DELIMITATION OF SAME MUNICIPALITIES OF CRACOW DISTRICT IN REFERENCE TO TECHNICAL AND SOCIAL INFRASTRUCTURE (USING NUMERICAL TAXONOMY METHODS) AND THEIR IMPACT ON LOCAL DEVELOPMENT

Julia Gorzelany, Barbara Prus, Tomasz Salata
University of Agriculture in Cracow
j.gorzelany@ur.krakow.pl, b.prus@ur.krakow.pl, rmtsalat@cyf-kr.edu.pl

Abstract. The special development is performed with varying intensity. This is due to different factors that determine the above mentioned development. Among the many factors influencing the regional development the technical infrastructure and social infrastructure should be distinguished, because of their extent business processes depend. The existence of technical and social infrastructure has a major impact on the quality of life and regional development. The purpose of this article is a comparative assessment of the status and development trends of selected elements of technical and social infrastructure in spatial terms, i.e. the cross-section of Cracow district municipalities and determination of their metrics development. In order to assess the level of the technical and social infrastructure, in the article the Word method is used. An additional objective of the study is delimitation as well as analysis and evaluation of local development in selected municipalities in the district of Cracow. The base is the county municipalities of the examined region, for which sets of features describing local development were prepared in the form of quantified indicators. Through the concept of delimitation we understand the distribution of areas at different purposes cognitive and practical, as well as using a variety of algorithms and delimitation methods. The result of such divisions may be areas of homogeneous (uniform) and other functional areas. The analysis will be to identify which elements of the technical and social infrastructure impact on the regional development of Cracow district. Moreover, development barriers will be indicated, and therefore the elements, which expand due to their inadequate strength.

Keywords: local development, technical infrastructure, social infrastructure, Ward method, development barriers.

Introduction

There are plenty of taxonomy methods [1], which used a variety of algorithms to describe the delimitation of homogenous and functional areas [2-4]. The study of regional development deals with researchers in various fields. To such study the works of the authors: J. Nijkamp, R. Brol, A.Szewczuk, J. Słodczyk, Gralak A., Myna A, Williamson J.G., P. Churski, Hausner J., Kudłacz T., Szlachta J, Markowska M., Biehl D. are dedicated. Noteworthy is the work edited by D. Strahl - Assessment of regional development, which concluded not only theoretical analysis of the problem, but also included: measurement method development, method of linear ordering, classification methods and econometric modeling. However, the regional aspects regarding the problem of the social and technical sphere development in the rural sector require more extensive studies. To determine the priority directions of social transformations in rural areas research oriented on the study of the degree of development for the education and treatment-rehabilitation infrastructure in rural and urban areas is also important. However, the problem is present, real and requires further analyzes [5-16].

The relationship between the infrastructure and regional development is one of the most intriguing problems in the regional policy for less prosperous areas. The improvement of the infrastructure is, for instance, a major policy instrument of the European Regional Fund (established in 1975) in order to develop the backward regions of the European Community. Especially since 1978 – when it was decided that a wide variety of public goods could be considered as infrastructure in which the Regional Fund (and other financial institutions of the Community) financially might participate – subsidies for infrastructure projects have gradually increased and amount nowadays to more than one half of the Regional Fund's annual budget [16].

Europe is particular for strong regionalist tendencies that have prevailed in this continent for centuries. This led to the division and differentiation of space. As a result, it has developed with varying intensity. There are a number of factors that determine this development. One of these is the technical infrastructure, which largely impacts economic processes.

The authors set themselves the goal of conducting a comparative assessment of the status and development trends of selected elements of the technical and social infrastructure in spatial terms (i.e. the cross-section of Cracow's district municipalities) and appointment of their development measures.

Research assessing the level of the technical and social infrastructure is based on the method of Wroclaw taxonomy. An additional aim of the study is to delimitate, analyze and evaluate the local development in selected municipalities in the district of Cracow.

Infrastructure as a whole exerts significant impact on social and spatial development of the region. Its roles could be defined in the following way:

- Location of infrastructure induces long-term effects and defines development trends,
- Planning of infrastructure development should be included into local spatial development plans for communes [17].

Forecasts related to the future of infrastructure are very difficult, but at the same important for local development, which is why they are one of the key issues in spatial plans for communes and provinces. The objectives and forms of planning are determined by the Polish act on spatial planning.

From a technical point of view, infrastructure is defined as the technical equipment (usually in the form of a network system) aimed at satisfying the needs of the domestic and economic system in the settlement; communication and transport (roads, streets, lanes, crossings) and utilities (water supply and sewerage, power grids and telecommunications, gas) as well as objects (cemeteries, wastewater treatment plants).

This concept is so wide that its social aspect also includes a network of facilities and equipment that meet social needs in a given system settlement (unit), in particular social infrastructure form the "devices" education, health, social welfare, culture and sport service facilities and trade. It can therefore quote for Miszczuk (2007) that it is a set of devices and institutions necessary to ensure proper functioning of the economy and society [18]. There is no doubt that infrastructure is important in the development of the region and achieving competitive advantage. Well-developed infrastructure provides residents optimal living conditions and promotes economic development. It is one of the basic elements of the socio-economic and spatial system. Infrastructure can be divided into two main groups: economic and social infrastructure [19].

Economic infrastructure, also known as technical, is crucial for economic development and achieving competitive advantage of the region. Its task is to ensure proper functioning of the economy and the integration of individual spatial systems. Therefore, it supports manufacturing operations and serves the development of production.

The level of development of the transport infrastructure has a very important role in economy, as it determines the accessibility of the area and allows the flow of people, goods and information and economic exchange with the environment. It consists of such elements as all kinds of roads, railways, airports and seaports, as well as information systems and telecommunications. Availability of facilities and equipment of communication infrastructure is important, as well as its efficiency, quality and throughput. In the development of the region connections with the international transport network, or a particularly good relationship with the great economic centres have important meaning [20].

In attractive housing areas with high population density the provision of infrastructure is one of the most important elements. With the increase in population, the population expectation of utilities and increasing investors' interest in this area increase. Thus, the infrastructure can be an engine of economic development of areas properly equipped with these devices. Many activities in the above mentioned area had to be taken by primarily rural communities that were not equipped with the required technical infrastructure or such infrastructure needed upgrading.

Social infrastructure plays an important role in the life of the community by meeting the basic needs of cultural, educational fields and those related to health care. With the development of civilization, needs of the population are increasing on the infrastructure that will provide them with not only the right conditions for development, education, but also to leisure time in an unconventional way. G. Rutkowska in scientific publications identified social infrastructure as "the whole civilization's devices and institutions with their factors and conditions necessary to social life and the transformation of society" [21]. J. Kroszel has defined analyzed the concept very broadly by writing that these are "devices and institutions providing services in an organized unit in the field of education, the dissemination of culture, health, social care and physical culture and tourism [22]. However, the level of society formed at the highest level is required for an adequate supply both in the form of the technical infrastructure and social [23].

Research methodology and process research of technical and social infrastructure in some municipalities of Cracow district

Nomenclature of the Territorial Units for Statistics (NUTS) divides Poland into territorial, hierarchical units on 5 levels, of which 3 are referred to as regional levels, while the other 2 as local levels [24]. The last two make municipalities and counties, and the regional levels include: sub-regions, provinces and regions. Region groups a number of sub-regions, and this, in turn, brings together several counties. The territorial scope of this analysis, which includes the municipalities of Cracow district, is shown in Figure 1.

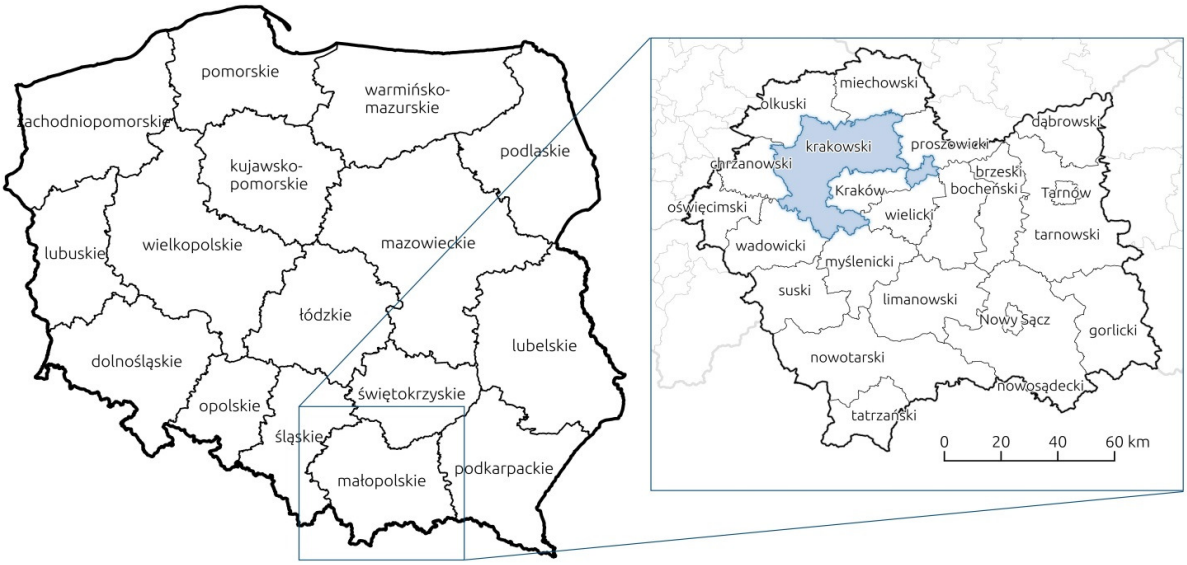

Fig. 1. **Location of municipalities of Cracow district**

The research material came from sources of public statistics [25] and databases of topographic objects BDOT10k [26]. The data reflect the state for 2014. The study was conducted in 17 municipalities of the district of Cracow (Fig. 1.). In the paper the method of calculation of the sum and the number of groups available in SQL queries was applied. The tool based on the above system was implemented at Group Stats plug-in in program QGIS. Plug in addition to statistical calculations creates the pivot tables as the result.

Among the 16 variables adopted for the analysis (Table 1), nine describe the state of the social infrastructure; the next seven variables show the status of the technical infrastructure. The characteristics adopted to analyze assigned to four specific groups of information: housing economy (variables x_1, x_2, x_6, x_7), social infrastructure (service centres of population – qualities x_3, x_4, x_5, x_8, x_9), equipment population in the public utilities (features x_{10}, x_{11}, x_{12}, x_{13}), road infrastructure (features x_{14}, x_{15}, x_{16}). The number of residential buildings (x_2) included houses, buildings with two or three homes and building collectives (blocks).

Table 1

The initial set of variables taken for analysis, describing the state of social and technical infrastructure

Variable group	No of variable	Variable
Social infrastructure	x_1	Housing put into use on population of 10 thousand
	x_2	The number of dwellings per 1000 inhabitants
	x_3	Number of retail and service buildings per 1,000 inhabitants
	x_4	The number of people at one clinic
	x_5	Tourist facilities (hotels) per 1000 inhabitants
	x_6	The number of social housing per 1000 inhabitants
	x_7	The average usable area of housing.
	x_8	Number of libraries and their branches
	x_9	Place in the nursery / 1000 inhabitants

Table 1(continued)

Variable group	No of variable	Variable
Technical infrastructure	x_{10}	Population using water supply system, %
	x_{11}	Population using sewage system, %
	x_{12}	Population using gas, %
	x_{13}	Population using sewage treatment plants per 1000 inhabitants
	x_{14}	Length of municipal roads at 100 km
	x_{15}	The length of county roads at 100 km
	x_{16}	Length of provincial roads and national 100 km

Source: own study

The prepared data were compared by using the Pearson correlation coefficient. Analysis included determination of mutual dependence variables. We analyzed the basic statistics, the value of the average, minimum, maximum, standard deviation and the coefficient of variation. Based on the calculated statistics and the correlation coefficient diagnostic features representing each of the four groups of information were selected. Selected diagnostic features are highly volatile, yet are little correlated with each other, and strongly correlated with other characteristics (not recognized as diagnostic) of the groups of information which they represent [27]. Diagnostic features were subjected to standardization in order to bring them into mutual direct comparability [28].

According to the adopted quotient value of all diagnostic features they have been divided by a constant equal to the average value of each variable. This transformation resulted in a change of the averages of the standard features and a change of standard deviations, however, while maintaining the same proportions. The value of the coefficients of variation was also preserved, as well as the ratio between the values of all the features. In order to determine the similarity between the objects (in our case municipalities) we used metric in the form of Euclidean distance (most commonly used for this type of analysis) (1):

$$d_{i,k} = \sqrt{\sum_{j=1}^{m} \left| x_{i,j}' - x_{k,j}' \right|^2}, \quad (1)$$

where $d_{i,k}$ – distance between the metric and the including the object
$x_{i,j}'$, $x_{k,j}'$ – value of the i-th and k-th row of normalized data matrix X' (i.e. the value assigned to the i-th and k-object)
$i, k = 1, \ldots, n; j = 1, \ldots, m$

The smaller the calculated Euclidean distance, the similarity between the objects is greater. The basis for classification and separation of clusters of objects (communes of Cracow) in 16-dimensional space features (diagnostic) was the matrix of Euclidean distances [29]. Using computer procedures for classification of the objects the hierarchical agglomeration Ward method of combinatorial is used. In this method, the objects are treated at the start of the analysis as individual aggregates (groups), and the classification process is to combine the groups, which reduce their numbers until a predetermined number of groups [29]. After the analysis measures of assessment classification were calculated, and the result is illustrated in the form of a dendrogram and cartogram. The program of numerical taxonomy was used for calculations.

Rating level of technical and social infrastructure of some municipalities of Cracow district (according to their local development)

A preliminary statistical analysis of the variables adopted for the analysis showed that the highest coefficient of variation is characterized by the variable x_6 – the number of social housings per 1000 inhabitants. You will notice that in rural communities there is a lack of social housing; the situation is different in municipalities where social housing appears.

The calculated correlation coefficient indicates a very strong dependence between several pairs of variables. The largest of the existing relation (0.947) refers to the percentage of the population using the sewage system (x_{11}) and the number of population using waste water treatment plants per 1000 inhabitants (x_{13}). Very strong correlative relationship (0.918) occurred between the variable x_5 showing the number of tourist facilities (hotels) per 1000 inhabitants and the variable x_{16} – the length

of provincial roads and national per 100 km^2. The high value of the correlation coefficient can also be found between the variables x_2 and x_3 or the number of dwellings per 1,000 inhabitants and the number of commercial buildings and service per 1,000 inhabitants as well as the variables x_1 and x_7 – the number of dwellings completed 10 thousand residents and the average usable area of the apartment.
The calculated Pearson correlation coefficient and the coefficients of variation allowed for the selection of the four diagnostic features in each of the groups of information. As diagnostic features were selected: from the group information – economy housing – variable x_7 describing the average usable floor space, in a group of social infrastructure – variable x_9 – places in kindergartens, for a group of information equipment in public utilities as a characteristic representative was selected the variable x_{10} describing the share of population with access to water, while in the group information road infrastructure – as a diagnostic feature the variable x_{16} – the length of provincial roads and national 100 km^2 has been selected. Designated diagnostic features can be considered as the basic criteria for a comparative assessment of the status and directions of development of the surveyed municipalities of Cracow district. The above-mentioned features can be seen as the key indicator of the selected for the analysis set of variables and objects (communes of Cracow). They are representative, carry the highest information value and the high coefficient of variation shows their high degree of diagnostic.

Table 2

Matrix of correlation coefficients between the variables adopted for research

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}
x_1	1.000	-0.171	-0.204	-0.286	-0.272	-0.238	0.831	-0.383	0.176	0.194	-0.038	0.407	-0.007	0.056	0.069	-0.223
x_2	-0.171	1.000	0.868	0.149	0.694	-0.567	0.121	-0.473	-0.440	0.224	0.088	-0.058	0.073	0.637	0.725	0.540
x_3	-0.204	0.868	1.000	0.057	0.633	-0.412	0.053	-0.330	-0.378	0.125	0.188	-0.076	0.218	0.603	0.510	0.390
x_4	-0.286	0.149	0.057	1.000	0.625	-0.221	-0.097	-0.315	0.133	-0.111	-0.185	0.003	-0.241	0.541	0.140	0.702
x_5	-0.272	0.694	0.633	0.625	1.000	-0.370	-0.046	-0.436	-0.076	0.121	0.055	-0.019	-0.012	0.722	0.308	0.918
x_6	-0.238	-0.567	-0.412	-0.221	-0.370	1.000	-0.579	0.755	0.292	0.019	0.296	-0.179	0.331	-0.478	-0.503	-0.254
x_7	0.831	0.121	0.053	-0.097	-0.046	-0.579	1.000	-0.642	0.001	-0.092	-0.209	0.450	-0.193	0.319	0.238	-0.022
x_8	-0.383	-0.473	-0.330	-0.315	-0.436	0.755	-0.642	1.000	0.291	0.122	0.353	-0.042	0.285	-0.538	-0.424	-0.357
x_9	0.176	-0.440	-0.378	0.133	-0.076	0.292	0.001	0.291	1.000	0.190	0.485	0.461	0.469	-0.118	-0.367	0.054
x_{10}	0.194	0.224	0.125	-0.111	0.121	0.019	-0.092	0.122	0.190	1.000	0.486	0.341	0.420	0.016	0.289	0.129
x_{11}	-0.038	0.088	0.188	-0.185	0.055	0.296	-0.209	0.353	0.485	0.486	1.000	0.281	0.947	-0.115	-0.041	-0.017
x_{12}	0.407	-0.058	-0.076	0.003	-0.019	-0.179	0.450	-0.042	0.461	0.341	0.281	1.000	0.194	0.183	0.083	0.161
x_{13}	-0.007	0.073	0.218	-0.241	-0.012	0.331	-0.193	0.285	0.469	0.420	0.947	0.194	1.000	-0.123	-0.013	-0.125
x_{14}	0.056	0.637	0.603	0.541	0.722	-0.478	0.319	-0.538	-0.118	0.016	-0.115	0.183	-0.123	1.000	0.336	0.658
x_{15}	0.069	0.725	0.510	0.140	0.308	-0.503	0.238	-0.424	-0.367	0.289	-0.041	0.083	-0.013	0.336	1.000	0.319
x_{16}	-0.223	0.540	0.390	0.702	0.918	-0.254	-0.022	-0.357	0.054	0.129	-0.017	0.161	-0.125	0.658	0.319	1.000

Source: own study

On the basis of 16 of the analyzed variables Euclidean distance matrix was calculated. This metric was a base to carry out the classification of the hierarchical agglomeration method (not combinatorial) – Ward. As a result of the classification four groups of municipalities meeting the conditions of homogeneity of the terms adopted for the research diagnostic features were received. In separate homogeneous groups of municipalities you may notice some regularity.

Metric classification ratings indicate that the result of the division in $K = 8$ groups is good (correct). The resulting measures of evaluation classification gauge $D = 8.860$ indicates the taxonomy diameter for the whole set of objects. It is the maximum distance in the distance matrix on which the similarity of objects is tested. Indicator $D_m = 3.716$ is the mean distance in the distance matrix. Indicator $V = 0.053$ is the average within-group variance [29].

Table 3

The matrix of Euclidean distances between the objects accepted for testing

	CZERNICHÓW	IGOŁOMIA-WAWRZEŃCZYCE	IWANOWICE	JERZMANOWICE-PRZEGINIA	KOCMYRZÓW-LUBORZYCA	KRZESZOWICE	LISZKI	MICHAŁOWICE	MOGILANY	SKAŁA	SKAWINA	SŁOMNIKI	SUŁOSZOWA	ŚWIĄTNIKI GÓRNE	WIELKA WIEŚ	ZABIERZÓW	ZIELONKI
CZERNICHÓW	0.0	2.1	1.5	1.5	1.9	2.5	1.8	2.0	2.2	4.1	6.3	3.6	2.8	5.1	3.6	2.3	2.6
IGOŁOMIA-WAWRZEŃCZYCE	2.1	0.0	1.7	1.5	1.6	3.9	2.2	1.7	1.9	4.4	7.4	4.5	3.2	4.3	3.5	3.4	3.6
IWANOWICE	1.5	1.7	0.0	1.4	1.1	3.4	1.9	1.1	1.9	4.6	7.0	4.1	3.2	5.1	3.4	3.1	3.0
JERZMANOWICE-PRZEGINIA	1.5	1.5	1.4	0.0	1.3	3.1	1.6	1.5	1.8	4.5	7.0	4.3	3.2	4.9	3.4	2.3	2.7
KOCMYRZÓW-LUBORZYCA	1.9	1.6	1.1	1.3	0.0	3.7	2.0	0.9	1.5	4.6	7.3	4.5	3.4	5.1	3.5	2.9	2.9
KRZESZOWICE	2.5	3.9	3.4	3.1	3.7	0.0	3.2	3.7	3.7	5.2	4.4	3.0	3.9	6.0	4.6	2.7	2.8
LISZKI	1.8	2.2	1.9	1.6	2.0	3.2	0.0	1.9	1.9	4.0	7.2	4.6	2.5	4.5	2.8	2.3	3.0
MICHAŁOWICE	2.0	1.7	1.1	1.5	0.9	3.7	1.9	0.0	1.3	4.4	7.3	4.6	3.2	4.9	3.2	2.9	2.8
MOGILANY	2.2	1.9	1.9	1.8	1.5	3.7	1.9	1.3	0.0	3.9	7.4	4.8	2.6	4.4	2.8	2.5	2.7
SKAŁA	4.1	4.4	4.6	4.5	4.6	5.2	4.0	4.4	3.9	0.0	8.5	6.4	2.8	4.9	2.7	4.6	5.3
SKAWINA	6.3	7.4	7.0	7.0	7.3	4.4	7.2	7.3	7.4	8.5	0.0	3.5	7.5	8.9	8.0	6.3	5.7
SŁOMNIKI	3.6	4.5	4.1	4.3	4.5	3.0	4.6	4.6	4.8	6.4	3.5	0.0	5.1	6.5	5.7	4.2	3.7
SUŁOSZOWA	2.8	3.2	3.2	3.2	3.4	3.9	2.5	3.2	2.6	2.8	7.5	5.1	0.0	3.7	2.3	3.5	4.2
ŚWIĄTNIKI GÓRNE	5.1	4.3	5.1	4.9	5.1	6.0	4.5	4.9	4.4	4.9	8.9	6.5	3.7	0.0	3.5	5.4	6.2
WIELKA WIEŚ	3.6	3.5	3.4	3.4	3.5	4.6	2.8	3.2	2.8	2.7	8.0	5.7	2.3	3.5	0.0	3.6	4.4
ZABIERZÓW	2.3	3.4	3.1	2.3	2.9	2.7	2.3	2.9	2.5	4.6	6.3	4.2	3.5	5.4	3.6	0.0	1.7
ZIELONKI	2.6	3.6	3.0	2.7	2.9	2.8	3.0	2.8	2.7	5.3	5.7	3.7	4.2	6.2	4.4	1.7	0.0

Source: own study

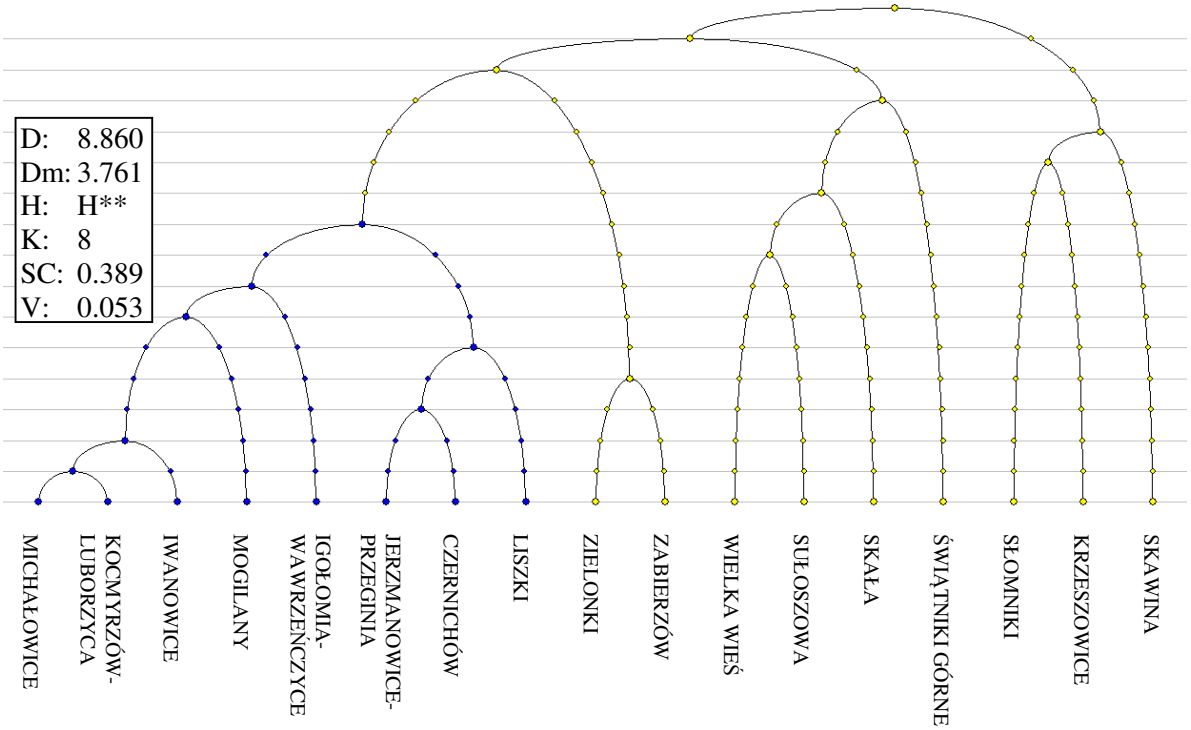

Fig. 2. **Dendrogram showing the classification of the Ward method for the full structure, based on the Euclidean metric**

Meter H = ** means very high heterogeneity of groups. However, according to Rousseeuw (1987) – the value meter *Silhouette* Coefficient SC = 0.389 indicates not very strong division into groups in the conducted classification [30].

From the statistical point of view municipalities are most dissimilar by x_{16} indicator or the length of national and provincial roads per 100 km^2. In the first group, which may include the following municipalities: Czernichów, Igołomia, Iwanowice, Kocmyrzów, Jerzmanowice Przeginia, Michałowice, Liszki and Mogilany, you can see some of the lowest values of the variable describing the length of the national and provincial roads per 100 km^2 – x_{16}. On the other hand, in the fourth group bringing together the community Wielka Wieś and Świątniki Górne, Skała oraz Sułoszowa – indicator- the length of national roads and provincial accept the highest values recorded in the whole district of Cracow. We can also observe (in the above mentioned areas) that a high percentage of the population uses the water supply system and the high number of places in kindergartens. One of the highest indicators here is also the area of housing in the municipality. In the second group were distinguished Krzeszowice, Skawina, and Słomniki. In the third group, which defined similar municipalities, Zabierzów and Zielonki were classified.

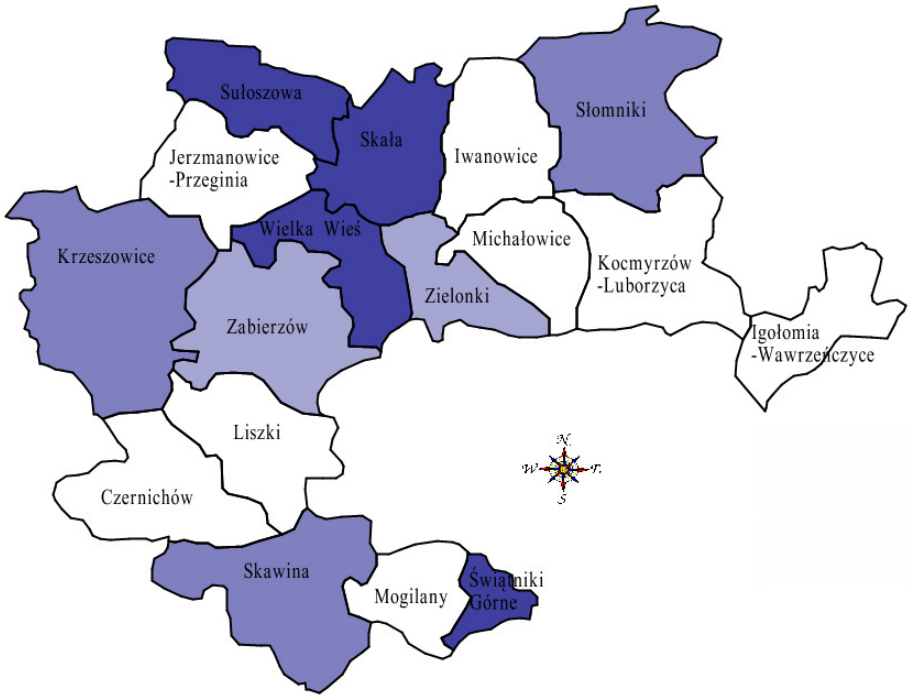

Fig. 3. **Spatial distribution of classification, by using the Ward method, according to municipalities of Cracow district, in reference to technical and social infrastructure**

Spatial distribution of separate types of municipalities (Fig. 3.) shows the diversity of the phenomenon of the development of infrastructure in the rural district of Cracow. Municipalities located in the eastern part of the district (North-East of Cracow) show a weaker development in terms of conditions of infrastructure in relation to the municipalities, e.g., in the central part of the county (north- west of Cracow), and southern (north-west of Cracow). Such spatial distribution of the phenomenon may be due to the fact that the municipalities poorly equipped with infrastructure, in this case (Cracow district) have a very agricultural character, which is related to, among others, with very good environmental conditions for agricultural development (high quality classes). The function of these areas has not changed for decades, development strategies are in these municipalities aimed at promoting the agricultural function. The situation is different in the communities with high rates of infrastructure endowment. There we are dealing with the development of multi-functional, including also in the neighbouring municipalities of Cracow (the so-called Cracow agglomeration), indications of severity of the suburbanization processes. The municipality Zielonki (for example) appears in residential areas of dense development, displacing its agricultural function of the area. It is not without significance also the fact that it is better equipped with the infrastructure city located in the county, i.e. Skała or Świątniki Górne. The development of infrastructure will also be affected with this type of

development which we have to deal with. For Sułoszowa you can be observed that this is the type of a street village – in which case the expansion of the technical infrastructure is easier than in the case of municipalities with scattered buildings.

Conclusions

The development of communes is performed with varying intensity. This is due to intensity of various factors that determine the development. One of the many factors affecting the testing phenomenon is the technical and social infrastructure, on which largely the economic processes depend. Therefore, the aim of the article was to conduct a comparative assessment of the status and development trends of selected elements of the technical and social infrastructure in spatial terms (i.e. the cross-section of municipalities in Cracow district) and the appointment of their metrics development and delimitation, analysis and evaluation of local development in selected municipalities in the district of Cracow.

The analysis of the factors describing the state of the technical and social infrastructure allows us to formulate some conclusions. Simple statistical analysis, including the analysis of correlation coefficients, allows us to identify the variables that from a purely statistical point of view (recorded in 2014 configuration 16 features) to a large extent determine the result of the classification of municipalities in the district of Cracow. Selected by the Hellwig method diagnostic features fulfill therefore the measures function of the development of the examined phenomenon.

Based on the assumption (that the determinants of local development in the test case are diagnostic features) it can be stated that the development of the local communes of Cracow is influenced in particular by the group information- economy housing – variable x_7 describing the average usable floor space of the apartment, in a group of social infrastructure – variable x_9 – places in kindergartens in the group information equipment on public utilities: the variable x_{10} describing % of population with access to water, a group of information road infrastructure - variable x_{16} – the length of provincial roads and national 100 km^2. The designated diagnostic features can be considered as the basic criteria for a comparative assessment of the status and directions of development of the surveyed municipalities of Cracow district. However, this should not be understood that these are the only features that have impact on the phenomenon. Anyway, from a statistical point of view, the qualities are most appropriate (representative) for further analysis. They carry the greatest among other variables cargo information.

The full analysis, based on 16 characteristics selected to describe the condition of the technical and social infrastructure, enabled the calculation of Euclidean, and at the same time the similarity between the 17 municipalities of the district of Cracow. The similarity is expressed in counts from the maximum diameter: D_m = 8.860 by an average distance of 3.716 and a minimum equal to 0851, assuming that the smaller the distance the greater the similarity between the objects (municipalities). The classification made by Ward, based on the previously calculated similarity (Euclidean metric), showed the relationship between the municipalities analyzed. Full classification structure includes 17 levels of iteration, which results from the assumptions of the method of Ward. However, to carry out all 17 iterations does not have its statistical reasoning, which is based on measures of the assessment classification. The highest similarity among the surveyed municipalities in the district of Cracow characterized Michałowice and Kocmyrzów - these two municipalities were connected in the second stage of the iterative procedure. In the third stage joined the two previous municipalities, the third - Iwanowice (Fig. 2). Iterations led to the condition that at 10, the district is divided into 8 groups. Agglomeration at this stage is characterized by the highest heterogeneity ratio ($H = H^{**}$). However, after this stage silhouette the coefficient reached a low value (less than 0.5), which indicates bad score measures carried out in the upper rows of classification. Subdivision, from a statistical point of view, is so indicated. Since the average value of the metric is “closer to” the minimum value, this indicates the fact that the majority of the municipalities is very similar to each other. Eight of the seventeen municipalities, i.e. 47 % of the objects were classified in one of the homogeneous groups. Other municipalities are divided into five one-objected, homogenous groups and two two-objected groups with more expressive individual qualities affecting their different nature from other objects.

This allows the formulation saying that analyzing the technical and social infrastructure in the context of their impact on the local development of municipalities in the district of Cracow should be

seen as an area diverse in this regard. Although each of the municipalities is with very individual traits, statistical methods showed that this area can be divided into 8 types of municipalities with varying degrees of the developed infrastructure. Statistical methods allowed to aggregate municipalities with the most similar conditions, expressed in discrete values adopted to study from the underlying factors, separating them (using a specific method of Ward criterion heterogeneity) from municipalities grouped into types with different conditions described by the features determining development taking into account the technical and social infrastructure. Further aggregation of the district of Cracow municipalities is not justified statistically.

Assessing the state of the infrastructure within the surveyed municipalities it should be noted that the level varies in different municipalities of the investigated area. Most preferred conditions reported in the municipalities of Wielka Wieś, Sułoszowa, Skała and Świątniki Górne. Good conditions related to the state of infrastructure are in municipalities: Skawina, Krzeszowice and Słomniki. The weakest conditions exist in the municipalities of Czernichów, Igołomia-Wawrzeńczyce, Kocmyrzów-Luborzyca, Michałowice, Iwanowice, Liszki, Jerzmanowice-Przeginia and Mogilany. Thus, the development of the infrastructure of the surveyed communes of Cracow should occur mainly in the direction of increasing the usable area of housing, increasing the number of places in kindergartens, construction of public utilities (mainly water supply network) and improvement of provincial and national roads.

The above-mentioned variables from a statistical point of view in the best way differentiate the communes of Cracow according to the analyzed phenomenon. These are the selected features contributed to the greatest extent on the outcome of the conducted classification. So, they affect the utmost to change the classification of municipalities in the district of Cracow, due to raising the level of similarity between the municipalities. Information about the different levels of development of individual municipality in the county can be a contribution to make by the district authorities' operations to compensate for the existing disparities between municipalities in the state of infrastructure. Featured determinants (meters development) indicate the weakest infrastructure, which should be encouraged aiming to equalize the value of these characteristics in all municipalities investigated in the county. The high level of co-creating district municipalities will in fact raise the overall assessment of the infrastructure of the county. This is especially important in the case of a district of Cracow adjacent, which is the part of the Cracow metropolitan area.

References

1. Kowalski A., Charakterystyka niektórych metod taksonomicznych, (Characteristics of some taxonomic methods), Państwowe Wydawnictwo Naukowe, Warszawa 1977.
2. Gatnar E., Symboliczne metody klasyfikacji danych (Symbolic methods of data classification), Państwowe Wydawnictwo Naukowe, Warszawa 1998.
3. Grabiński T., Metody aksonometrii, (Taxonomic methodes), Pracowania Pomocy Naukowo-dydaktycznych Akademii Ekonomicznej w Krakowie, Kraków 1992.
4. Wysocki F., Metody taksonomiczne w rozpoznawaniu typów ekonomicznych rolnictwa i obszarów wiejskich, (Taxonomic methods in identifying the types of economic agriculture and rural areas), Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu, Poznań 2010
5. Brol R., Czynniki rozwoju regionalnego, (w:) D. Strahl (red.), Metody oceny rozwoju regionalnego, Wydawnictwo AE we Wrocławiu, Wrocław 2006.
6. Słodczyk J. Demograficzne i społeczne aspekty rozwoju miast (Demographic and social aspects of urban development), Uniwersytet Opolski, Opole 2002.
7. Gralak A., Rozwój regionalny – zagadnienia ogólne (Regional development - general issues), Szkoła Główna Gospodarstwa Wiejskiego, Warszawa 2006.
8. Myna A., Modele rozwoju lokalnej infrastruktury technicznej (Models development of local technical infrastructure), Wydawnictwo UMCS, Lublin 2012.
9. Williamson J.G., Regional inequality and process of national development: A description of the patterns, "Economic Development and Cultural Change" 1965, XIII (4, Part II), Chicago.
10. Strahl D., Metody oceny rozwoju regionalnego (Assessment of regional development). Wyd. Akademii Ekonomicznej we Wrocławiu, Wrocław 2006.

11. Churski P., Czynniki rozwoju regionalnego i polityka regionalna w Polsce w okresie integracji z Unią Europejską (Factors of regional development and regional policy in Poland during the period of integration with the European Union), Wydawnictwo UAM, Poznań 2008.
12. Hausner J., Kudłacz T., Szlachta J., Identyfikacja nowych problemów rozwoju regionalnego Polski (Identification of new regional development problems of Poland), Wydawnictwo Naukowe PWN, KPZK PAN, Warszawa 1998.
13. Markowska M., Czynniki rozwoju regionalnego, (w:) E. Sobczak (red.), Gospodarka lokalna w teorii i praktyce (The local economy in theory and practice), Wydawnictwo AE we Wrocławiu, Wrocław 2002.
14. Obrębalski M., Rozwój regionalny – identyfikacja, pomiar i ocena (Regional development - the identification , measurement and evaluation, (w:) E. Sobczak (red.), Gospodarka lokalna w teorii i praktyce(The local economy in theory and practice), Wydawnictwo AE we Wrocławiu, Wrocław 2002.
15. Biehl D., The contributions of infrastructure to regional development. Report prepared for the EC Commission. Office for Official Publications. Luxemburg 1986.
16. Nijkamp J., Infrastructure and Regional Development: A Multidimensional Policy Analysis, empec, vol. 11, Wien 1986, 1 p.
17. Chudzik B., Programowanie rozwoju infrastruktury technicznej wsi, (Programming the development of rural technical infrastructure), Komitet Techniki Rolniczej PAN, Kraków 1998, 40 p.
18. Miszczuk A., Gospodarka samorządu terytorialnego, (Economy of the local self-government) PWN, Warszawa 2007, 166 p.
19. Borcz Z., Infrastruktura terenów wiejskich, (Infrastruture of rural areas), Akademia Rolnicza, Wrocław 2000, pp. 5-8.
20. Gralak A., Rozwój regionalny – zagadnienia ogólne, (Regional development - general discussion), Szkoła Główna Gospodarstwa Wiejskiego, Warszawa 2006, pp. 10.
21. Rutkowska G., Analiza porównawcza infrastruktury technicznej i społecznej w wybranej gminie z wymogami UE, (Comparative analysis of technical and social infrastructure in selected municipality with EU requirements), Przegląd Naukowy, Inżynieria i Kształtowanie Środowiska, 2007, Nr 36, 65 p.
22. Kroszel J., Infrastruktura społeczna w polityce społecznej, (Social infrastructure in social policy, Instytut Śląski, Opole 1990, pp. 18
23. Gorzelany-Plesińska J., Kurzeja K., Infrastruktura techniczna i społeczna jako czynniki kształtujące konkurencyjność regionalną, (Technical and social infrastructure as factors shaping regional competitiveness), Ekonomika i Organizacja Przedsiębiorstwa, 2015, nr 10(789), pp. 63-85.
24. Council of Ministers of 14 November 2007. On the introduction of the combined territorial units for statistics (NUTS), 2007.
25. BDL Bank Danych Lokalnych (Local Data Bank), (online) (04.11.2015) Available at: http://www.stat.gov.pl
26. Baza Danych Obiektów Topoograficznych, (Topographic Database Objects) BDOT10k
27. Grabiński T., Wydymus S., Zeliaś A., Metody taksonomii numerycznej w modelowaniu zjawisk społeczno-gospodarczych, (Methods of numerical taxonomy in modeling of socio-economic phenomena), Wyd. PWN, Warszawa 1989.
28. Nowak E., Metody taksonomiczne w klasyfikacji obiektów społeczno-gospodarczych (Taxonomic methods in the classification of socio-economic objects), Wyd. PWE, Warszawa 1990.
29. Kolenda M., Taksonomia numeryczna. Klasyfikacja, porządkowanie i analiza obiektów wielocechowych, (Numerical taxonomy. Classification, organization and analysis of multivariate objects), Wyd. Akademii Ekonomicznej we Wrocławiu, Wrocław 2006, 359 p. (In Polish)
30. Rousseeuw P.J. Silhouettes, a Graphical Aid to the Interpretation and Validation of Cluster Analysis, Journal of Computational and Applied Mathematics, No 20, 1987.