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CHANGES OF FUNCTIONAL URBAN HIERARCHY IN ŚWIĘTOKRZYSKIE VOIVODESHIP *VS.* FUNCTIONS OF THEIR RURAL SURROUNDING*

Abstract: The aim of this paper is to determine the relationship between the dynamics of changes in the functional hierarchy of cities and the dominating functions of the rural areas surrounding them. Answers to the following questions were sought in the paper: How had the functional hierarchy of cities changed in the Świętokrzyskie Voivodeship between 2002 and 2011? How diverse are the dominating functions of rural areas surrounding the cities in the Świętokrzyskie Voivodeship? Do the dynamics of change in the functional hierarchy of cities in the Świętokrzyskie Voivodeship depend on the functions of the rural areas surrounding them?

It has been observed that changes in the functional hierarchy of cities in the Świętokrzyskie Voivodeship result from, to a greater extent, the resources of particular nodes related to the number of inhabitants, administrative functions, historical past, geographical location than from the dominating functions of rural surroundings.

Key words: Functions of rural areas, Świętokrzyskie Voivodeship, urban functional hierarchy.

Introduction

Hierarchy is a natural order of settlement systems, which was originally based on the size of settlements. There are many theoretic approaches to the hierarchical order of settlements. It may be both a result of the relationship between the size of urban nodes expressed by the number of inhabitants (size hierarchy), and their location (spatial hierarchy). A hierarchy may also be determined by the basis of the relationships (links, bonds, connections) between the nodes.

Studies into the spatial structure of urban systems, as well as the relationships between cities and their surroundings, have had a significant importance in regional

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geography and settlement geography. Papers by Christaller [1933] and Lösch [1941] started trends of these kinds of studies, which resulted in the formulation and development of the central place theory. In the 1960s, 70s and 80s it became one of the basic theories explaining the processes occurring in urban systems. The hierarchical order of settlements was conducted most often on its basis. Place in a hierarchy, according to the central place theory, results from the number and diversity in functions performed by a given settlement, which are correlated with the number of inhabitants (consumers) [Pumain 2004].

According to the central place theory, cities are central settlements not because of their location but because of the functions they perform. A research trend has been derived from this assumption, whose aim is to divide a collection of settlements into types by level of central functions development (functional hierarchy). These functions include over-local activities [Maik 1997].

The higher ranking of a city is strictly related to its higher centrality; the higher the ranking, the bigger its range of influence. The central range of influence may be determined by the maximum distance inhabitants of a given region are willing to travel in order to buy goods and services available in a given centre. The central place theory assumes existence of an area where distribution of agricultural population and natural resources is even in the whole area.

There was a decline of interest in the central place theory in the 1990s [Coffey 1998]. The reason for this was to challenge theoretical assumptions, including the phenomenon of hierarchy [Davis 1998].

Moreover, it was observed that, as a result of urbanisation processes and multifunctional development of the country, central nodes became places of servicing not only for the agricultural population.

There are fewer and fewer traditional villages in the modern world, which, from the point of view of activity of population, can be defined as settlements of the people who work in agriculture and services related to it. Nowadays, inhabitants of rural areas practice different professions. Decrease in number of farmers is possible thanks to applying modern technologies in cultivation and livestock breeding as well as thanks to changes in distribution and sells of farming products. In many cases, traditional farms underwent transformation into production enterprises, not only producing agricultural goods but also processing and selling them. This caused a dynamic transformation of rural areas' functions. New functions related to services (trade, tourism) or industrial production as well as housing functions emerge next to traditional functions, related to agriculture and forestry [Kopacz-Wyrwał, Mularczyk 2013].

The aim of this paper is to determine relations between rate of changes of urban functional hierarchy and dominating functions of rural areas surrounding them. Answers to the following questions have been sought:

– How did the urban functional hierarchy change in Świętokrzyskie Voivodeship between 2002 and 2011?

– How diversified are the dominating functions of rural areas in surrounding of cities in Świętokrzyskie Voivodeship?
– Does the rate of changes in the urban functional hierarchy in Świętokrzyskie Voivodeship depend on functions of the surrounding rural areas?

1. Methods

In order to identify changes in the urban functional hierarchy in Świętokrzyskie Voivodeship between 2002 and 2011 a scalar method of Kamiński [1971] has been applied, whose essence is to compare numbers of institutions recognised as central in particular settlements. Selection of method was dictated not only by a cognitive objective but also in regard to the character of source materials, comprising of statements elaborated on the basis of Wojewódzka Baza Publikacyjna REGON (Voivodeship Publication Base of the National Economic Register), as at the end of December 2002 and 2011, containing data about entities, regardless legal and economic activity, for 30 cities of Świętokrzyskie Voivodeship in 2002 and 31 cities in 2011. Data concerning number of entities has been presented in fixed brackets by number of employees (0–9 employees, 10–49 employees, 50–249 employees, 250–999 employedes 1000 and more employees)[1]. Centrality of the analysed cities is determined only by those activities which do not occur in at least one analysed node. The index does not take into account size and range of influence of particular institutions, which is its disadvantage. Number of people employed in a given entity may indirectly express these values. In order to eliminate this disadvantage, a division of entities by number of employees into two groups was conducted after selecting activities recognised as central. The first group includes micro and small entities (respectively 0–9 employees and 10-49 employees) while the other one, having a bigger scale and range of influence, includes medium, big and huge entities (respectively 50–249 employees, 250–99 employees and more than 1000 employees).

Selection of entities which operate business recognised as central activity has been made in order to determine values of indexes of cities centrality. Service and craftsmanship production activities are included in that group according to Christall-

[1] Data was bought in the Voivodeship Statistical Office in Kielce. Due to the fact that information about number of employees presented in the Voivodeship Publication Base is collected at the moment of registration or update and there is no legal obligation to report changes in this respect, the data gathered may be encumbered with error. Inaccuracies may result also from the fact that rules of PKD classification (Polish Classification of Activity) were changed in 2007. Relation keys between particular classifications and commentaries published in Ordinance of Council of Ministers of 24 December 2007 have been applied in order to minimise the inaccuracies. The said inaccuracies do not disqualify the gathered information as they concern all the analysed cities to an equal extent, thus do not change relations occurring between them. Whole gathered data has a homogeneous character and has been collected according to the same procedures so it is suitable for conducting comparisons of the years selected for analysis.

er's central place theory. However, small production activity is omitted in the recent elaborations as it satisfies mostly local demand [Sokołowski 2006]. Finally, 49 activities from the following groups have been accepted: trade, repairing, rental and leasing, financial and insurance services together with environment of business, education, higher education, science, health care, public administration, juridical activity and other services in aid of the whole society, business related to telecommunication and information technology, cultural activity, entertainment, remaining service activity.

At the next stage the selected activities have been identified in classification schemes of PKD (Polish Classification of Activity). Years 2002 and 2011 were adopted for analysis.

Next, entities operating businesses recognised as central for all the cities of Świętokrzyskie Voivodeship in 2002 and 2011 were juxtaposed on the basis of Voivodeship Publication Base REGON and divided into two groups by number of employees (micro and small; medium, large and very large).

Another step was to determine weights of the selected central activities by the means of procedure proposed by Schwarts [1968]. Weights were calculated according to the following formula:

$$c_j = 100 - \frac{m_j}{m} \times 100$$

where:
C_j – weightof the j-th central activity
m_j – number of cities in which a j-th central activity occurs
m – number of all the cities in the analysed area

The index is a value from the interval from 0 to 100. Zero indicates an activity that occurs commonly, in all the cities of the analysed system, whereas 100 a business which is not found in the analysed city system. Higher weight determines higher level of centrality of a given activity.

Centrality index for particular cities in the settlement system of Świętokrzyskie Voivodeship for 2002 and 2011 was calculated in the next stage according to the following formula:

$$v_{ci} \quad \frac{\sum_{j=}^{k} c_j}{\sum_{j=}^{z} c_j} \times 100$$

where:
V_{Ci} – centrality index of an i-th city
C_j – weigh of j-th central activity
k – number of the central activities in a given city
z – number of all the central activities

Multiplication of the index by 100 allowed to receive values from the interval from 0 to 100.

The following measures were adopted for the needs of that paper in order to present diversity in dominating functions of rural areas in the surrounding of cities in Świętokrzyskie Voivodeship, taking into consideration experience in functional classification of rural areas in Poland [Bański, Stola 2002] and in Świętokrzyskie Voivodeship [Salomon 2007; Kopacz, Mularczyk 2011; Kopacz-Wyrwał, Mularczyk 2013]:

- for agricultural functions identification: share of arable lands in percentage of *commune*'s whole territory (*commune*– principal unit of territorial and administrative division in Poland; translator's note), number of people making a living from agriculture per 1000 inhabitants;
- for tourist functions identification: share of forest area in percentage of whole commune's territory, number of accommodation and restaurant facilities per 1000 inhabitants;
- for service functions identification: number of business entities in market services per 1000 inhabitants of working age, number of the employed in market services per 1000 inhabitants of working age;
- for industrial functions identification: number of business entities in industry per 1000 inhabitants of working age, number of the employed in industry per 1000 inhabitants of working age;
- for housing functions identification: commuters per 1000 inhabitants, number of newly commissioned finished individual buildings between 2000 and 2009 per 1000 inhabitants.

Coefficient of variation expressed in percentage for the selected characteristics oscillates from 26 to 158. The mean amounts to 73. The correlation coefficient between the characteristics selected for calculating particular synthetic indexes allows to recognise them as independent. Only those which have been selected for characterising the agricultural function constitute an exception. However, difficulties related to accessibility of other statistical data contributed to adopting them for further analysis. Similar characteristics have been used in former studies to describe agricultural functions. Thus, it can be accepted that the selected characteristics are both appropriately diversified spatially and have significant information value.

Most data concerned 2010 and originated from Bank Danych Lokalnych (Local Data Bank) published on the official web site of Central Statistical Office (www.stat.gov.pl).

In regard to the fact that the characteristics which have been taken into consideration are expressed by different measures, their normalisation was conducted. So called procedure of Zioło [1985] was applied to this end. Percentage shares of particular synthetic measures describing agricultural, tourist, service, industrial and housing functions in the aggregate value were calculated. Thanks to this, it was possible to

determine functions dominating in each commune. Those functions whose synthetic indexes were higher than the mean by at least a standard deviation were recognised as dominating.

2. Rate of changes of centrality of Świętokrzyskie Voivodeship cities *vs*. dominating functions of surrounding areas

Hierarchy is one of the basic characteristics describing settlement systems. Diversity in urban hierarchy of regional systems depends on many natural, demographic, economic and historical factors [Korcelli, Potrykowska 1979; Sokołowski 2006]. Sokołowski [2005, 2006] observed that diversity in demographic processes and economic development contributes to diversity in centrality of nodes which rank similarly in terms of size and administration. *E.g.* depopulation processes may lead to decrease in demand for services, alike decline in level of people's income, whereas deindustrialisation processes changing cities' economic base are likely to cause enforcement of service sector in relation to the remaining ones. Historical past which forms specific economic and social features of particular cities and their resources determining demand for specific services, is strongly influential.

Two subregions were distinguished in administrative division of the voivodeship: Kielce subregion, including Kielecki P*owiat* (*powiat,* pl. *powiaty* – secondary unit of administrative and territorial division in Poland; translator's note), Ostrowiecki *Powiat*, Starachowicki *Powiat*, Skarżyski *Powiat*, Konecki *Powiat* and Kielce City *Powiat*, as well as Sandomiersko-Jędrzejowski Subregion including Buski *Powiat*, Jędrzejowski *Powiat*, Kazimierski *Powiat*, Opatowski *Powiat*, Pińczowski *Powiat*, Sandomierski *Powiat*, Staszowski *Powiat* and Włoszczowski *Powiat*. Kielecki subregion is characterised by higher city density (2.8/1000 sq. km), close to the national mean (2.9/1000 sq. km) than Sandomiersko-Jędrzejowski Subregion (2.5/1000 sq. km). Four biggest cities of the voivodeship are located in it. Also urbanisation level is much higher there. In 2011 it amounted to 55.7%, whereas in Sandomiersko-Jędrzejowski Subregion to 28.6%.

It results from different history of these areas. Majority of cities in Kielecki Subregion owe their development to industrial function[2]. Before World War II they were included in Central Industrial Region, after the war they accounted for the core of Old-Polish Industrial Region. Whereas majority of cities in Sandomiersko-Jędrzejowski Subregion are classic central nodes servicing agricultural population. Despite the fact that before World War II they were also included in the Central Industrial Region,

[2] *E.g.* Starachowice gained civic rights in 1939, Skarżysko Kamienna in 1923, Suchedniów in 1962, Stąporków in 1967 as a result of dynamic industry development, in the Central Industrial Region till World War II, in the Old-Polish Industrial Region after the war.

development of industry had remained only a plan there, whose execution was interrupted by the war.

Differences in history of economic development influenced strongly diversity in functions of rural areas. Non-agricultural functions dominate in the north-western part of Świętokrzyskie Voivodeship in the past related to dynamic development of industry, currently undergoing modernisation, whereas agricultural functions dominate in the south-eastern part of the region. This diversity could have contributed to diversity in centrality indexes, their growth rate and diversity in insufficient or excess provision of services.

It is difficult to compare the influence of rural surrounding functions on centrality of cities of different sizes, which are in various levels of administrative, functional hierarchy. This difficulty derives mostly from the fact that size of the served surrounding depends to a large extent on hierarchical levels which cities take. The higher a given node ranks in a hierarchy, the bigger that surrounding is. It has been adopted for the sake of this paper that size of the served surrounding is conditioned by administrative rank of cities. Direct surrounding of a *powiat*-rank city and voivodeship-rank city is understood in this paper as rural areas of *powiaty* whose capitals those cities are, whereas direct surrounding of cities of lower administrative rank is constituted by rural areas of rural-urban communes.

Table 1

Dominating functions of cities' surrounding in Świętokrzyskie Voivodeship *vs.* level of provision of services and rates of change of the centrality index

No.	City	Dominating function of the surrounding	Provision of services (2011)	Centrality index (Vc_i) 2002	Centrality index (Vc_i) 2011	Rate of change (%)
1	Kielce*	Multifunctional	Insufficiency	59.0	69.2	16.0
2	Ostrowiec Św.**	Housing	Insufficiency	26.4	30.7	15.2
3	Starachowice**	Multifunctional	Insufficiency	29.3	21.9	-28.9
4	Skarżysko Kam.**	Tourism	Insufficiency	21.2	23.8	11.7
5	Sandomierz**	Agricultural	Excess	25.0	27.1	8.1
6	Końskie**	Multifunctional	Excess	19.6	18.1	-7.8
7	Busko Zdrój**	Agricultural	Excess	17.2	22.8	27.9
8	Jędrzejów**	Agricultural	Excess	18.2	20.6	12.3
9	Staszów**	Industrial	Excess	15.1	19.9	27.1
10	Pińczów**	Agricultural	Excess	16.7	20.1	18.3
11	Włoszczowa**	Housing	Excess	14.9	17.7	16.8
12	Suchedniów	Industrial	Excess	9.1	13.6	39.7
13	Połaniec	Multifunctional	Excess	11.3	15.7	32.7
14	Opatów**	Agricultural	Excess	12.7	16.8	27.5

No.	City	Dominating function of the surrounding	Provision of services (2011)	Centrality index (Vc_i) 2002	Centrality index (Vc_i) 2011	Rate of change (%)
15	Sędziszów	Housing	Insufficiency	9.2	9.6	3.9
16	Stąporków	Tourism	Excess	8.8	11.2	24.1
17	Kazimierza Wlk.**	Agricultural	Excess	13.1	14.3	8.6
18	Ożarów	Industrial	Excess	10.0	12.4	21.1
19	Chęciny	Multifunctional	Insufficiency	8.1	9.6	17.2
20	Chmielnik	Housing	Insufficiency	11.2	9.4	-17.7
21	Małogoszcz	Tourism	Insufficiency	8.3	8.4	0.9
22	Ćmielów	Housing	Insufficiency	3.0	5.4	57.8
23	Kunów	Tourism	Insufficiency	3.6	5.3	39.4
24	Daleszyce	Tourism	Insufficiency		5.8	
25	Wąchock	Tourism	Insufficiency	4.8	4.4	-9.9
26	Koprzywnica	Agricultural	Insufficiency	2.7	2.9	6.9
27	Bodzentyn	Tourism	Insufficiency	7.3	7.5	3.2
28	Osiek	Service	Insufficiency	4.0	7.3	58.4
29	Zawichost	Agricultural	Insufficiency	3.2	3.4	5.9
30	Skalbmierz	Agricultural	Insufficiency	2.7	3.3	21.1
31	Działoszyce	Agricultural	Insufficiency	2.9	1.7	-54.6
			Average	13.28917	14.8858	

*- voivodeship-rank city, **- *powiat*-rank city

Source: Own calculations on the basis of Voivodeship Publication Base REGON.

There are 12 *powiat*-rank cities, four of which have a seat in urban communes, while the remaining ones in urban-rural communes (Tab. 1). Six from among them have been characterised by surrounding with non-agricultural functions domination, another six by surrounding of agricultural functions domination (Tab. 1). Cities with non-agricultural surrounding, with exception of Staszów, are located in Kielecki Subregion, whereas those with agricultural surrounding in Sandomiersko-Jędrzejowski Subregion. *Powiat*-rank nodes with surrounding where agricultural functions dominate are characterised by better provision of central services in comparison to the cities with surrounding where non-agricultural functions dominate. All of them have excess of these services in relation to the number of inhabitants, while in Ostrowiec Świętokrzyski, Starachowice and Skarżysko Kamienna there is insufficient provision observed, whereas in the remaining ones (Końskie, Staszów, Włoszczowa) the excess is lower, considering standardised residuals of regression (Tab. 1). Sandomierz, in whose surrounding agricultural functions dominate, used to have the biggest excess among the analysed cities. It was characterised also by higher value of centrality index than Starachowice and Skarżysko Kamienna, which are located in Kielecki Subre-

gion, have surroundings where non-agricultural functions dominate and are inhabited by larger population, in 2011 close to the second city in the city system of the voivodeship – Ostrowiec Świętokrzyski (Tab. 1). Sandomierz is becoming a dominating city in the subregion. The average value of centrality index of *powiat*-rank cities for both analysed periods was higher in case of cities with surrounding where non-agricultural functions dominate (nodes with non-agricultural surrounding - Vc_{2002} = 21.1, Vc_{2011} = 22.0, nodes with agricultural surrounding - Vc_{2002} = 17.2, Vc_{2011} = 20.3). However, growth rate of centrality index in the analysed period was lower there (4.3%) in relation to cities with surrounding where agricultural functions dominate (16.6%). In case of *powiat*-rank nodes one can observe that there is a better provision of central services in relation to the number of inhabitants in the cities in whose surroundings agricultural functions dominate. Furthermore, centrality index of such cities is characterised by higher growth rate.

It is difficult to notice such relations, taking the remaining cities into consideration. Excess provision of services occurs in four from among 14 nodes with surrounding where non-agricultural functions dominate (Tab. 1). Four cities with surrounding where agricultural functions dominate are characterised by insufficiency of services. Moreover, they are described by lower average centrality indexes (nodes with non-agricultural surrounding - Vc_{2002} = 7.6, Vc_{2011} = 9.0, nodes with agricultural surrounding - Vc_{2002} = 2.9, Vc_{2011} = 2.8) and slower pace of changes. It can be conceded that in case of cities which do not perform *powiat* functions, higher growth of centrality is characteristic for these nodes in whose surrounding non-agricultural functions dominate.

Null hypothesis testing procedure has been conducted in order to determine whether the described differences are statistically significant. In regard to a small sample group size (31 cities) for assessing difference in growth rate of centrality index between the nodes whose surrounding is characterised by agricultural functions domination and cities in whose surrounding non-agricultural functions dominate a t – Student's statistics has been applied, whereas in order to determine diversity in provision of central services a Chi-squared test has been used.

On the basis of the analysed statistical data one can assume that more dynamic growth of centrality index in comparison to other nodes takes place in the cities, especially *powiat*-rank ones, with surrounding where agricultural functions dominate. The conducted statistical procedures indicate, however, that the presented differences in growth rate of centrality index between cities of the analysed groups are not statistically significant.

Statistical data analysis allows also to assume that cities with surrounding where agricultural functions dominate are characterised by a better provision of central services in relation to the other nodes. The Chi-squared test conducted allowed to confirm (at the significance level equal to 0.05) these suppositions only in regard to the group of *powiat*-rank cities. For the remaining cities and their whole set, differences in provision of the central services are not statistically significant.

Summary and conclusion

Average value of the centrality index of all the cities grew from 13.3 in 2002 to 14.9 in 2011. Its rate of change amounted to 11.3%. Diversity in the centrality index in both analysed periods was high and did not change (coefficient of variation in 2002 – 85.8, in 2011 – 85.8). Centrality of the first city strengthened in the city system of Świętokrzyskie Voivodeship. In contrast to the other voivodeship urban systems in Poland, there was an increase of the difference in centrality between the voivodeship-rank city and *powiat*-rank cities in the analysed period. Hierarchy at the level of the remaining cities flattened. Medium-sized *powiat*-rank cities lost importance, whereas importance of the remaining ones grew. Insufficient provision of services characterised the voivodeship-rank city, *powiat*-rank cities with seats in urban communes (with exception of Sandomierz) and the smallest nodes.

Changes in urban functional hierarchy of Świętokrzyskie Voivodeship result from resources of particular nodes related to the number of inhabitants, administrative functions, historical past and geographical location to a greater extent than from dominating functions of rural surrounding and globalisation or European integration processes. Foreign investment is oriented mostly towards industrial activity, which only indirectly influences less mobile activities recognised as central, while its size and number in Świętokrzyskie Voivodeship are lower than in other regions of our country. European funds alike, strengthen centrality of particular nodes mainly indirectly by improving their attractiveness for investors, whereas direct financing reaches a small number of entities from among all those which manage central businesses. They can be conceded as modifying the urban functional hierarchy in Świętokrzyskie Voivodeship by strengthening centrality of some nodes, *e.g.* Kielce, Ostrowiec Świętokrzyski, Sandomierz, Pińczów, Połaniec or Ożarów.

Rural areas of Świętokrzyskie Voivodeship are characterised by multifunctional development. In the light of the selected measures dominating functions can be determined for majority of *powiaty* and rural communes as well as rural areas of urban-rural communes. *Powiaty* and communes with agricultural function domination account for the most numerous group. They are concentrated in the south-eastern part of the voivodeship, in Sandomiersko-Jędrzejowski subregion.

Statistically significant relations between rate of change of centrality and provision of central services in cities in Świętokrzyskie Voivodeship on one hand and dominating functions of the terrains surrounding them on the other hand have not been found. Nevertheless, it can be observed that in case of *powiat*-rank cities, there is better provision of central services in nodes in whose surrounding agricultural functions dominate. They are also characterised by higher growth rate of centrality. Statistical data analysis allows to observe that in case of cities which perform neither voivodeship nor *powiat* role, nodes in whose surrounding non-agricultural functions dominate have higher centrality indexes and higher growth rate.

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