MULTICRITERIA BASED RANKING OF TERRITORIAL ADMINISTRATIVE UNITS IN ROMANIA ACCORDING TO THE AGGREGATE INDEX OF INFRASTRUCTURE

Laura BOGDAN[1]
Monika MOGA[2]

ABSTRACT:
THIS PAPER PRESENTS THE USE OF MULTI-CRITERIA ANALYSIS FOR RAKING TERRITORIAL ADMINISTRATIVE UNITS ACCORDING TO THE GENERAL LEVEL OF INFRASTRUCTURE DEVELOPMENT.
WE USE THIS METHOD TO DEFINE THE AGGREGATED INDEX OF INFRASTRUCTURE. THE MAIN ISSUE IS TO ASSIGN WEIGHTS TO THE INDIVIDUAL INDICATORS REFLECTING THE RELATIVE IMPORTANCE OF CERTAIN INDICATORS OVER EACH OTHER IN THE REGIONAL DEVELOPMENT.
IN ORDER TO CONSTRUCT THE AGGREGATE INDEX OF INFRASTRUCTURE, WE COMBINED INDICATORS FROM SIX INFRASTRUCTURE SECTOR: HOUSING AND PUBLIC UTILITIES, TRANSPORT AND TELECOMMUNICATIONS, HEALTH, EDUCATIONAL AND CULTURAL, TRADE AND TOURISM INFRASTRUCTURE.

KEYWORDS: INFRASTRUCTURE, MULTI-CRITERIA ANALYSIS, REGIONAL DISPARITIES, ECONOMIC DEVELOPMENT

INTRODUCTION

Originated from French, the notion of infrastructure (from Lat. Infra + structure - construction) means the complex of structures of interconnected service that forms and/or provides the basis of: development, establishment, operation of certain objectives.[3]

[1] PhD student, Faculty of Economics and Business Administration Babeș-Bolyai" University, Cluj Napoca, e-mail: by_laura99@yahoo.com
[2] PhD student, Faculty of Technological Engineering and Industrial Management, Transilvania University, Brașov, e-mail: moga_monika@yahoo.com

According to the genealogy of the term there are two views. According to the first view, the term was borrowed from military terminology, which is a complex of military constructions behind the front, ensuring uninterrupted supply of military assets.

After another point of view the term "infrastructure" comes from construction terminology. In construction "infrastructure" means building the foundation for the entire construction project, called "cycle 0".[4]

It is considered that for the first time in economic term "infrastructure" has been used by P. N. Rosenstein-Rodan. In his use the term "social overhead capital" means infrastructure. [5] Rosenstein definition corresponds to the broadly defined term that includes both "hard and soft" infrastructure. Hard infrastructure includes transport, communications, irrigation systems and other related construction. Soft infrastructure includes educational infrastructure, research, public health and the entire judicial and administrative system.

Regardless of the approach, economic theory and practice recognized the major role of infrastructure in regional economic and social development.

Nijkamp (1986)[6] argues that infrastructure is one of the tools that lead to the development of a region. This may directly or indirectly influence the socio-economic activities. The author points out that continuous improvement of infrastructure is a condition for regional development policies, but it cannot guarantee regional competitiveness, creating only the necessary conditions for achieving regional development.

Snieska and Draksaite (2007)[7] argue that infrastructure is one of the main factors that determine a country's economic competitiveness.

Martinkus and Lukosevicius (2008)[8] argue that infrastructure services and physical infrastructure are factors that affect local investment and increase attractiveness. Not only

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[3] Infrastructure, Online Compact Oxford English Dictionary, accessed March 19, 2013, http://www.askoxford.com/concise_oed/infrastructure

[4] Jochimsen, Reimut, *Theorie der Infrastruktur, Grundlagen der marktwirtschaftlichen Entwicklung*, Tübingen: J.C.B. Mohr (Paul Siebeck), 1966, 23.

[5] Rosenstein-Rodan, N. Paul, "Problems of industrialization of eastern and southern Europe", *The Economic Journal* 53/210 (1943): 202-211, accessed January 22, 2012. http://links.jstor.org/sici?sici=0013-0133%28194306%2F09%2953%3A210%2F211%3C202%3APOIOEA%3E2.0.CO%3B2-N

[6] Nijkamp Peter, "Infrastructure and regional development: A multidimensional policy analysis", *Empirical Economics*, 11/1(1986): 1-21, accessed July 3, 2012. doi: 10.1007/BF01978142.

[7] Snieska Vytautas and Draksaite Aura, „The Role of Knowledge Process Outsourcing in Creating National Competitiveness in Global Economy*", Inzinerine Ekonomimka-Engineering Economics* 3 (2007): 35-41.

that infrastructure investments attract businesses, they create jobs and generate tax revenues, it is recognized that an infrastructure project can be an economic incentive if it is managed correctly.

Infrastructure also has a positive effect on education and health: a healthy workforce with a high level of education induces economic growth.[9]

Regionalists distinguish two types of infrastructure of regional importance: economic and social infrastructure. Economic infrastructure is defined as infrastructure that promotes regional economic activities, such as roads, highways, railways, airports, seaports, electricity, telecommunications, water supply and sanitation. Social infrastructure (such as schools, libraries, universities, clinics, hospitals, courts, museums, theaters, parks, fountains and statues), is defined as facilities that promote health, education and cultural standards of the population.

As shown in national and international literature we find several classifications for infrastructure. Depending on the characteristics of each branch of the infrastructure they are clearly determined in regional and local development. Some types of infrastructure are closely related to economic development, while others are factors for the development of social systems.

This paper provides a depth analysis of the complex nature specific infrastructure, with particular emphasis on its spatial territorial feature.

Premises from which we started our research were to gain an insight into: infrastructure development level of counties in Romania and the disparities between counties in terms of infrastructure.

METHODOLOGICAL CONSIDERATIONS

According to previous analyzes made by us there are big regional differences in infrastructure. Some counties, especially those predominantly rural, are still disadvantaged in terms of physical infrastructure, public utilities, housing and access to basic social services. Preoccupation for rural and regional development remained a necessity. Furthermore there are important variations for the same county, meaning that some

[8] Martinkus Bronislovas and Lukosevicius Kazys, „ *Investment environment of Lithuanian resorts: Researching national and local factors in the Palanga case"*, Transformations in Business & Economics, 7/2 (2008): 67-83.

[9] Vytautas Snieska and Ineta Simkunaite, "Socio-Economic Impact of Infrastructure Investments", *Inzinerine Ekonomika- Engineering Economics* 3 (2009): 16-25.

indicators are higher, indicating a high potential for development, while the others record low values.

For this reason we appealed to calculate the aggregate index of infrastructure combining several indicators considered to be representative for development.

According to the literature the most effective methods of measurement are those that give us a true picture about the overall development of the infrastructure of an area, i.e. those which process with several indicators.

The best known methods for determining the level of infrastructure development are: Bennett method, deviation from the average, scoring method, multicriteria ranking, factor analysis, cluster analysis[10].

From the many methods that can be used to determine the aggregate index of infrastructure, defined in this paper by 18 statistical indicators (see table no.1) and to rank counties according to this indicator we chose the *advanced multi-criteria analysis method*.

In order to obtain a comprehensive view it was necessary to employ a hierarchy in which each indicator received an important coefficient, since each indicator has a different weight and importance in determining performance infrastructure.

APPLICATION OF MULTI-CRITERIA ANALYSIS FOR RANKING ADMINISTRATIVE UNITS DEPENDING ON THE LEVEL OF INFRASTRUCTURE DEVELOPMENT

In order to apply advanced multi-criteria analysis in this paper we follow these steps:

1. Identification of the criterions;
2. Determining the weight of each criterion;
3. Providing appropriate notes for each variant compared to the criterion considered;
4. Performance index calculation;
5. Hierarchy of administrative units by aggregate index of infrastructure, measured by quantifying the indicators chosen in the first stage.[11]

[10] Abonyiné Palotás Jolán, *Infrastruktúra*, Budapest: Dialóg Kampusz, 2007, 57.
[11] Bobancu, Şerban; *Creativitate şi inventică*, Universitatea Transilvania Braşov, Suport de curs, 2007. http://webyn.unitbv.ro/

1. Identification of the criterion, of indicators used in the study which allows comparative analysis of counties after the infrastructure development

Choosing indicators used for the multicriteria ranking after a certain class of indicators starts from the research objectives and requires a good knowledge of the field of the activity in which will be carried out investigations to ensure comparability of indicators and correlation of various aspects of community units for a more complete characterization of the variation in territorial aspect.[12]

Depending on the objectives mentioned in the research methodology, and statistical data available in each county, we selected a total of 18 indicators presented in the following table (Table no. 1):

Table No.1. System of used indicators

Symbol of criterion	Indicators / criteria
C1.	Number of inhabitants in 100 homes
C2.	Share of locations where there is natural gas (%)
C3.	Share of locations with drinking water facility (%)
C4.	Share of locations with public sewerage network (%)
C5.	Rate of upgraded roads
C6.	Density of public roads (km/100 km^2)
C7.	Density of railway lines in service (km/1000 km^2)
C8.	Total number of telephone connections per thousand people (through public and private telephone network in minutes)
C9.	No. doctors per 10,000 inhabitants
C10.	No. medical beds per 1000 people
C11.	The number of students registered in secondary and vocational education per 1000 inhabitants
C12.	Number of students per 1000 inhabitants
C13.	Number of volumes (books, brochures, collections of newspaper) per 1000 inhabitants
C14.	Ratio between the number of people who attended in a year (viewers), performances by theater, opera, philharmonic, folk orchestra and population
C15.	Number of museums and public collections per 100,000 people
C16.	The number of active business 1000 people
C17.	The number of tourist per 1000 inhabitants
C18.	Utilization accommodation capacity into service (%)

[12] Dobrin, Marinică; Tache, Antonio and Petrișor, Alexandru-Ionuț; "*Disparităţi de dezvoltare la nivelul unităţilor administrativ teritoriale din România, -metode de ierarhizare, indicatori, analiză statistic",* Romanian Statistical Review 5 (2010): 16, accessed 20 December, 2012, http://connection.ebscohost.com/c/articles/52655125/development-disparities-administrative-territorial-units-romania

Source: Elaborated by the authors

In the selection of the indicators were followed: highlighting the quantitative and qualitative elements to ensure a more complex measuring of the level of infrastructure development; their role in regional development strategies; traceability of the evolution over time and comparisons as enlightening inter-county level.

The main source of data used in this research is the Romanian Statistical Yearbook, 2012 and data provided on request by County Departments of Statistics.

2. Determining the weight of each criterion

In a table with both 18 rows and columns of chosen criterion (C) each criterion is compared with each, making on row entry and exit of each column.

If a criterion on a line is considered more important than the criterion for a column, then value 1 is assigned, when the line criterion is as important as the criterion in the column value 0,5 is assigned, and when the line criterion is considered less important, value 0 is assigned. For each line the values are added together (p), thus establishing the level of a criterion to the other (Table no. 2).

The value of the level coincides with the place occupied in the ranking criterion. If two or more criteria receive the same number of values, the position is the same and it is calculated as the arithmetic average of the positions corresponding to this criterion (Table no. 3). Individual comparison results are given in Table no. 2.

Table No. 2. Individual comparison of criterion

Symbol of criterion	C1	C2	C3	C3	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
C1	0.5	0	0	0	0	0	0	0	1	1	1	0	1	1	0	0	0	0
C2	1	0.5	0	1	0	0	0	0	1	1	1	0	1	1	0	0	0	0
C3	1	1	0.5	1	0	0	0	0	1	1	1	0	1	1	0	0	0	0
C4	1	0	0	0.5	0	0	0	0	1	1	1	0	1	1	0	0	0	0
C5	1	1	1	1	0.5	0	0	0	1	1	1	1	1	1	1	0	0	0
C6	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1	0.5	0.5	1	1
C7	1	1	1	1	1	0	0.5	0	1	1	1	1	1	1	0	0	1	1
C8	1	1	1	1	1	0	1	0.5	1	1	1	1	1	1	0	0	1	1
C9	0	0	0	0	0	0	0	0	0.5	1	1	0	0	0	0	0	0	0
C10	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0
C11	0	0	0	0	0	0	0	0	0	1	0.5	0	0	1	0	0	0	0
C12	1	1	1	1	0	0	0	0	1	1	1	0.5	1	1	0	0	0	0
C13	0	0	0	0	0	0	0	0	1	1	1	0	0.5	0	0	0	0	0
C14	0	0	0	0	0	0	0	0	1	1	0	0	1	0.5	0	0	0	0
C15	1	1	1	1	0	0.5	1	1	1	1	1	1	1	1	0.5	0	1	1
C16	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	0.5	1	1
C17	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0.5	0
C18	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	0.5

To determine the weight of each criterion we used the Frisco formula[13]:

$$Y_i = \frac{p + \Delta p + m + 0.5}{-\Delta p' + \frac{N}{2}} \qquad (1.)$$

Where:

Y_i – weight coefficient of criterion i,

p – sum of values obtained

Δp – difference between the item score and the score of the considered top level element,

[13] Tache, Antonio and Petrișor; "*Disparităţi de dezvoltare la nivelul unităţilor administrativ teritoriale din România, -metode de ierarhizare, indicatori, analiză statistic",* 11

m – the number of surpassed criteria (exceeded in terms of score) by the criteria taken into account,

N – number of criterion taken into consideration,

Δp' – difference between the item score and the score of the considered first element (resulting in a negative value).

The results of the calculation of the weight coefficient (Yi), for the criterion are given in Table no. 3.

Table No. 3. Results of the calculation of the weight coefficient (Yi)

Symbol of criterion	p	Level (place)	Y_i
C1	5.5	12	0.68
C2	7.5	10	1.08
C3	8.5	9	1.35
C4	6.5	11	0.87
C5	11.5	7.5	2.1
C6	16.5	2	1.47
C7	13.5	5	2.96
C8	14.5	4	3.47
C9	2.5	14.5	0.23
C10	0.5	15	0.039
C11	2.5	14.5	0.23
C12	9.5	8	1.57
C13	3.5	13.5	0.37
C14	3.5	13.5	0.37
C15	15	3	3.81
C16	17	1	5.33
C17	11.5	7.5	2.27
C18	12.5	6	2.51

After applying the Frisco formula, the most important criterion is C16 (the number of active commercial for 1000 people), followed by C15 and C8.

3. Giving appropriate notes for each variant based on the considered comparison criterion

At this stage of the analysis it is given the importance notes (Nji) for each variant analyzed (Vj) for our 42 counties and Bucharest Municipality in relation to the 18 criterion (Ci). Marks are given from 1 to 10.

Because of the large number of both variants (42) and of the criterion (18), the table with the grades given for the 42 territorial administrative units will not be included in this paper.

4. Performance index value calculation of the analyzed variants

For each county according to each criterion it is calculated a performance factor (F_{ji}) as follows:

$$F_{ji} = Nj_i \times Y_i \quad (2.)$$

Then for each county it is calculated the sum of these factors obtaining a total value FV_J factor, which we will call aggregate index of infrastructure on each county, given by:

$$FVj = \sum_{i=1}^{i=18} F_{ji} \quad (3.)$$

5. Complex hierarchy of administrative units after the aggregate index of infrastructure

The final classification is determined based on the value index of performance of infrastructure (FV_J). At the first place will be situated the county with the highest value of the aggregate index of the infrastructure.

Table no. 4. The ranking of counties after the aggregate index of infrastructure

Place	County	Coefficient of total value (FV_j)	Differences from the average
1	Brașov	273.78	1.27
2	Constanta	269.19	1.25
3	Municipiul București	268.9	1.25
4	Bihor	263.35	1.23
5	Cluj	260.71	1.21
6	Ilfov	249.91	1.16
7	Timiș	246.89	1.15
8	Mureș	242.5	1.13
9	Arad	237.61	1.11
10	Vâlcea	236.82	1.10
11	Harghita	234.23	1.09
12	Sibiu	233.55	1.09
13	Covasna	232.76	1.08
14	Hunedoara	231.7	1.08
15	Prahova	230.17	1.07
16	Maramureș	228.67	1.06
17	Argeș	227.77	1.06
18	Alba	227.46	1.06
19	Caraș-Severin	226.55	1.05
20	Iași	223.7	1.04
21	Satu Mare	222.58	1.04
22	Galați	218.76	1.02
23	Gorj	218.23	1.02
24	Bistrița-Năsăud	213.98	1.00
25	Suceava	212.72	0.99
26	Brăila	206.44	0.96
27	Bacău	202.27	0.94
28	Dolj	201.58	0.94
29	Neamț	199.55	0.93
30	Dâmbovița	191.76	0.89
31	Sălaj	190.59	0.89
32	Vrancea	190.05	0.88
33	Buzău	189.67	0.88
34	Tulcea	187.94	0.87
35	Ialomița	185.42	0.86
36	Mehedinți	178.93	0.83
37	Olt	173.41	0.81
38	Vaslui	167.12	0.78
39	Călărași	166.85	0.78
40	Giurgiu	162.52	0.76
41	Botoșani	153.49	0.71
42	Teleorman	148.16	0.69
Media		214.95	1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
VAR00002	42	148.16	273.78	214.95	32.51
Valid N (listwise)	42				

CONCLUSION

Analyzing the ranking (see Table no. 4) obtained from the multictiretial analysis on the first place it is noted that the best result after level of infrastructure development is Brasov with a value of performance of infrastructure: 273.78 exceeding with 58. 53 units the average of the counties, followed by Constanta (269.19) and Bucharest (268.9).

Regarding inter-district disparities in the infrastructure development level based on the county average we can mention that the half of the counties are above this level with a difference from 1 to 1.27 points, other counties being below the average with a difference from 1 to 0.68, resulting in an amplitude of 0.58 units as the difference between maximum and minimum value (see Table no. 4.). Also it is noted that the difference of the last counties from the ranking compared to the average is much higher than of those situated above average.

Depending on the global development index can be established areas including zones with low and very low values of it.

Counties that enter the category are: Teleorman, Botoșani, Giurgiu, Călărași, Vaslui, Olt, Ialomița, Mehedinți, Tulcea, Buzău, Vrancea, Dolj, Dâmbovița, Neamț, Suceava, Bistrița-Năsăud, Brăila.

The fact that these counties have low values may result from natural factors, anthropogenic, cultural but also lack of well founded policy towards regional infrastructure development. In the future will be needed through development strategies and through resources to pay special attention to infrastructure investment.

Knowing that there is a direct and strong correlation between the level of infrastructure development and economic development at the level of administrative units from Romania in the following researches will be verified this relationship.

The next dimension of our analysis aims to decompose the aggregate index of the infrastructure into individual indicators and to examine the contribution of each sector of infrastructure to the regional economic growth in Romania.

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