

# USING FACTORIAL ANALYSES FOR HIGHLIGHTING PATTERNS OF TERRITORIAL DEVELOPMENT. THE CASE STUDY OF ROMANIA

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**Abstract**— Starting from the idea that space is one of the factors that create differences in terms of territorial development, this paper has the aim of using factorial analysis to determine the components related to this phenomena. Local based development, at national level of Romania, is the expression of several factors which were decomposed using a multivariate methodology. Social, urban, demographic or territorial components (through accessibility) are factors taken into account in applying this method.

**Index Terms**— territorial development index, factorial analyses, geo-statistical methods

## I. INTRODUCTION

The use of quantitative methods in order to determine the level of territorial development for a region is the most common approach in this particular field of research. The proposed indicators vary widely from simple index, consecrated through the use of reports of international organizations (e.g. Human Development Index, Human Poverty Index in [1]) or in reports of statistical institutes (e.g. rate risk of poverty or social exclusion, proposed in 2020 Europe Strategy or present data bases of EUROSTAT) to indicators derived from the analyses of satellite images [2] or complex multi-criteria analyses approach. The first of these has the advantage of being easily reproducible and communicative, but complex enough to take into account the interdependencies between components of territorial development.

Using multi-criteria methods have the advantage of splitting the phenomenon in distinct components, which makes it easy to identify the factors that compose the territorial development. For example, [3] highlights the use of principal component analyses as a method of synthesis for 58 social and economic variables, in order to obtain a measure for social and economic development for the regions of Turkey. [4] propose a multi-criteria model for assessing the impact of rural development plans in Greece.

On the same line, the direction is trying a correlation of results obtained from the objective approach to subjective approaches [5], partial findings indicating that there are links (e.g. between GDP and life satisfaction), while others do not (e.g. between spiritual aspects, such as happiness, and material).

Territorial development is a multidimensional phenomenon, which is not a sufficient analyses outside of a systemic approach. Of the many available quantitative methods, factor analysis allows a wide range of explanatory variables interrelated, reason for being recommended for

approaches with a strong systemic phenomena [6]. Moreover, [7] argue the idea of creating decision support systems in area where divergent opinions can be by combining Geographical Information Systems and multi-criteria analyses.

Territorial development from the point of view of the Romanian studies provides different approaches and perspectives. Dumitru Sandu is the one who performs at the Romanian territory a set of indicators for territorial development at the local or community level [8] [9]. Other approaches make us of multi-criteria analysis (factorial) to build an indicator of development for communes in the mountain and sub-mountain area of Dâmbovița county [10] or to analyze disparities in the Romania-Hungary border area [11] [12].

In this context, the paper analyses the communitary development for 3181 local administrative units in Romania, by integrating X sequentially indicators in one dimension, which has the following properties:

- The use of a multi-criteria analyses (factorial analyses) to recombine the specific variables for each sequence in a final indicator of territorial development.
- To keep the particularity of each type of variable, but to eliminate the interference between them, by reducing the effect of collinearity.
- To extract a summary of the original variables by simplifying linear or quasi-linear relations which connect to variables at a time
- Synthesis of variables must allow the extraction of invisible relations through exploratory statistical analysis and identify other dimensions of territorial development which, finally will cancel a share of the redundancy of the original size.

## II. DATA AND METHODOLOGY

The elaboration of communitary development indicators represents a practice of general interest in studies where the purpose is to pinpoint and understand the mechanisms producing territorial disparities. Taking into account the high diversity of indicators that study the diverse sides of territorial development, the priority was to identify the variables that contain latently an important amount of spatial information:

- *Global Housing Quality Indicator (HQI)*, was calculated using the formula:

$$HQI(2011) = 0,35 * I_{ic} + 0,25 * I_b + 0,2 * I_a + 0,2 * I_c, \text{ where:}$$

- HQI – *Global Housing Quality Indicator* (2011);
- I<sub>b</sub> – presence of toilet inside the house

- Ic – connection to a heating system
- Ia – presence of running water inside the house
- Ic- connection to sewer system
- *Urban Housing Quality Indicator (HQI\_UR)*, was calculated alike HQI, but only for urban areas.
- *Synthetic Index of Fertility (SIF)*;
- *Third Age Index or Laslett Index (LT)*;
- *Mean cost of access to air transport services (Cost airport) calculated as the average cost of travel (RON) for all communes from each county*;
- *The intensity of territorial polarization by airports, evaluated using the Huff-Convers polarisation model*;
- *Demographic potential (DemoPot) in a 43 km radius*;
- *Accessibility to urban centres according to 3 categories (using the National Plan for Planning AcR1, AcR2 and AcR3). AcR1 is the time distance to the closest 1<sup>st</sup> rank locality (cities with regional function), AcR2 is the time distance to the closest 2<sup>nd</sup> rank locality (Municipality level) while AcR3 is the time distance to the closest 3<sup>rd</sup> rank locality (any other city)*;

All variables were available at the analysis scale of Romanian rural centres (LAU2 level); we transferred them to the county level (NUTS3) through weighted averages.

The way in which variables assess the communality test indicates the presence of two cases with uncertain behavior within the factor space: *Laslett Index* and *index of accessibility to first-rank urban centres* (Table I). From a technical perspective, the destination of such variables depends on the factorial sub conjecture determined by the relationships within the correlation matrix between primary variables. It is not justifiable to eliminate these variables unless they are found no to bring extra information for interpreting the information hidden in the correlation matrix.

The identification of variables with bimodal distribution represents the first argument for the necessity of a rotation of factorial space. Such an artifice will contribute to the unimodal loading of primary variables by factors, and they will benefit from a clearer cumulative variance on the first factors selected by the model. The initial selection of primary indicators comprising an important spatial component becomes decisive in selecting the most suitable type of rotation for determining the factors of community development. In order to extract factors that maintain in a subjacent plan relations bearing the same content – spatial content, in our case –, the model must allow the presence of minimum correlation between factors. The extraction method that met this requirement was OBLIMIN.

TABLE I. COMMUNALITIES

Communalities		
	Initial	Extraction
HQI	1.000	0.862
HQI_UR	1.000	0.830
SIF	1.000	0.859
LT	1.000	0.753
Cost_airport	1.000	0.834
Huff_airport	1.000	0.859
DemoPot	1.000	0.664
AcR1	1.000	0.724
AcR2	1.000	0.847
AcR3	1.000	0.853

Extraction Method: Principal Component Analysis.

Through this rotation variance, we obtained a four-factor model, with a cumulative variance of 81%. The way in which initial variables co-participate to the loading of various factor dimensions maintains the circumstances determined a priori:

- There are bimodal behaviours: the variable housing quality loads in a different sense on factor 1 and on factor 4, while the variable accessibility to third-rank urban centres brings additional information on factor 4, though it loads mainly on factor 1;

- Variables with lower extracted communality are explained by the intensity of participation to creating factors 2 and 3.

- The way in which variables conjugate in the creation of factors identifies the existence of spatial subjacent determinations;

The presence of a latent, space-generated explicative environment is explained by the creation method of each factor, as follows:

**Factor 1** indicates the existence within the Romanian space of a dominant connection between accessibility to average and low urban centres and the overall housing quality. The absence of urban housing quality indicator brings additional information – most of the Romanian space benefits from a relatively balanced distribution of urban structures, which facilitated a balanced diffusion of city-planning innovation. Furthermore, it is confirmed that regional differences in housing endowments with basic facilities concern the rural areas. The way in which initial variables explain the factor indicates that, in Romania, the creation of community development differences is mainly administered by mechanisms specific to territorial cohesion, but it always involves the competitive development vectors, which will influence velocity of smoothing the disparities within the settlements network. The counties that load positively on this factor are those that benefit from a county centre with higher county functions and that have a balanced repartition of low-rank urban centres, which, in their turn, easily manage the dependent rural spaces.

TABLE II. PATTERN MATRIX (A)

Pattern Matrix(a)				
	Component			
	1	2	3	4
HQI	-0.547			0.598
HQI_UR				-0.884
SIF				-0.723
LT			0.675	
Cost_airport			0.923	
Huff_airport		0.914		
DemoPot		0.639		
AcR1		-0.755		
AcR2	0.949			
AcR3	0.656			-0.487

Extraction Method: Principal Component Analysis.  
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 27 iterations.

**Factor 2** depicts an entirely different side to territorial development compared to factor 1. In its case, the subjacent spatial relations are determined by the repartition of first-rank cities and by the dominant relations that they induce in space: emergence of periurban belts, concentration of economic activities with high added value and monopolist behaviours in

the polarization of air transport services. If we analyse it from the opposite perspective, the counties with significant negative saturation in this factor have higher densities than the national mean, they are predominantly urban – and most of the rural population inhabits the periurban areas – or they represent counties near Bucharest (Ilfov, Prahova, Giurgiu, Brasov, Timis, Cluj, etc.). From this perspective, the factor responds better to the conditions for creating territorial competitiveness, including the one induced by proximity.

**Factor 3** extracts the negative component of isolation from the entire factor space. Within it, Laslett Index and time-space distance from the nearest airport index are correlated positively. Two variables are conjugated that inculcate the same spatial capital deficit – multi-scalar isolation of vast rural areas. The counties that load positively on this factor are those that do not benefit from a high-rank urban centre and that – from a demographic perspective – have manifested as exodynamic counties in the past 50 years (Teleorman, Buzau, Covasna, Tulcea, etc.).

**Factor 4** manifests a residual character within the factorial design, because it pinpoints a dimension that contradicts the first factor. Housing quality indicators present a paradoxical situation, as they show negatively correlated values between the urban and the rural setting. The bimodal aspect of the housing index indicator is justified by the over-representation of the factor in areas with high accessibility to low-rank urban centres. The counties that respond the best to this factor benefit from rural spaces well connected to urban types of services; they entered more rapidly the process of spatial diffusion of city-planning innovations from the urban centres toward rural hinterlands. The same process favoured the emergence of new centrality conditions, a process that contributed to the extension of urban network; however, these new urban localities failed to reach the average profile of housing quality specific to the Romanian urban setting (Caras-Severin, Ilfov, Timis, Hunedoara, etc.).

### III. RESULTS AND DISCUSSIONS

The processing of scores specific to each variable and to the variance explained by each factor allows us to create a

synthetic indicator meant to bring together all four dimensions created by the factor model: it is called Community Development Index (CDI) (Fig. 1).

The mapping of final scores and a cluster analysis of territorial distribution of territorial development factors allowed us to find two complementary outcomes: emphasizing on a ranking of Romanian counties depending on the community development level (rich, average, and poor counties), and detailing on the components of territorial development for each case. Such an approach indicates the distance that a certain territorial unit has to cover in order to reach the average community development profile and, at the same time, the levels worth stimulating within territorial development strategies, at the national and regional level. The ultimate purpose is to mitigate the inter-county gaps.

Depending on the ranking index, the analysis details certain trends in the organization of territorial development in the Romanian space. The favored counties are those centred on big and average cities, able of managing the synergy between competitiveness and cohesion (factor 2 and factor 1 of the factor analysis). The second characteristic is attested by pertaining to a certain type of region: the peripheral ones are penalized, including in the counties comprising the most important regional urban centres (NE and SW of Romania). Areas with high community development index have the common denominator of prosperity, described by the Trans-European transport networks (counties of Prahova, Sibiu, Hunedoara). The last positions are occupied by peripheral counties, dominated by rural population, comprising an uneven distribution of territorial capital, mainly to urban centres (Vaslui, Tulcea, Mehedinti, etc.).

The cluster analysis (Fig. 2) completes the information provided by the mapping of county development index, by including in the outcomes an average profile for each county; hence, we analyzed territorial structures depending on their specific type of vulnerability. Because the variables of this analysis actually include the latent dimensions extracted by the factor analysis, it results that these vulnerabilities are represented by the position of each county in relation to the mean of factor scores.

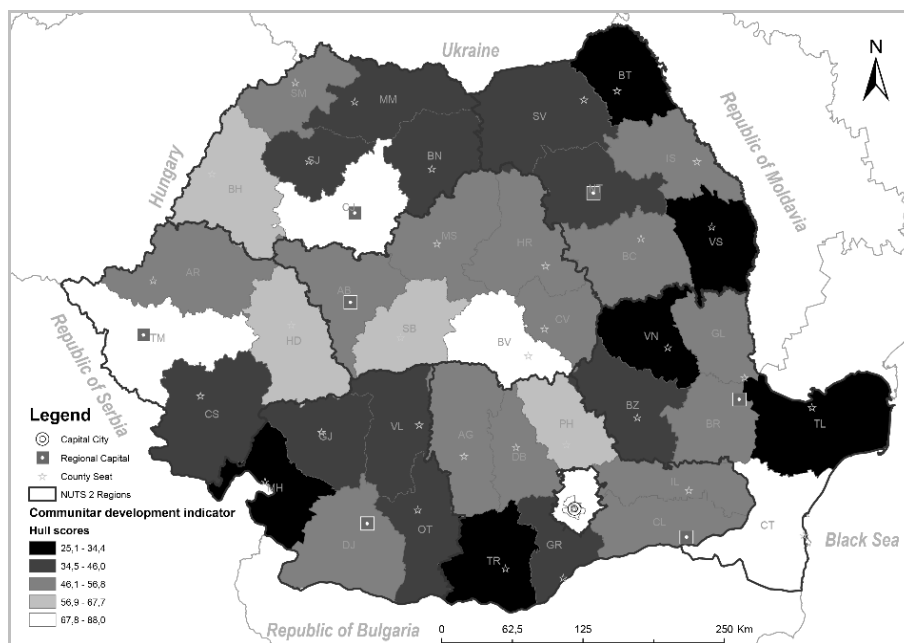


Fig. 1 Community development index at county level (Source: authors)

The outcomes of cluster analysis extract three principal categories of counties, described by five profile types:

A. Peripheral and/or poorly urbanized counties – described by types 1 and 5 of ascending ranked classification. The main characteristic is the negative position in relation to the national average profile of all community development factors and their preferential positioning in the extra-Carpathian region of Romania. The differentiation between the two types of this class is provided by the behaviour of factor 4 (residual factor): type 5 counties benefit from an earlier and more rapid diffusion of social and city-planning innovation from urban centres toward the rural setting. This gap between the two types is partially decided by the primacy of the county centre within the system of settlements. The advantage belongs to the counties that concentrate more population in the urban centre that functions as a county centre; this favors the development of more extended functional urban areas.

B. Counties that comply with the average classification profile, thus showing intermediary values of final community development index, as well as average values for each factor. The deviation from this normality context is provided only by the positioning of factor 4 in opposition to factor 3. The mirroring position of the two factors indicates the existence of misbalances in the distribution of community development; the intermediary values of factors is the result of the arithmetic mean between high values for the urban setting and low values for the rural setting.

C. Counties with high accessibility in a regional and national context, where urban population is dominant. This category is included in types 2 and 3, because it presents positive deviations for all the factors extracted by the analysis. The differentiation within the class is provided by the presence of a negative deviation of factor 2 in case of type 3. This aspect indicates a lower competitiveness for the counties in question, associated to higher incidence of isolated areas with tendencies of territorial decoupling. In exchange, the positioning of type 2 counties claims the dependence of community development diffusion on the repartition of competitive regional major urban poles and on the disposition of main connecting axes between them (Bucharest, Timis, Cluj, Brasov, Constanta).

#### IV. CONCLUSIONS

Community development is a concept that can be declined into quantifiable vectors.

In this paper, by using the factor analysis, we obtained four factors with increased autonomy for explaining the territorial development phenomenon. The synthesis of the four development factors allowed the creation of a community development indicator, as well as of a typology of counties in Romania by the way in which they respond to the average profile of the various sides of development.

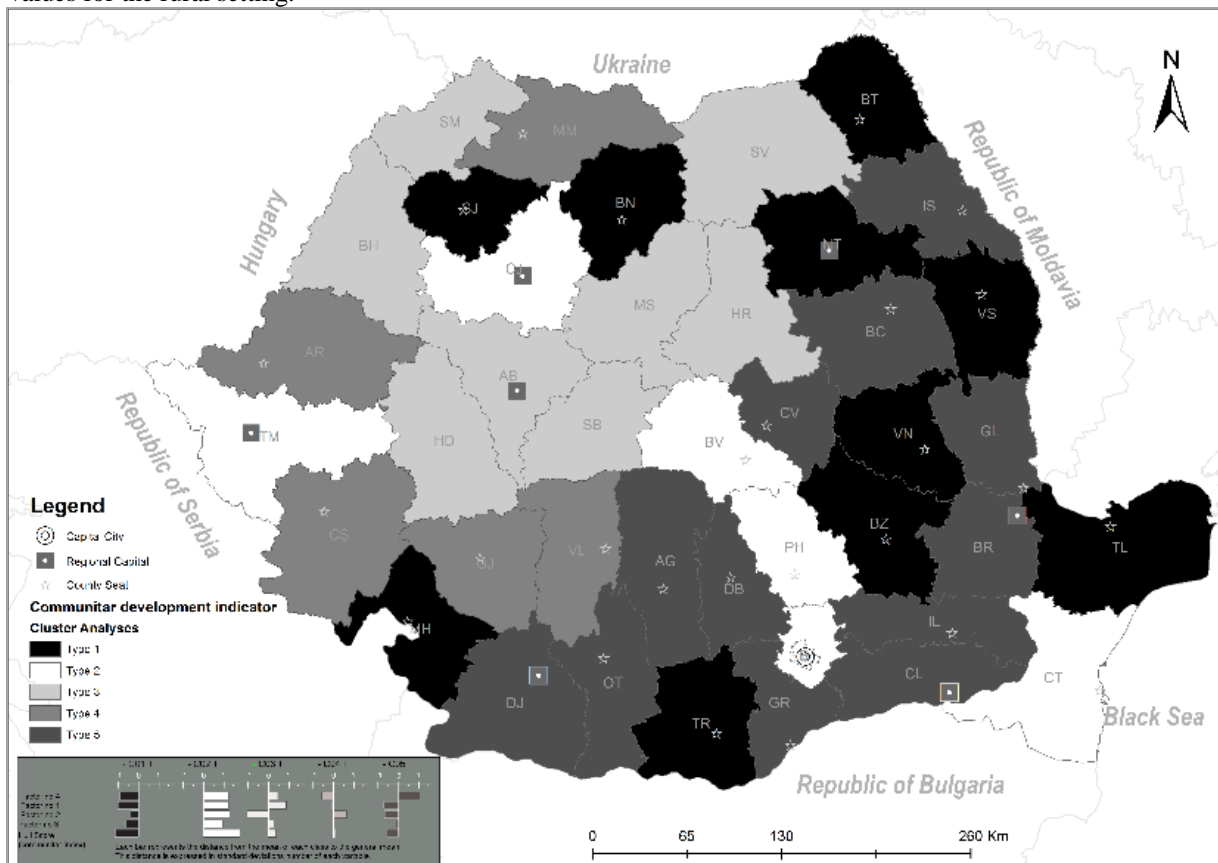


Fig. 1. Cluster analyses for community development indicator (Source: authors)

The spatial and statistical interpretation of the couple of factors enables us to determine latent forms of community development, such as *cohesion* and *territorial competitiveness*, invisible during the simple analysis of composite indicators. The complex statistical-quantitative techniques used for calculating community development indicators reduce risks

inculcated by the intuitive typological and themed approaches. At the same time, they have the capacity of orienting the specialists' attention in space toward subtle/conjugated mechanisms produced in the territorial system and that require control measures: the trend of concentrating territorial development in metropolitan areas, the axialization of

communitary development, the increase in territorial disparities in the administrative units with precarious urban network, the migration of community poverty toward the periphery of the national space, etc.

From the last perspective, the capacity of quantifying the various dimensions of development represents a considerable support for the policies of systematized territorial planning and organization.

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