.

## 5 Conclusion

In this paper, the problems of evaluation of regional development and disparities in Visegrad Four are considered. The states strive to achieve a higher level of development by eliminating the gap in economic, social and territorial development among their regions. The EU cohesion policy plays crucial role in funding regional development within EU member states. To ensure efficient allocation of investments, it is necessary to recognize the actual level of economic, social and territorial development of particular regions. The regional development can be characterized by various types of parameters (economic, social, and territorial). Therefore, multicriteria approach is used to evaluate the actual level of development of regions in complex way. Multicriteria decision-making methods are widely used, and there are many application proposed in the literature. The advantage of MCDM methods is that it can give its users many dimensions to consider related elements, and evaluate all possible options under variable degrees [6]

With regard to the absence of the mainstream in regional disparities evaluation, the purpose of this paper is to highlight an alternative ways of

quantitative evaluating of differences in the level of socio-economic development. The paper constructed a comparison of regions' ranking according to their socio-economic development based on selected MCDM methods. First, AHP was used to establish hierarchy architecture and then expressed individual weights of criteria by comparing pairs. After that, SAW and TOPSIS were utilized to make non-linear calculations in order to obtain final appraisal values and to rank the performance alternatives (regions). The paper discusses the regions' ranking according to particular group decision method and compares the ranking outcomes among SAW and TOPSIS.

The results showed that SAW and TOPSIS do not have identical rankings in some cases in examined period. Different ranking can be caused by own means of calculation of both methods that differ in advantages and disadvantages. SAW is simple technique based on the principle of utility maximization and benefits from additive property for calculating final score of alternatives. While TOPSIS represents an alternative that should have the shortest distance from the positive ideal solution and the farthest from the negative-ideal solution for solving a multiple-criteria decision-making problem. The advantage of SAW is that it is simple and easy to use and understand. SAW reflects main concept underlying quantitative multicriteria evaluation methods, consisting in integrating the criteria values and weights into a single magnitude – the criterion of the method [22]. TOPSIS considers positive and negative ideal solutions as anchor points to reflect the contrast of the currently achievable criterion performances [5]. Both methods assume that there exists a performance matrix obtained by the evaluation of all the alternatives in terms of criterion. In SAW method, all the values of the criteria should be maximizing. Minimizing criteria should be transformed to maximizing ones. Also before the execution of TOPSIS, procedure that converts all the criteria so that all of them were either minimization or maximization is implemented. Both methods assume to use normalization to eliminate the units of criterion values. The difference appears in the technique of normalization. SAW method uses linear normalization and calculated values are dependent on the size of the interval  $\max_i x_{ij}$ ;  $\min_i x_{ij}$ . The TOPSIS method uses vector normalization and the ratio of the values remains constant for this type of normalization in the interval [0;1], [33]. Both methods are based on aggregating function that is used as a ranking index. The difference appears in the aggregation approaches. SAW assumes

preferential independence of criteria and adopt the simplification in that it assumes only linear utility function. TOPSIS method introduces the ranking index in Eq. (8), including the distances from the ideal point and from the negative-ideal point. These distances in TOPSIS are simply summed in Eq. (8), without considering their relative importance. However, the reference point could be a major concern in decision making, and to be as close as possible to the ideal is the rationale of human choice. Being far away from a negative point is goal in this particular situation [19]. Both methods provide a ranking list. The largest value of the utility  $u_i(x)$  corresponds to the best alternative. The alternatives compared should be ranked in the decreasing order of the calculated values of the criterion  $u_i(x)$ . The highest ranked alternative by TOPSIS is the best in terms of the ranking index, which does not mean that it is always the closest to the ideal solution [22].

Although, the results of SAW and TOPSIS methods differs in some ranking of regions, the results of both methods confirm that NUTS 2 regions with capital cities (Praha, Bratislavský kraj, Mazowieckie, Közép- Magyarország) and Czech region Střední Čechy have had significant and different socio-economic position from the other regions in V4. The dominance of capital cities results from more intensive integration into the world economy, which is reflected in different structures in comparison with other regions. Capital cities are main administrative centres, where the great mass of public institutions and the private sector is concentrated (corporate headquarters, central administrative authorities, universities, etc.). On the other hand, it is necessary to take into account the statistical effect that can overvalue some indicators of economic performance. According to average ranking of both methods Polish regions Podkarpackie, Świętokrzyskie, Warmińsko-Mazurskie and Slovak region Východné Slovensko can be considered as the least developed. These regions should focus on higher expenditure on research and development which are major drivers of economic growth and it also supports future competitiveness that results in higher GDP. The public investments in infrastructure (transport, communication, and energy), spending on education active labour market, and effective utilization of subsidies from European funds, play key roles in developing these regions. Also highly developed regions can be the motivation for lagging regions to catch up with them. Due to diffusion effects, the support of economically successful capital cities and their competitiveness results later in higher

performance of whole state, including the lagging regions. Regional disparities can also play a motivation role.

## Acknowledgement

This research paper was supported by the Faculty of Economics, VŠB-Technical University of Ostrava within Student Grant Competition, project's registration number SP2013/173 and within The Education for Competitiveness Operational Programme, project's number CZ.1.07/2.3.00/20.0296.

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## Annex

Table 1 Pairwise comparison matrix of subcriteria with respect to the goal

	Economic disparities	Social disparities	Territorial disparities
Economic disparities	1	5	7
Social disparities	1/5	1	3
Territorial disparities	1/7	1/3	1

Source: own elaboration

Table 2 Pairwise comparison matrix for criteria with respect to economic disparities

	GDP	DI	GERD
GDP	1	3	5
DI	1/3	1	3
GERD	1/5	1/3	1

Source: own elaboration

Table 3 Pairwise comparison matrix for criteria with respect to social disparities

	ER	UER	TE
ER	1	1/3	5
UER	3	1	7
TE	1/5	1/7	1

Source: own elaboration

Table 4 Pairwise comparison matrix for criteria with respect to territorial disparities

	IM	HB
IM	1	3
HB	1/3	1

Source: own elaboration