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Spatial performance evaluation of Hungary

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# 1. ANTECEDENTS AND OBJECTIVES OF THE WORK

My choice of topic fell on this topic because in my high school, university and doctoral studies - through agriculture to regionalism - I have always been interested in the study of micro-regional units, the possibilities and limitations of their examination. During my university studies and three TDK / OTDK, I dealt with the regional impact of professional providers, career tracking, quality assurance and complex development methodology, touching on several topics. These researches have been directed towards spatial theories and spatial studies, as the multidisciplinary relationship of the research is reflected in its spatial impact. Their impact assessment requires knowledge of database management and mathematical statistics, as well as Geographic Information System (GIS) knowledge in order to display a significant amount of input data, which I readily stood and stand before acquiring. During my teaching career, I gained significant insight into the regional policy of the European Union (hereinafter: the EU), including local economic development, faithfully to my interest in small units. Thus, I had the opportunity to participate as a contributor in the writing of the Local Development Strategy (hereinafter: LDS) of two Local Action Groups (hereinafter: LAG). Writing strategies has expanded my operational and strategy-making knowledge and confirmed the importance of my research topic. In such a “network”, a variety of aptitude assessment procedures are used in the preparation of development documents, but with these it is difficult to measure the success of strategies. My studies and scientific activities so far, as well as the resulting complex, systems-oriented perspective, still help my work in carrying out the tasks related to the Test Plant System, and encourage me to look for a solution to the problem.

The survival and continuous sustainable development of a settlement largely depends on the capital invested there, which can be attracted by the settlements with the appropriate, sustainable use and development of their own resources. However, a systems-based, sustainability-oriented approach, using too few or subjective (even erroneous) factors, can lead to a counterproductive position and result in rural areas. Inadequate identification of the processes affecting the region (rearrangement of economic and social conditions) may in some cases lead to an increase in territorial inequalities. Out of this complex system, those who can see the winning processes in time (territorial inequality) and space (spatial structural change), are able to assess their own resources (with appropriate situation analysis) and gain a competitive advantage by adapting to the changed circumstances.

An increasingly important question today is what makes a region, an economy, or a society fit to gain ground in global economic competition. Many factors influence this, including the nature of space, knowledge, the willingness to innovate, partnership-based self-government, which many researchers say is key to sustainable development, and the mental and physical state of society. There is an increasing focus on harmonious development, meaning that in addition to overestimated economic growth, professionals are placing increasing emphasis on integrating the environment and society (through examining the potential positive and negative impacts of

interventions) in decision-making processes. The importance of taking these factors into account lies in the fact that society indirectly (e.g. economy) or is directly related to nature, the environmental impacts of which have a direct impact on society, meaning that we live in a proactive relationship with our environment. In my opinion, these (based on objective facts) integrations came into the spotlight too late, as the negative effects of their lack so far can already be felt. Due to the low potential of territorial (development) competition in rural areas, I consider it important to identify the actual “hot spots” of the areas under study, which can be either the pillars of development or an essential point for development in the future planning period.

Due to the complexity of territorial inequalities, it is not worth conducting a territorial study on the basis of an economic characteristic. However, it is expedient to use a complex statistical method influencing development, which is able to determine the “hot spots” at the settlement level, which influence the development of the settlement in a positive or negative direction. The EU is demanding increasingly stringent requirements, such as monitoring, from planning documents, but the quality of these materials currently varies widely. In my opinion, the answer to this can be a complex expert system, ie the construction of a situation exploration and monitoring system based on an objective point of view. The methodology used in the research covers the development and development of a desired time range,

The topicality of the topic, summed up in a few sentences, is the following: the negative impact of development based on improperly grounded planning - unplanned - is mostly reflected in rural space. This unfavorable condition can be detected in many social, economic, environmental and infrastructural data, and the process of increasing territorial inequalities can also be detected by conducting more detailed studies.

In my doctoral dissertation, I carry out a complex examination of each level of space based on its internal endowments (based on objective factors) in order to show development and territorial inequality in Hungary. Individual areas and regions will find their place in the global competition if they implement their developments through careful planning. A proactive relationship can result in innumerable scenarios, not all of whose outcomes can be modeled, but general regularities can be explored in a variety of complex, systems-based approaches.

The aim of my research is to develop a statistical method showing the level of development which can be used to determine the individual “hotspots” even at the level of settlements. During the examination, the methodology to be developed compares the different characteristics and properties of the examined territorial unit (s) with the same characteristics of an area at a higher administrative level on the basis of a predefined system of criteria. This step is necessary because the development trajectories of territorial units and the territorial (development) competition between them play a decisive role in the formation of territorial inequalities. In my research, I address the difficulty of identifying these “hotspots” and possible solutions.

In connection with my doctoral dissertation, I aimed to:

- C1: with my review of the domestic and foreign literature, I justify the need for an objective methodology using both complex, dynamic and static studies to reduce territorial inequalities.
- C2: point out that the tools available in LDS design were used too broadly by LAGs, which makes it a difficult factor in measuring effectiveness.
- C3: develop a research methodology that uses an optimized indicator system to describe the development and evolution of the resources of an area or region in an easily interpretable way using a situation exploration index number.
- C4: from the results of the developed methodology I reveal regional correlations, which can be displayed with a simple data analysis - even with a GIS display - or with the application of a multivariate methodology.

Prior to the research, in accordance with my research goals, I formulated the following hypotheses.

- H1: It is necessary to develop an objective methodology using complex, dynamic and static studies to measure and reduce spatial inequalities.
- H2: The tools available in LDS design were not used uniformly by LAGs, which makes it difficult to measure effectiveness.
- H3: In order to create a successful strategy, a research methodology is needed that - using an optimized system of indicators - describes the development and performance of the resources of an area or region in an easily interpretable way using a situation exploration index number.
- H4: From the results of the methodologies based on performance evaluation, regional contexts that can be interpreted quickly for everyone can be outlined, which also provides an opportunity to enforce the principle of monitoring.

## 2. MATERIAL AND METHOD

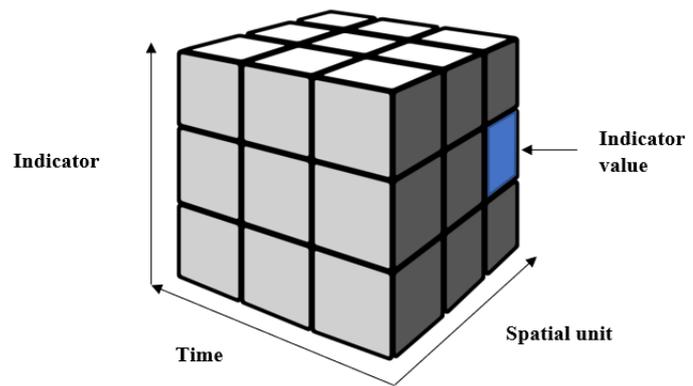
When processing a topic, I consider it extremely important what database the data comes from, how it was processed, and by what methods. In this chapter, I present and systematize all the major databases and methods I used in my dissertation.

After studying several case studies, I have come to the experience that a multitude of different static or dynamic analyzes characterize the majority of documents, but their coupling takes place only on a theoretical level. As a result, comparability and monitoring of the same type of design documents cannot be achieved. As I have already mentioned, the fundamental problem with improvements is that predicting the impact of a development is a difficult task, as the impact only becomes known once it has occurred. Quantifying the impact in the future and the load-bearing capacity of space is often impossible or difficult to achieve. The negative effects of developments can only be influenced by proper management, for which continuous evaluation of the effects before, after and during the development is essential.

With my methodology, I attempt to integrate a static and a dynamic study based on the selected indicator system to analyze the properties / resources of the studied field in order to trace the development and to determine the homogeneity or heterogeneity of the field elements. The method can provide a “systems-based” approach, help to identify the local problems needed for objective strategy-making based on an extensive database and modern methodological processing, the exploration of so-called development hot spots, and the establishment of effective development activities. The identification of hotspots of the smallest spatial elements is also important because in these rural areas with low competitiveness characteristics, the identified “hot-spots” may be the cornerstones of development in future planning periods.

The importance of delimiting the research area lies in drawing attention to the territorial limitations of the research. In my dissertation, the limitation of the research is the administrative border of Hungary from a territorial point of view. Thanks to the methodology used, all administrative units used in the country can be included in the study. Of course, the reference point can always be one of the administrative units above the given administrative unit under study. The applied model can perform a total of 250 combination tests in the basic case (all elements of the examined administrative level are examined simultaneously). This can be many times the number of combinations, if we examine only certain combinations of the examined administrative level elements. In my dissertation, I carried out the examinations at settlement level, for which the micro-region, county, region and country represented the necessary basis of comparison.

According to the data cube approach used in informatics, we treat all our data as if the dimensions were points of an n-dimensional cube, where n denotes the number of each dimension. The basic units of the three-dimensional data cube I use, as well as those most applicable in spatial research, consist of indicators or values at a location defined by each dimension (Figure 1). Thus, the metrics or values are located in the cells of the cube so that they can be clearly identified by a triple of a metric-time-space unit. For example, the minimum data content of my data cube: what was the resident population in a given year, in a given settlement. Dimensions can also have hierarchies, which can mean several levels, we simply form groupings. The best example of this is the spatial unit dimension, because we can group 3,155 settlements into 174 micro-regions, which can be divided into 20 counties, these into 8 more regions and 3 more large regions, which are included in the country as the main unit. Of course, the level of spatial units could even be raised to the level of the EU or the Earth.



**Figure 1. Applied three-dimensional data cube**  
*Source: own editing (2020)*

Due to the 3-dimensional structure of the cube and its hierarchical structure, we can use selection, aggregation, drilling, rotation, and slicing-type operations during analyzes and queries on data cubes. Due to the hierarchical structure, a code system structure was also required to identify the data. The time plane has a unique identifier (year), the indicator plane has a three-level (multidimensional, dimension, indicator), while the spatial unit has a plane six-level (country, large region, region, county, micro-region, settlement) unique identifier. Thanks to the identifiers, the calculator based on the methodology used in excel made it possible to quickly and easily identify the data of the spatial elements required for the calculation and the corresponding reference area. The groups of indicators formed along the four dimensions in the data cube were created in order to explore the level of development and the examined territorial units, namely in the field of local economy, society, environment and infrastructure. Thus, I examined the 4 dimensions examined in the applied methodology (environment, infrastructure, local economy, society) with the help of a total of 40 projected, basic or derived indicators, for which I used a total of 136 basic indicators, of which 15 were used for projection. The examined time interval is the period from 2007 to 2018 covering 11 + 1 years, of which the first year (2007) was used as the base year.

During the development of my complex indicator system, I took into account two aspects. On the one hand, I consciously sought to include only relevant indicators in the study that could provide useful basic and background information when making development proposals. My other principle

is to develop distributional, intensity, and dynamic ratios projected to compare the data in order to eliminate the biasing effects of area and population size.

My methodology is called Spatial Performance Evaluation, during which I compare the processes and results of the different functional areas of the examined territorial unit with the similar characteristics of a larger territorial unit on the basis of a predefined system of criteria. That is a performance measurement procedure in which I compare the own performance of an area unit with the regional average performance in order to shed light on the areas that need improvement and the strengths on which these improvements can be based.

Due to the complexity of the methodology, it became necessary to create an “application”. For this I chose Excel, which uses calculations and macros to perform the calculations. The application has been named Spatial Performance Evaluation Calculator. The Calculator can automatically calculate the development values of an indicator, for which you only need to select the desired indicator and the reference level. Thanks to the data system of the data cube, the system itself combines the necessary data from the data cubes of 2,059,067 pieces. The Spatial Performance Evaluation Calculator runs nearly 5 million formulas per benchmark, while determining the Spatial Performance of each spatial element in a series of settlements.

The Spatial Performance Evaluation is an expert method that compares the various characteristics and properties of the examined spatial element(s) with the specifics of a region, from which the development and evolution of the spatial element is determined on the basis of a predefined system of criteria. The action mechanism of Spatial Performance Evaluation examines a given spatial element along two levels along an indicator, a dimension and a multidimension.

First, the dynamic examination is performed, the Progress Partial Index (hereinafter: PPI) calculation. In doing so, I examine the year-on-year change of the indicators of the area(s) - settlements in my dissertation - compared to the change of the reference area – micro-regions, counties, regions, countries - based on which individual elements are classified into development categories, ie level of development is determined (Table 1).

**Table 1. Progress Partial Index (PPI) formulas**

<b>Pointer</b>	
$PPI_{d_{ij}} = \frac{\sum_{i=0}^n \left[ \left( \frac{X_{d_{ij}} - X_{d_{ijt-1}}}{ X_{d_{ijt-1}} } \right) - \left( \frac{Y_{d_{ij}} - Y_{d_{ijt-1}}}{ Y_{d_{ijt-1}} } \right) \right]}{n} * AT \subseteq P$	
<b>Dimension</b>	<b>Multidimension</b>
$PPI_{d_i} \approx \frac{\sum_{i=0}^n F\acute{O}R_{d_{ij}}}{s}$	$PPI = \frac{\sum_{i=0}^n F\acute{O}R_{d_i}}{d}$
<i>The legend and comment can be read in the doctoral dissertation.</i>	

Source: own editing based on own research (2020)

The dynamic test is followed by the static test, the Development Partial Index (hereinafter: DPI) calculation. In doing so, I examine the deviation of the indicators of the area(s) to the value of the reference area in the examined years, on the basis of which the area(s) are classified into a development category system, ie the level of development of the examined area(s) is determined (Table 2).

**Table 2. Development Partial Index (DPI) formulas**

Pointer	
$DPI_{d_{ij}} = \frac{\sum_{i=0}^n (X_{d_{ij}} - Y_{d_{ij}}) /  Y_{d_{ij}} }{n} * AT \subseteq P$	
Dimension	Multidimensional
$DPI_{d_i} \approx \frac{\sum_{i=0}^s FeR_{d_{ij}}}{s}$	$DPI = \frac{\sum_{i=0}^d FeR_{d_i}}{d}$
<i>The legend and comment can be read in the doctoral dissertation.</i>	

Source: own editing based on own research (2020)

The methodology combines the results of static and dynamic analysis in a Spatial Performance Evaluation Index (hereinafter: SPEI), which gives a realistic picture of the development level and evolution of the examined spatial element (Table 3).

**Table 3. Spatial Performance Evaluation Index (SPEI) formulas**

Pointer	Dimension	Multidimensional
$SPEI_{d_{ij}} = \frac{PPI_{d_{ij}} + DPI_{d_{ij}}}{2}$	$SPEI_{d_i} = \frac{PPI_{d_i} + DPI_{d_i}}{2}$	$SPEI = \frac{PPI + DPI}{2}$
<i>The legend can be read in the doctoral dissertation.</i>		

Source: own editing based on own research (2020)

The classification of the Spatial Performance Evaluation is illustrated in Table 4, which, based on the applied methodological scheme, forms 7 categories (dynamically developing, developing, developing, stagnant, lagging behind, declining, lagging) on a scale of 100 to 100. The 7 categories were formed on the basis of the results - standard deviation and outliers - of 129,024 analyzes performed at the dimension level.

**Table 4. Criteria and classification of the Spatial Performance Evaluation**

Classification		
Classification scale		Name
$\geq 30$	$\leq 100$	<i>Dynamically developing</i>
$\geq 15$	$< 30$	<i>Developing</i>
$\geq 5$	$< 15$	<i>Slightly developing</i>
$\geq -5$	$< 5$	<i>Stagnating</i>
$\geq -15$	$< -5$	<i>Lagging</i>
$\geq -30$	$< -15$	<i>Declining</i>
$\geq -100$	$< -30$	<i>Completely declining</i>

Source: own editing based on own research (2020)

The complex methodology provides us with a number of possible analyzes thanks to a significant number of benchmarks while maintaining an objective point of view. Of course, the benchmark also means a limitation, since in the case of a micro-region level benchmark, we can only calculate a Spatial Performance Evaluation at the settlement and micro-regional level. In case of a national-level benchmark, it is even possible to assess PPI, DPI and SPEI at the municipal, micro-region, county, regional and national level, as well as at the micro or specialized regional level defined by us. Of course, since we are talking about a complex analysis system, the applied program (Excel) performs the calculations completely automatically (using functions and macros).

With such significant input data (number of settlements), a realistic picture can be obtained by using a map representation, which is one of the constant methods of spatial analysis. The map is mainly an illustrative tool, but it can also be used as a method of analysis, as the map plays an important role in displaying the spatial distribution of phenomena, processes, individual objects, as well as in exploring spatial features, regularities and interrelationships. GIS helps to map the data masses, which represents the data in map form, as well as the data were plotted on maps using QGIS for better illustration.

GIS is a computer system designed to collect, store, manage, analyze data related to a geographical location, to display derived information, and to observe and model geographical phenomena. Thus, GIS can provide us with valuable information that can be extracted from the data after spatial analysis, which can serve as a basis for solving all professional tasks in which the geographical location plays a decisive role. GIS integrates spatial and descriptive information into a single system, making it possible to represent the results associated with geocodes (geographical identifiers) obtained during the computer analysis of a large number of economic and / or social (and / or environmental) data sets. In many cases, we need this method in connection with regional development, as complex processes become visible that other methodologies would not be able to shed light on.

### 3. RESULTS AND DISCUSSION

In this chapter, I present the results achieved at the level of each dimension and multidimension, following the structure of the complex model methodology presented in the previous chapter - Spatial Performance Evaluation. The purpose of this chapter is to prepare a performance evaluation of all settlements in Hungary based on the developed model and methodology. In my dissertation, I want to focus on the methodology I have developed, thus illustrating the causes of territorial processes and inequalities at the local level.

#### **Performance evaluation of the local economy**

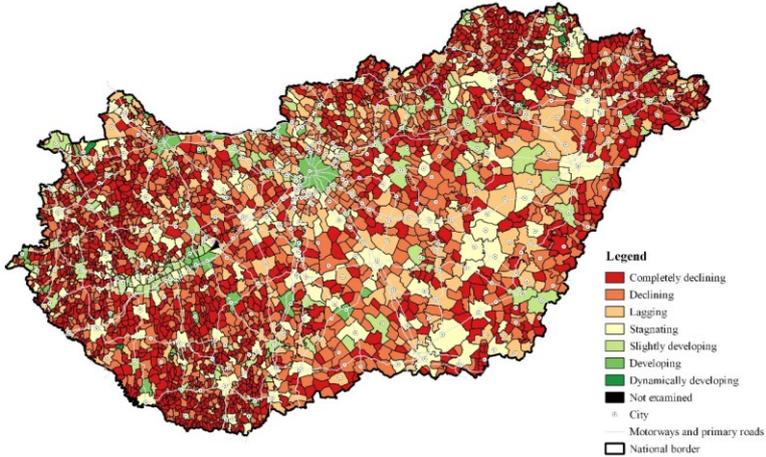
The local economy, as one of the most important dimensions, has a prominent place in all territorial research, including my own. Its significance lies in the fact that its spill-over effect, including the influence of other dimensions, is the largest of all dimensions.

The Development Partial Index shows the worst situation in the national context, because 92% of the settlement population belongs to the “declining” category group, 73% to the lagging category, ie the development of these settlements is significantly low in the national context. A total of 151 settlements “show development” and 106 stagnating during the period under review. There is a significant territorial inequality in the local economy of the country at the settlement level, which is also reflected in the fact that the difference between the best and worst evaluation in relation to the local economy is 127 points out of a possible 200. Cities with more than 10,000 inhabitants achieved more significant development than, based on declining performance, Siófok, Komárom, Győr, Paks, Budapest, Balatonfüred, Sárvár, Budaörs, Eger, Esztergom, Törökbálint, Sopron, Tiszaújváros, Keszthely. Of course, smaller settlements have also shown dynamic development, but in these cases the development is based on settlement-level development or economic investment after a poor starting value. It should be mentioned that among the settlements belonging to the lagging category there are also cities belonging to the agglomeration of Budapest, which have a population of over 10,000, such as Isaszeg, Dunakeszi, Tököl, Maglód, Szigethalom, Pécel. In my opinion, this is due to the fact that the local economy of these cities could not withstand the demographic pressure on them, because the data show that significant immigration was observed in these cities during the period under study.

Nationwide, the Progress Partial Index of Settlements does not show significant differences from the micro-region, county and regional benchmarks. From my research, I have come to the conclusion that the settlements that fell into a given category each year are the winners or losers of a top-down initiative. Nearly 60% of these settlements are cities or municipalities with a population of over 2,000. A significant part of the remaining 40% is a municipality that belongs either to an agglomeration ring - or to the classification of a beneficiary settlement - or to a priority area from the point of view of regional development. The concentration of the vast majority of settlements belonging to the lagging category can be observed in the most disadvantaged areas -

Northern Hungary and the Western and Southern Transdanubia region - 89% of which are settlements with less than 500 inhabitants.

On a national scale, based on the Spatial Performance Evaluation Index calculated from the two sub-indices (Figure 2), it can be stated that 5% of the performance of the Hungarian settlement is in the “developing” consolidated category, 8% in the stagnating category and 87% in the combined “declining” category, 52% of which fall into the completely declining category. Half of the 160 developing or dynamically developing settlements have urban status, half of them are counties with a population of more than 10,000 or belonging to an agglomeration, the other half are agglomeration or regional development priority areas with a population of less than 10,000 (e.g.



**Figure 2. Spatial Performance Evaluation Index of the Local Economy - Nationwide**

*Source: own editing based on own analysis using QGIS (2020)*

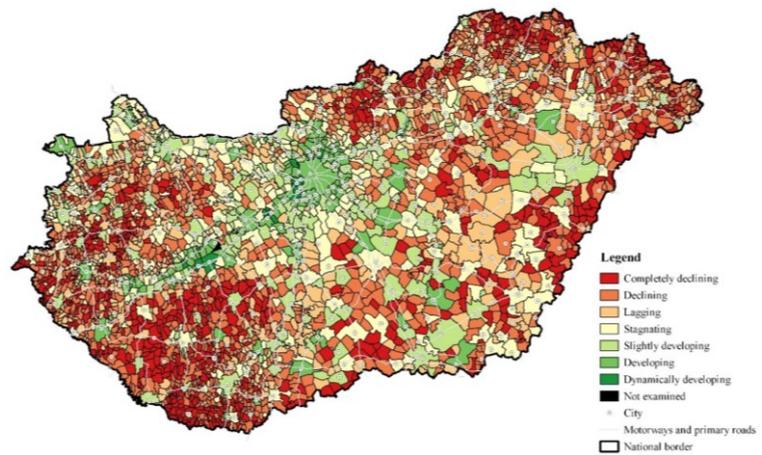
Lake Balaton area). Of the 1,450 completely declining settlements, 99% are municipalities, 93% have less than 2,000 inhabitants, and 78% have less than 1,000 inhabitants - which is all small, 63% - and 54% - of small and dwarf villages are classified as beneficiaries. Based on the illustrated Figure 2 and the data described above, it is easy to recognize in relation to the local economy that there are differences

in performance between settlements by population size category, which is supported by the literature on the ability of higher population areas to attract capital. much larger than in areas with smaller populations. In addition to this fact, another important connection should be mentioned, the relationship between the economy and the immediate environment. The Spatial Performance Evaluation revealed that, in addition to the aforementioned reason, development could be achieved by those settlements that could forge the features of their immediate environment into an economic advantage. So environmental, topographic, hydrographic, their geographical, landscape or cultural features have been successfully integrated into their economy through tourism. Furthermore, the location of infrastructure hubs in space is an important factor for the economy - as shown in Figure 2 - a significant proportion of developing and stagnant settlements are located along major transport corridors.

**Infrastructure performance evaluation**

The study carried out in addition to the national comparison outlines a larger territorial difference in the infrastructural development of the individual settlements than in the case of the other administrative units. The Development Partial Index of the Social Dimension (Figure 3) shows the worst situation in the national context, because 75% of the settlement population belongs to the “declining” category, of which 21% fall into the completely declining category and 34% into the

declining category, ie it can be said that the development of these settlements is extremely low. In the period under review, a total of 376 settlements “show development” and 417 stagnating. Figure 3 clearly shows that there are significant territorial inequalities in the development of the country’s infrastructure at the settlement level. Based on the data, Hungary is typically divided into 3 parts based on development, similar to Faragó’s “winner-loser” finding published in 1999. The developed zone established by it on the line of Szeged - Budapest - Győr can be supplemented with a striped shape starting from Budapest - along the motorways - as well as with a hot focal point forming around Debrecen



**Figure 3. Infrastructure Development Sub-Index - Nationwide**

*Source: own editing based on own analysis using QGIS (2020)*

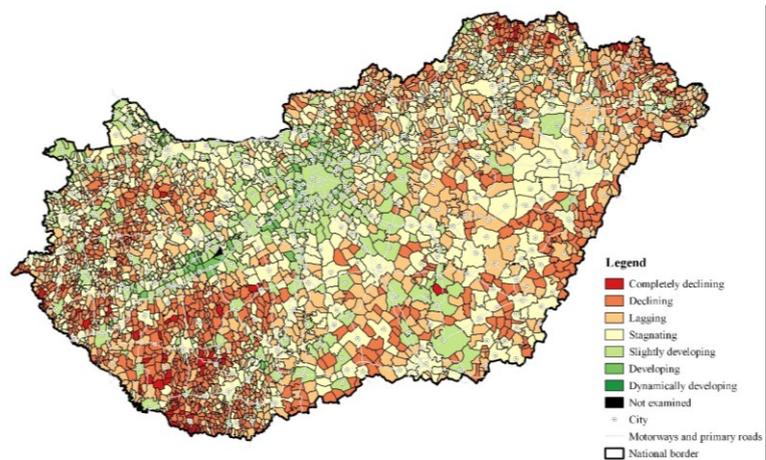
in the eastern part of the country. In terms of infrastructure, the difference between the best and worst ratings in national comparison shows a difference of 100 points out of a possible 200. Significant development was achieved by the cities belonging to the Budapest agglomeration of more than 10,000 people and around Lake Balaton, such as Siófok, Érd, Budaörs, Törökbálint, Dunakeszi, Halásztelek, Vecsés, Balatonfüred, Szigetszentmiklós, Maglód, Budakeszi. In this case, too, the development of smaller settlements is based on the results achieved through settlement-level development or national-level (tender) infrastructure investment after a poor starting value, as well as the territorial classification (priority area, agglomeration). The completely declining and declining categories mostly include those settlements that are most often mentioned by regional research as the most disadvantaged settlements. Such are the population of small villages in Transdanubia, as well as the settlements located along the border of the country from Nógrád county to the eastern part of the country. The hot spot can also be clearly seen. in Heves County, which has been shown more and more nowadays.

Nationwide, the Progress Partial Index of Settlements does not show significant differences from the micro-region, county and regional benchmarks. My research revealed that almost 3% of the “developing” settlements (23% of the total settlement population) belong to the city, 25% to the agglomeration area, 31% to the free enterprise zone, 27% to the beneficiary classification and 32% are municipalities with less than 1,000 inhabitants. From this I came to the conclusion that in the 10 years examined, development was mostly achieved only by those settlements that the regional development policy categorized into a priority area (beneficiary area, free enterprise zone, etc.), ie “external” conditions that could not be influenced by them (as in the SWOT analysis) due to the improvement in the values of the indicators. It may also that the disadvantage was an advantage for them in obtaining funding for the application, which also facilitated their development. 76% of the settlements belonging to the completely declining category - less than 4% of the total

settlement population - are small or dwarf village settlements, typically in the Southern Transdanubia region. According to the data, the infrastructural deficiencies (public sewer, gas network, primary school, developed road network) caused by the declining and aging population appear as hot spots in these settlements. These were formed because either their investment or their maintenance is costly, and their financing is impossible on the part of the settlement, and the utilization and return level of the investment on the part of the state is very low. Due to low solvent demand and an aging society, there is a lag in the car fleet and the number of internet subscriptions.

On a national scale, based on the Spatial Performance Evaluation Index calculated from the two sub-indices (Figure 4), it can be stated that 13% of Hungary's settlement population belongs to the “developing” consolidated category, 28% to the stagnating category and 59% to the “declining” combined category, to the latter 2% is the completely declining category.

34% of the 418 settlements that are developing or have started to develop are urban, of which 60% are county or micro-region centers with a population of more than 10,000, as well as settlements belonging to an agglomeration. The majority of the remaining 40% is a municipality belonging to an agglomeration with a population of between 2,000 and



**Figure 4. Infrastructure Spatial Performance Evaluation Index - Nationwide**

*Source: own editing based on own analysis using QGIS (2020)*

10,000. Of the completely declining and declining 1807 settlements, 94% are villages, 86% have less than 2,000 inhabitants, 66% have less than 1,000 inhabitants, which is 69% of all small dwarf villages, and 64% are classified as some kind of beneficiary. On the basis of Figure 4 and the data described above, it is easy to identify the correlation in relation to infrastructure, as well as in relation to the local economy. that there are significant differences in performance between settlements by resident population size category. In addition, another important context, the relationship between infrastructure of local and national importance, should be mentioned. The Spatial Performance Evaluation revealed that development could be achieved by settlements that belong to the agglomeration area of larger cities or are located along major transport corridors.

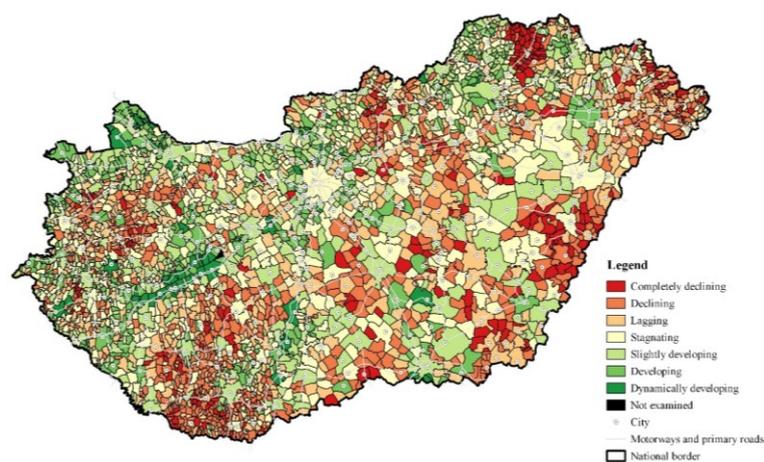
### **Performance evaluation of the environment**

In case of a national comparison, the settlements reach the lowest point of their development, based on the Development Partial Index, as we can see a decline in the case of 83% of the settlements, although the distance between the extreme values decreases at national level. The concentrated places of development in the country are the Balaton area, the agglomeration area of Budapest and Győr catchment area. In addition to these areas, the environmental performance of the country's major cities has improved, such as Gyula, Nyíregyháza, Kecskemét, Pécs, Kaposvár, Nagykanizsa

and Sopron. It is an unfortunate fact to see that even from an environmental point of view, there are such significant differences in a country with an extensive natural environment.

As has been the case so far at all administrative levels, it shows a sharp contrast to development at the national level. In our country, a large-scale intensive development can be observed, among which - showing a weak grouping - there are scattered “declining” settlements, mostly with the status of municipalities (19% of all settlements). Examining the map representation of the DPI and PPI indices together, I came to the conclusion that despite the fact that the level of development of the individual settlements is outstanding, their development is very low. This is due to the fact that the development of environmental indicators can be described as an almost general trend in space and time, which is constantly growing year by year, so the development of underdeveloped areas does not mean an increase in the level.

Knowing this context, the results of the Spatial Performance Evaluation Index made with a national comparison are easier to interpret. Figure 5 shows that more than half of the urban population is “developing” settlements, the rest are stagnating and only a small part are “showing decline”. The performance of the environmental indicators of the municipalities in the catchment area of developing cities also shows a significant improvement. In addition, settlements with significant economies or along major transport channels show a similar shift in the performance scale. We can also see hot spots in every segment of the country, of which the micro-region of Encsi, Gönci, Szikszó, Szerencs, Berettyóújfalú, Püspökladány, Pápa and Kaposvár showed a strong “decline” in almost all benchmarks.



**Figure 5. Spatial Performance Evaluation Index of the Environment - Nationwide**

*Source: own editing based on own analysis using QGIS (2020)*

### **Performance evaluation of society**

According to the Development Partial Index, the society of the country is divided into three parts (Figure 6), of which two are characterized by decline and one by development. The south-eastern part of the country (Southern Transdanubia region) and the areas north of the Budapest-Szeged line are declining. A significant part of the “showing” settlements is located on the Budapest-Győr-Vienna axis, which has been mentioned several times in the literature, and in the immediate vicinity of the motorways starting from Budapest. After mapping the data, I made the observation that the results outline the area of the most disadvantaged and beneficiary areas of Hungary. Based

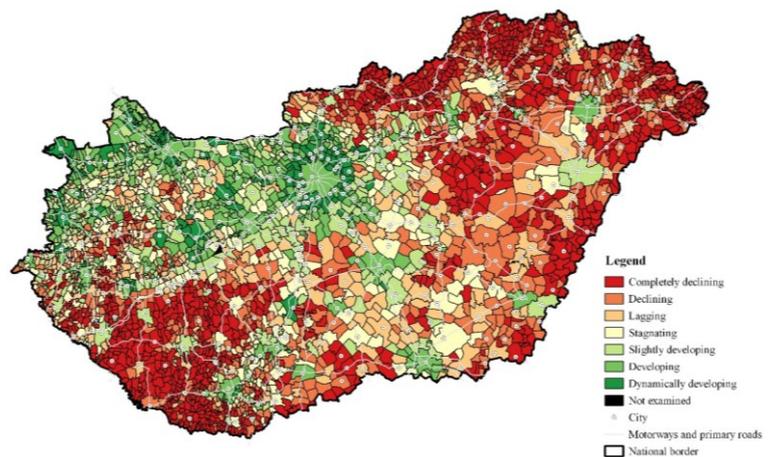
on these, it can also be stated that the indicators measuring the social territorial aspects may have been included in the methodology of designating the beneficiary areas.

On a national scale, the development of settlements - based on the Progress Partial Index - shows a mostly lagging and declining state, but its territorial distribution is practically even for each category.

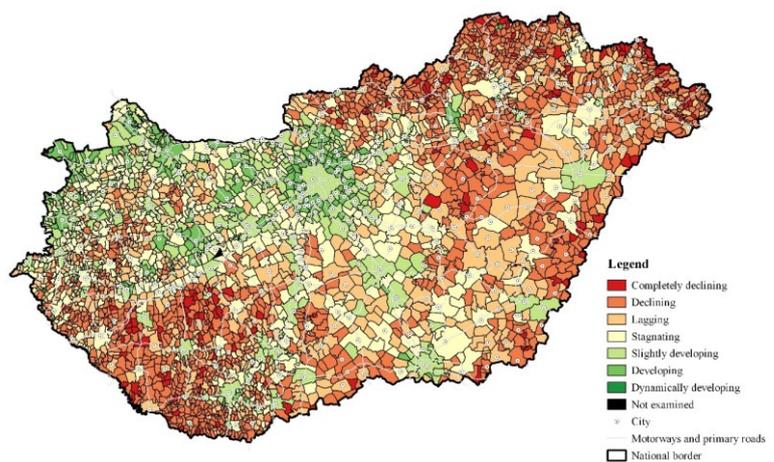
13.6% of the settlements (431) “show development”, and only 18% of these are cities, so from a social point of view we can observe the development of villages in space. 61% of these municipalities showed an underdeveloped condition and 26% developed an advanced condition at the time of the study. It is true for the latter that it typically has an agglomeration area and / or a significant number of inhabitants, as well as settlements with less than 1,000 inhabitants, where the migration balance and natural increase are positive, the aging and dependency rate and economic activity are average, unemployment and public employment, and the number of crimes is zero or negligible. Stagnation can be observed in the largest proportion in the case of municipalities, but half of the cities also fall into this category.

The settlement social achievements measured at the national level are illustrated in Figure 7. As can be seen, the development-adjusted value of development, which in my research means the performance of individual settlements, takes the form of a star on the country map. The well-performing settlements are located in the direction of Győr, Keszthely, Pécs, Szeged and Miskolc along the country's motorway network, starting from Budapest. The performance of our larger cities is also “improving”, but their location is, of course, scattered. The larger areas between the development axes were typically rated as lagging or declining, while the smaller ones were rated as declining or lagging.

Therefore, I believe the distance from big cities and the main transport corridors and the available resources induced from them are the factors that largely determine the performance of society.



**Figure 6. Society Development Sub - Index - Nationwide**  
*Source: own editing based on own analysis using QGIS (2020)*



**Figure 7. Society's Spatial Performance Evaluation Index - Country**  
*Source: own editing based on own analysis using QGIS (2020)*

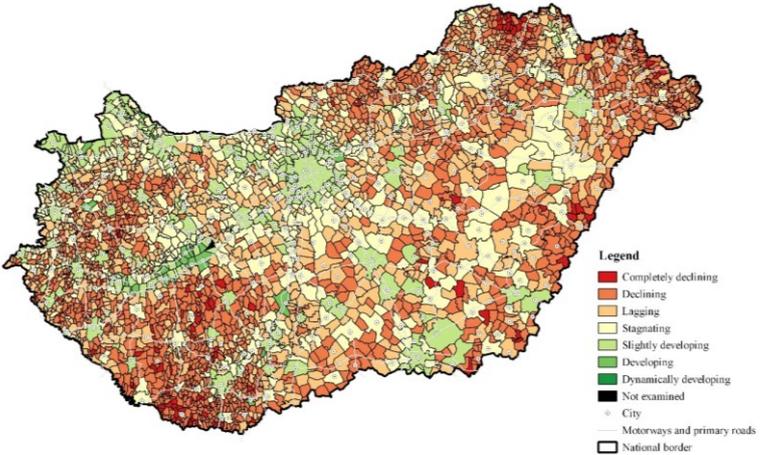
These include the availability of welfare-enhancing services, high-income jobs and a drastic reduction in commuting time, and thus access to quality goods, services and work.

### **Multidimensional Performance Evaluation**

Nationwide, the multidimensional Development Partial Index of Settlements shows the largest territorial inequality. Lake Balaton and its region, Budapest and its agglomeration, as well as its larger cities and the country's villages with a population of between 2,000 and 10,000, can only "show development". The extent of nationally declining concentrated areas extends from disadvantaged areas to the center of the country compared to county and regional comparisons. These contiguous areas are broken down by the developed areas of the main transport corridors, but even their infrastructural features do not affect the said areas to such an extent that they raise the development of the settlements above the average level. The data also show that at the national level, the dimension that best determines development is - disregarding the environmental dimension, as it shows homogeneity in terms of territorial inequality - society in 49%, followed by infrastructure and the local economy in 43%.

According to the Progress Partial Index, in terms of development, 28% of the country's settlement population (almost half of its area) is "developing". At the national level, the dimension that best determines development - disregarding the environmental dimension, which shows homogeneity in terms of territorial inequality - is 55% infrastructure, then 28% society and 17% the local economy. The high proportion of infrastructure, in my opinion, reflects not only the development of indicators in the dimension, but also the fact that it is present as a determining spatial organizing element in territorial inequality. The infrastructure provides an opportunity to build economic and social well-being in a given settlement. It plays an important role in the urban-rural, center-periphery relationship and in the accessing services and high-income work. Of the previous studies, at the multidimensional level, "development" shows the smallest territorial difference in a national context (50 points out of a possible 200 points). Broadly speaking, we can state that the even development of the country is partially realized at the settlement level. There is no completely declining settlement, and there are only 179 declining settlements, which is 5.6% of the total settlement population.

The relationship between the Spatial Performance Evaluation Indices of each dimension based on a national benchmark (Figure 8) was also examined by correlation calculation. The strongest relationship (0.557) was between society and infrastructure, while the weakest (0.267) was between the environment and the local economy. Based on the average of each relationship, the role of dimensions within the multidimensional value of settlements can be determined. Hence, the following results were obtained: infrastructure: 0.491; society: 0.430; environment: 0.386; local economy: 0.347. Based on the evaluation criterion of the correlation study, the average relationship shows a moderately positive relationship. There is a positive relationship between the dimensions, but neither affects the other dimension completely. Therefore, I examined in relation to SPEI which indicators best determine performance. Based on these, the environment is dominant in 46%, society in 25%, infrastructure in 23% and the local economy in 6%. I concluded that the performance of settlements is significantly determined by the level of infrastructure, as it is related to many other factors, and the condition of our increasingly valuable environment (on which Hungary's tourism is also based) largely determines the performance of individual settlements. The role of the local economy, which is in the last place in the two studies, is so small because without the existence and quality status of the other three dimensions, the local economy cannot develop.



**Figure 8. Multidimensional Spatial Performance Evaluation Index - Nationwide**

*Source: own editing based on own analysis using QGIS (2020)*

Source: own editing based on own analysis using QGIS (2020)

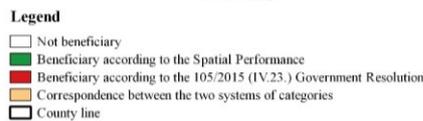
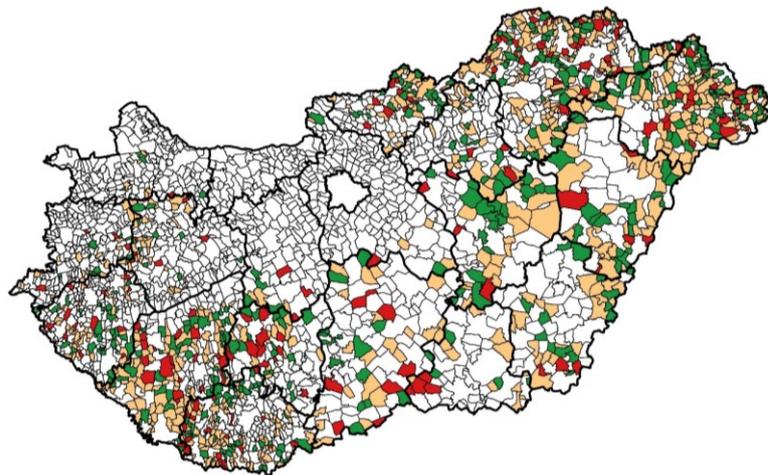
relationship shows a moderately positive relationship. There is a positive relationship between the dimensions, but neither affects the other dimension completely. Therefore, I examined in relation to SPEI which indicators best determine performance. Based on these, the environment is dominant in 46%, society in 25%, infrastructure in 23% and the local economy in 6%. I concluded that the performance of settlements is significantly determined by the level of infrastructure, as it is related to many other factors, and the condition of our increasingly valuable environment (on which Hungary's tourism is also based) largely determines the performance of individual settlements. The role of the local economy, which is in the last place in the two studies, is so small because without the existence and quality status of the other three dimensions, the local economy cannot develop.

In connection with the Spatial Performance Evaluation Index (Figure 8) prepared on the basis of a national benchmark, which can be considered as my main result, I found that significant performance can be achieved by settlements that have the following characteristics: their administrative role is high and / or; belongs to an agglomeration of a large city and / or; is located close to a tourist-favored geographical unit and / or; located along transport corridors and / or; it affects the Szeged-Budapest-Vienna axis, and its social, infrastructural and environmental conditions are optimal for the development of the local economy.

And low performance is achieved by settlements that have the following characteristics: they cannot meet the mentioned items related to development and / or its resident population does not reach 1000 people and / or is located in an area without an attraction center.

I compared the results of my Spatial Performance Evaluation Index prepared along the national comparison with 105/2015 (IV. 23.) Government Decree on the classification of beneficiary settlements, in order to determine whether my research results match the list of beneficiary settlements based on professional and political consensus. I consider the stagnating and “declining” categories of the classification of the Spatial Performance Evaluation to be the beneficiary settlements in the present study. Figure 9 illustrates the two classifications, showing that there is a significant overlap between the two (beige-marked settlements).

In the two classifications, non-beneficiary and beneficiary (including transitional settlements according to the regulation) settlements are the same in 74% of the total settlement population. In addition, my applied methodology places 25% of the settlements in the beneficiary classification. In the case of the remaining 1%, on the other hand, the Spatial Performance Evaluation did not show the right to benefit by



**Figure 9. Difference between SPEI declining and beneficiary settlements**

*Source: own editing based on own analysis using QGIS (2020)*

the decree. In my opinion, this stems from the fact that the regulation was made in 2015, when most of the data that could be used was only available until 2013, while in my research, 85% of the data was available until 2018.

In view of the high degree of similarity, I transferred the list of settlements belonging to the “declining” group based on the Spatial Performance Evaluation Index of my research to the grouping of settlements benefiting under the 105/2015 (IV/23) Government Decree. The difference between the two classifications - based on the number of items belonging to each group - is that although the Spatial Performance Evaluation designates more settlements as beneficiaries, it designates fewer settlements with the worst classification.

## 4. CONCLUSIONS AND RECOMMENDATIONS

During the preparation of the dissertation, I came to the conclusion that structured knowledge synthesis related to the theoretical background of objective situation exploration is useful in several respects. In practical life, you can effectively help the work of local government staff involved in strategy planning, LAGs, and even lecturers and students in the form of teaching aids. Therefore, I suggest the application of similarly synthesized knowledge in teaching materials connected to regional development.

The same is true of the “spatial data cube” theory. It may be important and useful for spatial planning, development staff, colleagues or educators / students in any segment to frame data collection. Proper handling, systematization, hierarchy, and coding of large amounts of data can make subsequent test results more accurate and credible. I recommend the promotion and utilization of the theory of data cube among researchers in regional studies.

Furthermore I suggest the widespread application of the theory and methodology of spatial performance evaluation because of its practical benefit. Most of the users clearly come from the previously mentioned layers (local government, education, LAG), they can be the basis for the development concept. As the obtained index values can be traced back to the level of dimensions and indicators, the local endowments, which can be seen as strengths and as weaknesses, become clearly visible. In this way, development hotspots (endowments or spatial units) that need to be developed or that can give a new impetus to development can be identified. The users of this methodology should be the abovementioned groups such as local government staff, LAGs and education.

During my research I have faced some difficulties in relation with the determination of hot-points (areas with similar characteristic, spatial units or facilities connected to geographical or infrastructural factors). First of all, the biggest obstacle was the selection of objective indicators which are capable to reveal cause-effect relations because only a few long-term database are available for the researchers. The next obstacle was the formation of the methodology. To create a method that detect the development and progress level in a complex way, consider the content of the data, handle the annual data gaps and outliers and contains a scoring system takes a lot of time. Nothing proves it better that I have fined the Spatial Performance Evaluation for four years. The last difficulties were the the detection of spatial relations and the analyses of the several data/ results in which I could only step further with the aquisition of GIS knowledge. The learning of the program operation and the purchasing of the neccessary map layers have taken two years.

From the perspective of development concepts, it is worth emphasizing that the indicator system also takes into account national and international resources, ie we can conclude their positive and negative effects, the efficiency of the use of resources. Thanks to the simultaneous static and dynamic analysis, it can show the development and the level of development compared to the micro-region, county, regional and national projected data.

Due to the nature of the scaled index number, it can quickly and spectacularly show regional correlations, the typical form of which is map display. Thus I recommend the widespread integration of the GIS knowledge in the regional development courses. This type of representation is also used in government work, for example, to illustrate the classification of beneficiary areas. Because the methodology of Spatial Performance Evaluation is very similar to the structure developed by the government and is also able to categorize settlements, its use can facilitate the work of decision-making even at the highest level.

Based on the literature and my research, I consider it necessary to formulate the data collection and data provision at the settlement or law level at the level of settlement and to enforce it with sanctions, as the current databases return a very narrow spectrum to space and often incomplete (e.g. annual lack of data). In addition, the creation or separation of administrative units also requires the return of databases, which is currently did not happen in case of them.

Based on my micro-region level Spatial Performance Evaluation study, I came to the conclusion that development can be demonstrated by micro-region centers and the settlements in their immediate vicinity. In terms of partial progress the social aspect, while in terms of development the infrastructural aspects are the determining factors, and the local economy is in decline in both respects. In terms of performance, the infrastructure and environment dimension shows strength at micro-region level.

In county comparison, my study showed that there is a significant gap in terms of development between developing and declining settlements, both in extent and in the number of settlements. Above-average development was achieved by settlements with a larger population due to the development of infrastructure and society, while underdeveloped areas may be due to the below-average level of their local economy. In terms of development, the environment, society and infrastructure are decisive in a significant part of the settlements, but the degree of development is so balanced that the reduction of territorial differences cannot be observed at the county level. Mentioning about at the county level, too, the high level of environment and infrastructure characterizes well-performing settlements, which are larger cities and their agglomerations, as well as settlements located in tourist areas.

From a regional point of view, I concluded from the results of the performance evaluation methodology that, although to a different extent, significant regional differences can be detected between the settlements. These hotspots are located in a concentrated location within the region. These concentrated areas are represented by small-village settlements for all dimensions. Irrespective of regional borders, developed areas along the main transport channels appear as axes of development in the country. The best example of this is the social dimension. Regarding development, I drew the general conclusion from the study of all dimensions that in county and regional comparison the development of settlements does not differ significantly from each other, because the county and regional development trends are very similar.

In terms of development, the extent of nationally declining concentrated areas extends from disadvantaged areas to the center of the country compared to county and regional comparisons. These contiguous areas are divided by the developed areas of the main transport corridors, but even their infrastructural features do not affect the mentioned areas to such an extent that the development of the settlements is raised above the average level. The data also show that at the national level, the dimension that best determines development - disregarding the environmental dimension, as it shows homogeneity in terms of territorial inequality - is society, followed by infrastructure and, last but not least, the local economy. According to the study, 28% of the country's settlement population "shows development" in terms of development. After analyzing the data, I found that infrastructure largely determines development, which in my opinion reflects not only the development of indicators in the dimension, but also that it is present as a determining spatial organizing element in territorial inequality. So infrastructure provides an opportunity to build economic and social well-being in a given settlement. Based on these, I concluded that the effectiveness of settlements is significantly determined by the level of infrastructure, as it is related to many other factors, and the condition of our increasingly valuable environment (on which Hungary's tourism is also based) largely determines the performance of individual settlements. The role of the local economy, which is in the last place in the two studies, is so small because without the existence and quality status of the other three dimensions, the local economy cannot develop.

As my main result, I found that significant performance can be achieved by settlements that have the following characteristics:

- its administrative role is high and / or;
- belongs to an agglomeration of a large city and / or;
- is located close to a tourist-favored geographical unit and / or;
- located along transport corridors and / or;
- affects the Szeged-Budapest-Vienna axis, and
- its social, infrastructural and environmental conditions are optimal for the development of the local economy.

Low performance is achieved in settlements with the following characteristics:

- the items mentioned in connection with the development cannot be fulfilled and / or;
- its resident population does not reach 1000 people and / or;
- is located in an area without an attraction center.

Related to my research I drew up the following suggestions:

- I recommend spatially balanced development induced by the state, thus improving the development potentials of the regions currently lagging behind.
- I recommend a decentralization in public administration to a higher extent to increase the role of settlements, since the higher function the settlement has, the more development

potentials are hidden in it and the more ways how it can interact with the surrounding settlements.

- I recommend to expand the category of advanced areas for tourism to further settlements which may bring significant development potential for them.
- I recommend the development of inferior infrastructure which would allow the development of small settlements and would enable the link to national economic and infrastructural networks.
- I recommend the identification of development axes and zones along them. I also recommend to realize targeted activities that accelerate the economic development in those zones.
- From development policy point of view, I recommend to prefer developments that consider social, infrastructural and environmental conditions in a complex way to establish local economy, especially in the tiny and small settlements.
- In cities of the Budapest agglomeration under demographic pressure, I recommend to frequently and closely control the change in the number and structure of the population, since it is the only way how the local economy players are able to prepare and react on the ever changing and sometimes new demand by the society.
- Regarding the tiny and small settlements, I recommend to pay attention on their situation. By providing professional expertise, I recommend to define development goals based on their endogenous resources, their own identity that will enable them to fit to the socioeconomic development system of a larger spatial unit.

I see the possibility of continuing the topic by examining a selected settlement or region belonging to a given area in the form of a case study using the Spatial Performance Evaluation method and discussing the results with the settlement leaders, if necessary fine-tuning the database or formulas and equations.

I see the development of the methodology by putting the calculator based on it at the service of society in a user-friendly form, and by further developing it by integrating several micro- and macro-spaces. I see another opportunity to integrate other databases into the system if the right amount and quality of data is available in that particular database.

Based on the literature review and my own research, the results of the examination of the hypotheses presented at the beginning of the dissertation are described below.

**H1: It is necessary to develop an objective methodology using complex, dynamic and static studies to measure and reduce spatial inequalities.**

I fully accept my first hypothesis, because both the literature sources and my own research results have shown that the territorial inequalities that exist and are known so far can still be detected, in fact, the gap between the different parts of the country has deepened. The importance of measuring differences is emphasized by many experts, as is the need for objectivity in the data used for

measurement. Objectivity includes a multidimensional approach, which is also an important element of theories dealing with local design.

The Act XXI of 1996 on Spatial Development and Spatial Planning also provides for the need to monitor and evaluate social, economic, infrastructural and environmental spatial processes. However, it is not enough to monitor and evaluate the processes with static methods, as we can only get a snapshot of the state of the given factors. The dynamic examination says more than that, as it can show the result achieved in a period and the development of the given spatial unit in relation to itself, but the dynamic approach of the spatial unit cannot be properly represented in all cases either. The complex and combined application of the two methods can give a more realistic picture of the state of development and performance of the examined field.

**H2: The tools available in LDS design were not used uniformly by LAGs, which makes it difficult to measure effectiveness.**

I consider my second hypothesis, which sets out my critical remarks on the methods used in the creation of Local Development Strategies and their use, to be only partially justified. In the literature review section, I described that the database available to LAGs contains a wide variety of data, which can be obtained even by sector, yet gave a one-sided result. LAGs were only required to use indicators and indicators, but did not specify which of the available data sets to use and how to analyze them. As a result, the LAGs, in their own competence, chose indicators in a subjective way to explore the situation, so they were only able to examine the development of the settlements belonging to their area of competence, outlined from a few perspectives.

My personal experience also supports the above. I had several opportunities to participate in HFS planning, during which on the one hand I found that there is no common position on the application of indicators and methods for complex situation analysis, and on the other hand it was noticeable that as soon as the strategy entered the control phase, its effective implementation. This is because there was no unified system-based methodology that they could “go back to” in order to be able to objectively assess the results achieved or to be achieved. Given the above facts, I accept the second half of my hypothesis that non-uniform use is a difficult factor in measuring effectiveness. However, I cannot fully substantiate the sub-hypothesis of non-uniform use of tools. My personal experience has shown that LAGs make individual decisions on the use of the available database, but this is not representative, it cannot be said with absolute certainty that all LAGs in the country have done so - and my own research has not responded to this.

**H3: In order to create a successful strategy, a research methodology is needed that - using an optimized system of indicators - describes the development, development and performance of the resources of an area or region in an easily interpretable way using a situation exploration index number.**

In my third hypothesis, in connection with the first two, I assumed that in order to map the resource supply that is the basis of territorial inequalities, a predefined, objective indicator system is needed, from which an index number can be significantly facilitated. I accept the hypothesis with reference to the theoretical background related to spatial planning and strategy making, which is also described in the literature, and to the methodology I have developed.

In my dissertation, the optimized indicator system essentially meant that I performed correlation studies for each indicator to exclude closely related factors that follow each other's changes in parallel. This eliminates potentially misleading information and conclusions resulting from the selection of the subjective indicator described in the previous hypothesis. Another advantage of this index is that, despite the exclusion of correlating indicators (for example, low employment - high unemployment), it forms an index from other indicators that can tell the settlement values in relation to their former self or other higher level territorial units that the given area declines, stagnates, or develops. By interpreting the index number, we can also highlight to what extent these changes were and how they developed numerically in relation to the values of the larger territorial units. Furthermore, it can be easily established that the development and performance of each settlement is better or worse than that of other settlements, so it is easy to determine their position in territorial competition. Thus, the second half of my hypothesis also proves that the developed indices easily describe the development and performance of the resources of an area or a region. thus, it is easy to determine the position of municipalities in territorial competition.

**H4: From the results of the methodologies based on performance evaluation, regional contexts that can be interpreted quickly for everyone can be outlined, which also provides an opportunity to enforce the principle of monitoring.**

I partially confirm and partially reject my last hypothesis on the basis of the complex methodology that gives the essence of my dissertation. The principle of monitoring in the second half of the hypothesis was mentioned several times in the literature, and material and method chapters of the dissertation, and I also emphasized its significance during the hypothesis testing. The performance evaluation methodology for the implementation of my research is based on a pre-defined and optimized (correlated) multi-dimensional (local economy, infrastructure, society and environment) settlement-level indicator system, in which an automated formula system values the values of settlements on a scale from -100 to 100 indexes in two ways. One is a static study that shows the development of spatial units and the other is a dynamic analysis that shows their evolution. The combination of the two results in the Spatial Performance Evaluation Index, which measures the actual performance of areas in relation to larger territorial units. This index number is able to represent the results of the settlements at the multidimensional level on a single map, for example, compared to the national values.

The above-mentioned complexity of the methodology results in a lack of full acceptance of the hypothesis. Since the formulas used on the indicator system are fully automated, the calculator based on my methodology is clearly suitable to tell the current performance of the studied area,

even in the case of an incomplete database on an annual basis. This provides a perfect background for monitoring activities, because if we worked with the same indicators at the beginning of the planning process when preparing the situation analysis as we want to monitor the changes now, the system can show the difference between the two dates in a completely objective way. However, the complexity of the method also results in the rejection of the first half of the hypothesis. Although Spatial Performance Evaluation can to indicate regional contexts with a single number, but a deeper and more detailed interpretation of this number requires serious professional knowledge. Thus, the assumption that the method freezes results that can be interpreted quickly for everyone is not valid, as it may be necessary to systematize the indicators of the background database, which no longer requires only professional knowledge covering territoriality.

## 5. NEW SCIENTIFIC RESULTS

The following new scientific results were formulated on the basis of the literature processing of my dissertation, the research work carried out in connection with it, and the results of my hypothesis tests:

- I consider the theory of the spatial data cube to be a new scientific result, which lays the principles of organizing, hierarchizing and coding a significant amount of spatial data on new foundations.
- Based on a complex approach, I created the theory of Spatial Performance Evaluation, which integrates the performance evaluation theories known in human resources into spatial research.
- I developed a new situation exploration methodology, the Spatial Performance Evaluation Methodology, which is able to integrate static and dynamic analysis into a system, handle data gaps, and result in a value in the range of a scale system for easier comprehension.
- Using statistical and mathematical methods, I developed three new indices - the Progress Partial Index, the Development Partial Index and the Spatial Performance Evaluation Index - to determine the level of development, the state of development and the spatial performance determined by each level of administration.
- I developed the Spatial Performance Evaluation Calculator, which is capable of performing a large number of automated analyzes.
- With my settlement-level research, I determined the characteristics and factors of the performance of settlements.

## 6. THE AUTHOR'S PUBLICATIONS RELATED TO THE TOPIC OF THE DISSERTATION

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György, Á. - Henrietta, N., 2018. Identification of Development Hot-spots in Nógrád County. In International Scientific Days 2018. “Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems.” Conference Proceedings. pp. 1592–1605.

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Áldorfai, G., 2016. Regional Performance Review. In XV. International Science Days: Abstract Volume. pp. 50-50.

Áldorfai, G., 2015. A settlement development model in the spirit of catching up. In Multidisciplinary Challenges - Diverse Answers 2015/2. pp. 7–22.

MTMT notice and citation summary table				
Data of György Áldorfai (November 2, 2020)				
Notice types	Number		References	
	All	Detailed	Independent	All
Scientific publications	All	Detailed	Independent	All
<b>I. Scientific journal article</b>	<u>17</u>	---	---	---
in a foreign-published journal in a foreign language	---	<u>8</u>	<u>2</u>	<u>2</u>
in a foreign journal published in Hungarian	---	0	0	0
in a domestic journal published in a foreign language	---	<u>1</u>	0	0
in a Hungarian-language journal published in Hungarian	---	<u>8</u>	<u>9</u>	<u>9</u>
<b>II. Books</b>	<u>2</u>	---	---	---
<b>a) Book, as author</b>	0	---	---	---
foreign language	---	0	0	0
Hungarian	---	0	0	0
<b>b) Book, as an editor</b>	<u>2</u>	---	---	---
foreign language	---	<u>1</u>	---	---
Hungarian	---	<u>1</u>	---	---
<b>III. Book excerpt</b>	<u>9</u>	---	---	---
foreign language	---	<u>5</u>	<u>1</u>	<u>1</u>
Hungarian	---	<u>4</u>	<u>1</u>	<u>1</u>
<b>ARC. Conference paper in a journal or conference volume</b>	<u>20</u>	---	---	---
foreign language	---	<u>14</u>	0	0
Hungarian	---	<u>6</u>	0	0
<b>Total publications (I.-IV.)</b>	<u>48</u>	---	<u>13</u>	<u>13</u>
<b>Abstract</b>	<u>6</u>	---	0	0
<b>Research data</b>	0	---	0	0
<b>Other scientific works</b>	<u>2</u>	---	0	0
<b>All scientific publications</b>	<u>56</u>	---	<u>13</u>	<u>13</u>
<b>Hirsch index</b>	<u>2</u>	---	---	---
<b>Educational works</b>	0	---	---	---
Higher education works	0	---	---	---
Higher education textbook in a foreign language	---	0	0	0
Higher education textbook in Hungarian	---	0	0	0
Part of a higher education textbook in a foreign language	---	0	0	0
Part of a higher education textbook in Hungarian	---	0	0	0
Educational material	0	---	0	0
<b>Forms of protection</b>	0	---	0	0
<b>Creation</b>	0	---	0	0
<b>Dissemination works</b>	0	---	---	---
Journal article	---	0	0	0
Books	---	0	0	0
Other educational works	---	0	0	0
<b>Works of public interest or not classified</b>	0	---	0	0
<b>Further announcements</b>	0	---	0	0
<b>Other authorship</b>	0	---	0	0
<b>Citation for edited works</b>	---	---	0	0
<b>Citation in dissertation, other types</b>	---	---	<u>1</u>	<u>1</u>
<b>All announcements and all their citations</b>	<u>56</u>	---	<u>14</u>	<u>14</u>