ORIGINAL PAPER

Citation: Nowak, P. (2018). Regional variety in quality of life in Poland. *Oeconomia Copernicana*, 9(3), 381–401. doi: 10.24136/oc.2018.019

Contact: pnnowak@tu.kielce.pl, Kielce University of Technology, Al. Tysiąclecia PP 7, 25-214 Kielce, Poland

Received: 24 May 2017; Revised: 14 February 2018; Accepted: 12 March 2018

Paulina Nowak

Kielce University of Technology, Poland

Regional variety in quality of life in Poland

JEL Classification: I31; R13

Keywords: *quality of life; welfare measures; regional variety, Hellwig's method, Ward's method*

Abstract

Research background: Quality of life is viewed as the degree of people's satisfaction of various needs, especially including material, spiritual, safety-related needs and life aspirations. The aspects taken into consideration are economic, spatial, environmental and cultural ones. Quality of life is therefore determined by various conditions in which a human lives and the source of which is the hierarchy of needs and a value system. At the same time, quality of life can be viewed in terms of collectivity (objective aspect) and an individual's evaluation (subjective aspect). The former view shapes the existing living conditions and the latter results from the satisfaction from a specific person's life, experiences and ambitions. The multidimensionality of the quality of life categories translates into difficulties in defining and measuring it, and constitutes an interesting research object.

Purpose of the article: The purpose of the article is to diagnose and evaluate the variety of the quality of life in Polish voivodeships, in objective terms by building a synthetic measure allowing for estimating inequalities in the quality of life of regional communities. It was assumed that quality of life will be characterised by indicators grouped into the following areas: material living conditions, economic activity, health, education and living environment quality.

Methods: The main method used for measuring quality of life is the linear ordering based on Z. Hellwig's taxonomic measure which allows for organising voivodeships in terms of the quality of life of communities. Additionally, the cluster analysis (Ward's agglomerative

grouping method) was used, which allowed for distinguishing voivodeships similar in terms of the analysed phenomenon.

Findings & Value added: During the realisation of the research goal, special attention was paid to the complexity of the quality of life issue and its measurement in terms of economy and rather important varieties in voivodeships were emphasized. The conducted analysis allowed for distinguishing groups of regions with the highest, high, low and the lowest quality of life.

Introduction

Spatial variety of social and economic growth, followed by the quality of life of the population, are multi-dimensional and constantly evolving. In literature, much attention is paid to the topic of social and economic inequalities in the spatial dimension. The most often emphasised are varieties between eastern and western Poland (Pietrzak & Balcerzak, 2016; Kuc & Sobiechowska-Ziegert, 2018), city — country (Rosner, 2011; Domański & Pokropek, 2009; Kusideł, 2013), metropolitan areas — peripheral areas and increasingly, varieties inside metropolitan areas (Smętkowski & Płoszaj, 2011) and between rural areas with various functions (Adamska, 2012; Rosner 2011). On the other hand, in terms of internal cohesion of the European Union (and outside of it), emphasis is put on NUTS 2 level varieties (Jaworska, 2014; Jędrzejczak, 2015; Wawrzyniak, 2016) or varieties in particular member states of NUTS 1 (Kuc, 2017a; Balcerzak & Pietrzak, 2017; Kuc, 2017b). The need to counteract their negative consequences by reducing the differences by the use of a cohesion policy (Treaty on the Functioning of the EU 2009) is also emphasised. Quality of life constitutes the main category of priorities in Poland's and the EU's development strategies. A strategic goal of the Long-term National Development Strategy is the improvement of the quality of life of Poles, measured by GDP per capita, improvement in social cohesion and reduction of territorial inequalities (DSRK, 2013). Similarly, the medium-term document assumes that the main goal is to create conditions for an increase in earnings of Polish citizens with simultaneous improvement in cohesion in social, economic, environmental and territorial terms (*Responsible Development Strategy*, 2017).

The purpose of the article is to diagnose and evaluate the variety of the quality of life in Polish voivodeships, in objective terms by building a synthetic measure allowing for estimating inequalities in the quality of life of regional communities. The measurement of the studied phenomenon was conducted using Hellwig's linear ordering and Ward's agglomerative grouping methods. In order to achieve the goal, the paper presents an outline of quality of life conditions, which requires a complex approach due to

it being a multi-dimensional category. It includes emphasizing the existence of two integral spheres: living standards resulting from the material and immaterial objective statistical view and level of life satisfaction resulting from a human's subjective evaluation. The latter part of the paper presents the selected methodology of studying quality of life. It includes an evaluation of objective quality of life in Polish voivodeships with the use of Hellwig's and Wards method. The measurement is based on features characterising the following areas: material living conditions, economic activity, health, education and living environment quality. The paper ends with conclusions drawn from an analysis conducted for 2010 and 2015. The choice of the years resulted, on the one hand, from the availability of the up-to-date statistical data and from the adequately long time interval enabling observations of changes in quality of life. The data source are public statistics of the Central Statistical Office (GUS), available in the Local Data Bank.

Quality of life conditions

Quality of life is a multi-dimensional term, which translates into difficulties in defining and measuring it, thereby making it an interesting research area. Most often, quality of life is viewed as the degree of people's satisfaction of various needs, especially including material, spiritual, safety-related needs and life aspirations. The aspects taken into consideration are economic, spatial, environmental and cultural ones. They lead to overall content, satisfaction, being pleased with health and social status, welfare and consumption (Bywalec & Rudnicki, 1999, p. 27). Quality of life is therefore determined by various conditions in which a human lives and the source of which is the hierarchy of needs and a value system (Mularska-Kucharek & Wiktorowicz, 2012). The term's multidimensionality leads to using terminology related to quality of life, i.e.: living standards, social well-being, welfare, social development (Adamska, 2012; Jędrzejczak, 2015; Sompolska-Rzechuła, 2016; Zadrożniak, 2016).

The *quality of life* category encompasses two integral spheres: living standards resulting from the material and immaterial objective statistical view and level of life satisfaction resulting from a human's subjective evaluation. Quality of life in collectivistic terms is deemed as objective, whereas in terms of an individual's evaluation — as subjective quality of life. The former view shapes the existing living conditions and the latter results from the satisfaction from a specific person's life, experiences and ambitions. Subjective evaluation is formed as result of non-measurable psycho-

logical and cultural conditions. Such an approach forces the question about the impact of current physical and mental health on the quality of life evaluation. And consequently: To what degree should the quality of life evaluation be a result of subjective evaluation of one's life situation and to what degree should it be objective?

In terms of its complexity, measuring the quality of life requires considering various dimensions. It is, however, necessary to remember that the potential features of the studied phenomenon have measurable and non-measurable dimensions. Literature provides many different research approaches. The level of worldwide social development is studied, among others, by the United Nations Development Programme, which calculates the social development index of regions and poviats (Local Human Development Index) (*National Report on Social Development*, 2012). It is determined by features classified in 3 groups: wealth, education and health (*National Human Development Report*, 2018, p. 12). In international research, quality of life is measured by the Living Conditions Index (LCI), which encompasses not only living conditions, health care, sports and cultural activity or ecology, but also dietary conditions or mobility. In 2010, OECD introduced the Better Life Index (BLI), which assesses the social and economic well-being in member states with the use of 20 indexes grouped according to economy sectors. On the other hand, the member states of the European Union conduct comparative analyses of the data concerning income, poverty, social exclusion and living conditions as part of the European Union Statistics on Income and Living Conditions study (EU-SILC).

In Poland, the evaluation of the overall quality of life of the Poles is prepared by the authors of the Social Diagnosis (*Diagnoza Społeczna*, 2015). Periodical reports present quality of life measured in 8 dimensions: civilisation level, material well-being, social, physical and mental welfare, number of pathologies, level of stress and social capital. Many of the presented indicators refer to the spatial view. A similar multi-dimensional view is presented by GUS studies (*Quality of life in Poland*, 2015). Many source data is used in it, including the SILC, among others. Quality of life is evaluated in 9 areas: material living conditions; main type of activity, work; health; education, free time; economic and physical safety; state and basic rights, citizen activity; environment quality in the place of residence; subjective well-being. This view stands out with the analysis of the objective and subjective quality of life, which provides a fuller view of the phenomenon. It is worth noting that the objective approach is preferred by government institutions, whereas the subjective approach is used by research organisations, including academic institutions (Kerce, 1992, p. 2). As any other complex phenomenon, quality of life is treated and studied in

various ways. The authors use many research tools and detailed indexes to capture the essence of a community's quality of life (Malina & Zeliaś, 1997; Gotowska & Jakubczak, 2012; Lewandowska-Gwarda & Olszewski, 2017; Zadrożniak, 2016; *Diagnoza Społeczna*, 2015). The subject paper uses the objective approach to measure quality of life, which is distinguished by a methodical approach (used methods of analysis) and dynamic treatment (the quality of life study was conducted for two years: 2010 and 2015 in order to observe changes in the quality of life of Polish voivodeships' residents).

Research methodology

In the subject paper, the main method used for measuring quality of life is the linear ordering based on Z. Hellwig's taxonomic measure (Hellwig, 1968; 1972). It allows for classifying voivodeships based on the community's quality of life from highest to lowest. The preliminary stage featured standardisation to obtain mutual feature comparability (with the use of the so-called zero-one formula encompassing the arithmetic mean and standard deviation of the standardised feature value set):

$$Z_{ik} = \frac{x_{ik} - \bar{x}_k}{s_k} \quad (1)$$

where:

z_{ik} – standardised value of feature k in unit i ,

x_{ik} – absolute value of feature k in unit i ,

$\bar{x}_k$ – arithmetic mean of feature k ,

s_k – standard deviation of feature k .

We designated the development model (abstract object P_0) and determined the distance of voivodeships from the model. The smaller the distance, the higher the region community's quality of life. The development model was defined as an object characterised by highest values for stimulants and lowest for de-stimulants, and possessed standardised coordinates $z_{01}, z_{02}, \dots, z_{0k}$, where:

$$Z_{ok} = \begin{cases} \max \{z_{ik}\} & \text{– when } x_k \text{ is e stimulant} \\ \min \{z_{ik}\} & \text{– when } x_k \text{ is e destimulant} \end{cases} \quad (2)$$

For each object, we calculated its distance from object P_0 (model object), designated as c_{io} , according to the following formula:

$$c_{io} = \sqrt{\sum_{k=1}^K (z_{ik} - z_{ok})^2} \quad (i = 1, 2, 3, \dots, N) \quad (3)$$

The variable c_{io} created according to formula (3) is not standardised. In order to meet this postulate, we create the so-called relative taxonomic development measure according to the following formula:

$$d_i = 1 - \frac{c_{io}}{c_o}, \quad (i = 1, 2, 3, \dots, N) \quad (4)$$

where:

$$c_o = \bar{c}_o + 2 \cdot s_o \quad (5)$$

$\bar{c}_o$, s_o – accordingly, arithmetic mean and standard deviation of sequence c_{io} ($i = 1, 2, 3, \dots, N$);
 d_i – synthetic index;

wherein:

$$\bar{c}_o = \frac{1}{N} \cdot \sum_{i=1}^N c_{io} \quad (6)$$

and

$$s_o = \sqrt{\frac{1}{N} \cdot \sum_{i=1}^N (c_{io} - \bar{c}_o)^2} \quad (7)$$

The obtained synthetic development measure d_i (4) usually has a value in the range from 0 to 1. Its top limit amounts to 1, whereas the probability that it will be smaller than 0 is minor (if there are voivodeships that substantially stand out in comparison to other objects, the indicator can have a negative value). The closer the measure d_i is to one, the smaller the distance between the object-voivodeship and the model, and the object is

characterised by higher quality of life. For the calculations, we adopted a constant development model, which was the condition for the comparability of the results for the studied years.

As the supplementary method, we used the cluster analysis (Ward's agglomerative grouping method), which allowed for distinguishing the object-voivodeships similar in terms of the analysed phenomenon (Ward, 1963). The method is classified as a hierarchical method and is often used for grouping objects, i.e. spatial classification, in which the intragroup variability is taken into consideration. The distance between the groups is designated as the relative value of differences between the sums of squared distances of points from the centres of groups to which the points belong (Strahl (ed.), 2006, p. 236). For the grouping of regions, we used the agglomeration algorithm calculated as the geometric distance in a multi-dimensional space (Euclidean distance). Due to the fact that Euclidean distances are affected by the differences of units between dimensions, used for estimating distances, we used standardisation to have data of comparable scale. The result of using the agglomeration algorithm — grouping of units in gradually bigger clusters — is a hierarchical tree. It is necessary to note that the study results are affected by the selected features and the used research method. As already mentioned, the multitude of factors conditioning quality of life, difficulty in measuring some of them and the features selected for the study result in varied evaluations. For example, in her evaluation of the quality of life in Polish voivodeships E. Polak (2016) used 58 features viewed in 10 dimensions, which encompass, aside from commonly used aspects, the following: strong and weak sides of a social and economic policy or inflow of foreign capital.

In the preliminary stage, we prepared a list of 33 potential features, following a substantive criterion describing objective quality of life in accordance with the study's aim and data availability¹. Based on objective and subjective criteria, it was assumed that quality of life in voivodeships will be characterised by indicators grouped into the following areas: material living conditions, economic activity, health, education and living environment quality.

Quality of life is described mainly by *material living conditions*, understood as living conditions and income situation, especially availability of housing and its infrastructural equipment (central heating, computer with Internet access) and, as supplementation, passenger cars registered per one thousand people. The income situation is reflected by disposable income

¹ Due to the lack of data for 2015 in terms of the *Overweight or obese persons at the age of 15 and more in % of overall population* variable, we adopted the values for 2009 and 2014.

per person, people using social assistance services, food and alcohol-free beverage expenses. Furthermore, in terms of living conditions, it is necessary to take into consideration the problem of poverty, which is represented by the risk of poverty index (minimum subsistence level deemed as the boundary of extreme poverty).

The material living conditions are supplemented by the residents' *economic activity* features group, which encompasses selected aspects of occupational activity. For analysis, we selected the employment rate, average gross monthly remuneration as well as pension and annuity. Unemployment is also a key issue and is represented here by the registered unemployment rate and the share of long-term unemployed persons. The group of variables was broadened with the balance of internal and foreign migration, and permanent residence.

Health aspects are key for the resident's quality of life evaluation. In the *health* group, we adopted for analysis the life expectancy and rate of deaths due to tumours and heart diseases, which are the measures of impact on health. The study also included the index of share of overweight or obese persons, which characterises the residents' life style, among others. Patients find the quality and availability of health care (medical personnel) and medical infrastructure (beds in hospitals) important.

Education plays a special role in the evaluation of the quality of life. The selection of features was dictated by the assumption of the importance of the process of education throughout the life. We adopted indexes related to education from pre-school age to adult education, i.e. children covered by pre-school education, students of higher education schools, percentage of population with higher education and adults participating in education and training.

The list of features describing quality of life is supplemented with variables from the population's *living environment quality* group. The living environment is represented by indexes reflecting exposure to environmental pollution, use of waste treatment plants and wastes subjected to recycling. The group also consists of features reflecting the share of greenery and recreation areas, improving quality of life and affecting health.

The next stage featured a reduction of the set of variables by taking into consideration the statistical criteria. The condition for defining the final set was the adequately high variety of the features (Table 1) and adequately low level of correlation between them. The measure of variety is the variety index. The minimum index level was defined as $V = 7\%$ (the adopted level results from the fact that the set of features is relatively small). From the set of preliminarily defined features (33), we eliminated those for which the variety index did not meet the assumed 7% threshold ($x1$, $x3$, $x8$, $x12$, $x17$,

x18, *x20*, *x32*). However, we saved the *x10 Households equipped with a computer with Internet access in %* feature for which the index was below 7% in one of the studies years. In the next stage, we verified the dependencies between the features. The variables (25) were analysed using the correlation index. We diagnosed 9 strong dependencies between the features, the correlation index of which exceeded 0.8. On this basis, we excluded *x11*, *x16*, *x27*, *x29*. Due to substantive aspects, we saved *x9 People benefiting from social assistance services per 10 thousand people*, which had a strong positive correlation with variable *x13* and a negative correlation with variable *x24*. There was also a strong positive dependency between *x2* and *x7*. Due to the study's aim and despite negligible excess in the reference value, we decided to save them for analysis. The reduction resulted in saving 21 features for further analysis.

Quality of life in voivodeships according to Hellwig's synthetic development measure

The regions with the highest quality of life in 2015 are the Lower Silesian, Mazovian and Silesian voivodeships (Table 2). In 2010, the leaders were the same, but the regions took different places. Silesian dropped from first to third position, whereas the two other voivodeships moved up by one position. The development measure has not exceeded 0.4 in the studied years, which means that the values are far from 1, i.e. far from the development model. The distance between the leader in quality of life in 2010 and the next voivodeship is not significant, and amounts to 0.042; in the next studied year it is even smaller (0.019). The last position in the ranking in both years is taken by Warmian-Masurian, the distance of which to the leader is 1:15. An even bigger variety occurred in 2015 between Lower Silesian and Warmian-Masurian, i.e. 78:1. The next to last position is again taken by Subcarpathian, and then Świętokrzyskie. The synthetic index in Polish voivodeships resulted in 5 of them taking the same positions in 2010 and 2015. For Lesser Poland, Pomeranian, West Pomeranian, Subcarpathian and Warmian-Masurian these are position four, five, eight, fifteen and sixteen, respectively. In the analysed years, the regions' quality of life index has not changed substantially (Figure 1). In eleven voivodeships, the index was higher. The biggest improvement occurred in Lubusz (by 0.071), Łódź (by 0.055) and Lower Silesian (by 0.049). In relation to 15 variables in the first of the aforementioned voivodeships, the values improved in the studied years and one remained unchanged. In Łódź, which moved up from ninth to seventh position, we can observe improvement of 17 variables.

Substantial changes in the quality of life can be observed in Lower Silesian, which as the leader of 2015 improved the variables of 16 studied features. All 3 regions improved in terms of the poverty index, decrease in the number of students per 10 thousand people and lower share of wastes subjected to recycling in the wastes generated in a year.

The largest decrease in a synthetic index was observed in the Warmian-Masurian (by 0.066) and Greater Poland (by 0.053) voivodeships. Remaining in the last position of the quality of life ranking, Warmian-Masurian has recorded a decline in 5 indexes and simultaneously assumed minimum values in x_{24} and in x_{33} . Furthermore, we recorded the maximum poverty index in 2015 (at 12.5%, whereas the national average amounted to 7.1%).

On the other hand, Greater Poland moved down from sixth to ninth position. The situation is a consequence of a decline of several indexes, among others. The extreme poverty index has improved substantially in the region (from 6.6% to 8.9%). The number of higher education school students per 10 thousand people has declined however. Furthermore, in the group of features characterising health, two variables took minimum value (x_{21} and x_{22}). The calculated synthetic index allowed for designating the development types based on statistical criteria with the use of the arithmetic mean and standard deviation of the synthetic measure (Zeliaś, 2000). On this basis, we distinguished groups with similar quality of life. For this purpose, we designated 4 divisions: I — regions with the highest quality of life, II — regions with high quality of life, III — regions with low quality of life and IV — regions with the lowest quality of life. In 2010 and 2015, their numbers were comparable (Figure 2 and 3). In both analysed years, half of voivodeships became part of groups with the highest and high quality of life. The group of regions with the highest quality of life in 2010 includes Silesian, Lower Silesian and Mazovian. In 2015, this group was joined by Lesser Poland, despite not changing its position in the ranking. The lowest quality of life is noted in Warmian-Masurian and Subcarpathian, which were joined in 2015 by Świętokrzyskie, despite no changes in the region's ranking position.

The constant positions of regions with the highest quality of life is maintained by Pomeranian, Opole and West Pomeranian. Similarly, Podlasie, Kuyavian-Pomeranian, Lubusz and Lublin are classified in group III, i.e. regions with a low quality of life. It is worth noting the weakening of Greater Poland, which moved from group II to group III, whereas Łódź conversely, moved from III to II.

Quality of life in voivodeships according to the cluster analysis

In the Ward's grouping procedure, we distinguished voivodeship clusters with relatively homogenous features. The grouping results are presented on the dendrograms (Figure 4 and 5). In 2010, with a region division into three clusters, we distinguished two one-element groups: first — Mazovian voivodeship, second — Subcarpathian, and a single fourteen-element group. Five clusters were formed in a bond length of 5,000. The first two were two-element, as in the previous frame. The largest, two six-element clusters were formed by the following regions: Lower Silesian, Łódź, Lublin, Kuyavian-Pomeranian, Lesser Poland and Silesian as well as Podlasie, Pomeranian, Świętokrzyskie, Warmian-Masurian, West Pomeranian and Greater Poland. A separate cluster is composed of Lubusz and Opole.

Mazovian stands out from other units by five features with maximum values (x_2 , x_7 , x_{10} , x_{21} , x_{26}). It is necessary to note that the values are also substantially higher than the highest values of subsequent voivodeships. For example, disposable income per 1 person in Mazovian amounted to PLN 1539.05, whereas in Pomeranian — PLN 1199.98; with a national average of PLN 1105.95. The situation is similar for several other features. Mazovian has 54 doctors per 10 thousand people and the next region, Lubusz — 49, with a national average of 40 doctors. Mazovian distinguishes itself when compared to other regions in terms of the number of higher education school students per 10 thousand people and the percentage of population with higher education. In the analysed voivodeship, the aforementioned indexes are as follows: 614 and 25.4; whereas for Lower Silesian — 577, and Pomeranian — 18.1, with national averages of 440 and 16.9. It is, however, necessary to remember that the capital city of Warsaw positively affects the situation of Mazovian.

The distinctiveness of the Subcarpathian voivodeship clusters is surely due to low results when compared to other regions, especially in terms of material living conditions. This is reflected by the lowest index for the number of housing per 1 thousand people (291.1), whereas in Mazovian, which has the best result, the index amounted to 391.7. In Subcarpathian, there are 395 registered passenger cars per 1 thousand people, whereas in Mazovian — 497 (country average — 440). The region similarly stands out negatively in terms of disposable income per person and in the average gross monthly pension and annuity. In the first case, the index in Subcarpathian amounted to PLN 866.05, whereas in Mazovian — PLN 1539.05. As for the second index, it was PLN 1351.01 and PLN 1637.58 (Mazovian).

With a division into three clusters, the grouping of regions in 2015 looks similar to the grouping of 2010. Mazovian forms a separate cluster, similarly as in the previous view. The next two-element group consists of two regions: Opole and Lubusz. Other regions formed the most numerous five-element cluster. In the five clusters division, we can distinguish the following groups: one-element, two two-elements, four- and seven-element. Mazovian formed a separate cluster. The largest cluster consisted of: Greater Poland, Warmian-Masurian, West Pomeranian, Pomeranian, Świętokrzyskie, Podlasie and Lower Silesian. The least numerous two-element groups consisted of: Lubusz and Opole as well as Subcarpathian and Silesian. It is worth noting the similarity of Opole and Lubusz, which was also observed in 2010. There is a similarity of indicators for which the variability index was the highest. This concerns the following variables: x_6 , x_{13} , x_{21} i x_{30} . For example, in Lubusz and Opole, the poverty index amounted to 4.8 and 6.5, respectively, whereas the average in Poland amounted to 7.1, minimum — 3.4, and maximum — 12.5.

Conclusions

Quality of life is a complex economic category and must be approached and studied in various ways. The diagnosis and evaluation of the quality of life in Polish voivodeships were conducted by taking into consideration the material living conditions, economic activity, health, education and living environment quality, as objective determinants. Their evaluation with the use of the development model and cluster analysis methods leads to the following conclusions:

- The quality of life of the Polish voivodeships' population is not high. The synthetic index calculated using Hellwig's development measure for the best region was substantially below the development model. The ranking leaders in the studied years were as follows: Silesian (0.384) and Lower Silesian (0.391).
- In both analysed years, half of the voivodeships became part of groups with the highest and high quality of life. The groups with the highest, high, low and lowest quality of life are similar for both years. Regions with the highest quality of life in 2010 were Silesian, Lower Silesian and Mazovian, whereas in 2015 — Lower Silesian, Mazovian, Silesian and Lesser Poland. On the other hand, units with the lowest quality of life in the first studied years were: Warmian-Masurian and Subcarpathian, while in the second year: Warmian-Masurian, Subcarpathian and Świętokrzyskie.

- The largest improvement in the quality of life occurred in Lubusz, Łódź and Lower Silesian. In the above units, most variables improved, thereby ensuring the voivodeships promotion in the ranking. The largest decrease in the synthetic index was observed in Warmian-Masurian and Greater Poland. Remaining in the last position of the quality of life ranking, Warmian-Masurian has recorded a decline in several indexes and simultaneously assumed minimum values for two features. Furthermore, we recorded the maximum poverty index in 2015. Greater Poland moved down from sixth to ninth position. The situation is a consequence of decline of several indexes, among others. The extreme poverty index is substantially increasing and we can observe a decrease in the number of higher education school students per 10 thousand people, whereas in the features characterising health, two variables took minimum value.
- The quality of life in Polish voivodeships is relatively varied. In 2010, the distance between Silesian and Warmian-Masurian amounted to 15:1. In the next studied year, the difference increased and amounted to 78:1 (Lower Silesian to Warmian-Masurian).
- All regions in the weakest group are classified as East Poland. This means that the development distance between West Poland and East Poland is not only maintained, but is increasing. Other eastern voivodeships (Podlasie and Lublin) remain in the group with low quality of life. In the light of the conducted studies, the situation is due to the decline in indexes, especially in the group of material living conditions.
- In the Ward's grouping procedure, we distinguished clusters with relatively homogenous features. Mazovian forms separate clusters, because it is distinguished by five features with maximum values. It is necessary to note that the values are also substantially higher than the highest values of subsequent objects. It is worth noting the similarity of Opole and Lubusz clusters observed in both studied years. We observe a similarity in indexes for which the variability index was the highest (poverty index, unemployment rate, doctors per 10 thousand doctors, among others).

It is necessary to remember that the conducted studies do not exhaust the complex topic, because they concern the objective quality of life and omit its subjective dimension. Studying the quality of life is difficult due to the phenomenon's complexity and due to the lack of clear terminology. Furthermore, the problem concerning the studies' methodology remains unresolved. The taxonomic and agglomerative methods used in the paper supplement one another and allow for deeper diagnosis of the topic undertaken. The results of the quality of life studies can constitute a precious

source of information for public and creative institutions, and for institutions implementing the development policy, in which quality of life constitutes the overarching objective. It is necessary to continue research on the quality of life of regional communities with consideration of various methods of study. Without doubt, in order to obtain a full image of quality of life, it is worth considering the subjective perception of quality of life by regional communities in the next studies.

References

- Adamska, H. (2012). Standard and quality of life of rural areas population in the view of new paradigm of development. *Journal of Agribusiness and Rural Development*, 3(25).
- Balcerzak, A. P., & Pietrzak, M. B. (2017). TOPSIS with generalized distance measure GDM in assessing poverty and social exclusion at regional level in Visegrad countries. In P. Prażák (Ed.). *35th international conference mathematical methods in economics MME 2017 conference proceedings*. Hradec Králové: University of Hradec Králové.
- Bywalec, C., & Rudnicki, L. (1999). *Basics of consumption economy*. Kraków: Akademia Ekonomiczna.
- Domanski, H., & Pokropek, A. (2009). Regional differentiation of the relationship between the level of education and income. *Economist*, 5.
- Gotowska, M., & Jakubczak, A. (2012). Application of selected methods for the evaluation of the variated quality of life in Poland. IX Kongres Ekonomistów Polskich, Warszawa. Retrieved from <https://www.pte.pl/kongres/referaty>.
- Hellwig, Z. (1968). Application of the taxonomic method for the typological division of countries in terms of their development as well as resources and structure of qualified staff. *Przegląd Statystyczny*, 15(4).
- Hellwig, Z. (1972). Procedure of evaluating high-level manpower data and typology of countries by means of the taxonomic method. In Z. Gostowski (Ed.). *Towards a system of human resources indicators for less developed countries. Papers prepared for a UNESCO research project*. Wrocław: Ossolineum-The Polish Academy of Sciences.
- Jaworska, R. (2014). Health inequalities across the European union regions: a beta-convergence approach. *Comparative Economic Research*, 4(17). doi: 10.2478/cer-2014-0033.
- Jędrzejczak, A. (2015). Regional income inequalities in Poland and Italy. *Comparative Economic Research*, 4(18). doi: 10.1515/cer-2015-0027.
- Kerce, E. W. (1992). *Quality of life: meaning, measurement, and models*. San Diego: Navy Personnel Research and Development Center.

- Kuc, M., & Sobiechowska-Ziegert, A. (2018). Standard of living in Poland at regional level – classification with Kohonen self-organizing maps. In M. Papież & S. Śmiech (Eds.). *The 12th professor Aleksander Zeliaś international conference on modelling and forecasting of socio-economic phenomena. Conference proceedings*. Cracow: Foundation of the Cracow University of Economics.
- Kuc, M. (2017a). Is the regional divergence a price for the international convergence? The case of the Visegrad group. *Journal of Competitiveness*, 9(4). doi: 10.7441/joc.2017.04.04.
- Kuc, M. (2017b). Social convergence in Nordic countries at regional level. *Equilibrium Quarterly Journal of Economics and Economic Policy*, 12(1). doi: 10.24136/eq.v12i1.2.
- Kusideł, E. (2013). Convergence of regional human development indexes in Poland. *Comparative Economic Research*, 1(16). doi: 10.2478/cer-2013-0006.
- Lewandowska-Gwarda, K., & Olszewski, W. (2017). What is the best place for elderly people? Analysis of the spatial variation of the quality of life of elderly people in Poland. *Polityka społeczna*, 10(523).
- Local Data bank (2017), GUS. Retrieved from http://www.stat.gov.pl/bdl/app/stro na.html?p_name=indeks (30.03.2017).
- Long-term National Development Strategy, Poland 2030 (2013). Third Modernity Wave, adopted by RM on 5 February 2013. Warszawa.
- Malina, A., & Zeliaś, A. (1997). On the creation of a taxonomic quality of life measure. *Taksonomia*, 4.
- Mularska-Kucharek, M., & Wiktorowicz, J. (2012). Quality of life of Łódź residents. Subjective dimension. *Studia Regionalne i Lokalne*, 2(48).
- Namyślak, B. (2015). Application of Hellwig's development model method for studying the culture sector in voivodeship capitals. *Wiadomości Statystyczne*, 3.
- National Human Development Report (2018). United Nations Development Programme, New York, USA.
- Pietrzak, M. B., & Balcerzak, A. P. (2016). Socio-economic Sustainability in Poland. SEM Analysis at Regional Level. In T. Klietk (Ed.). *16th international scientific conference globalization and its socio-economic consequences. (Part IV.)*. Zilina: University of Zilina.
- Polak, E. (2016). Quality of life in Polish voivodeships – comparative analysis of selected regions. *Nierówności Społeczne a Wzrost Gospodarczy*, 48(4). doi: 10.15584/nsawg.2016.4.6.
- Quality of life. Issue 2016 (2016). GUS, Warszawa.
- Rosner, A. (2011). Spatial variation of rural areas. In I. Nurzyńska & M. Drygas (Eds.). *Development of rural areas in Poland. Diagnoses, strategies, policy concepts*. Warszawa: IRWiR PAN.
- Smętkowski, M., & Płoszaj, A. (2011). Large Polish cities – development challenges and intervention as part of the cohesion policy 2004-2006. *Studia Regionalne i lokalne. Wydanie specjalne*. Warszawa.
- Social Diagnosis 2015, Conditions and quality of life of Poles (2015). Rada Monitoringu Społecznego. Warszawa.

- Sompolska-Rzechuła, A. (2016). Variation of social development in spatial view. *Wiadomości Statystyczne*, 1(656).
- Strahl, D. (Ed.) (2006). *Methods of evaluating regional development*. Wrocław: Akademia Ekonomiczna.
- Sustainable Development Strategy until 2020 (with a 2030 perspective)* (2017). Ministry of Development, adopted by RM on 14 February 2017, Warszawa.
- Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community* (2007). Lisbon, 13 December 2007.
- United Nations Development Programme. National Report on Social Development. Poland 2012. Regional and local development* (2012). Biuro Projektowe UNDP w Polsce. Warszawa.
- Voivodeship Statistical Yearbook* (2016). GUS. Warszawa.
- Ward, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association*, 301(58).
- Wawrzyniak, D. (2016). Standard of living in the European Union. *Comparative Economic Research*, 1(19). doi: 10.1515/cer-2016-0008.
- Zadrozniak, M. (2016). Quality of life in cities. In M. Nowakowska, Z. Przygodzki and A. Rzeńca (Eds.). *Eco-city. Society. Sustainable, intelligent and participatory development of a city*. Łódź: Uniwersytet Łódzki.
- Zeliaś, A. (2000). Selection of diagnostic variables. In A. Zeliaś (Ed.). *Taxonomic analysis of spatial variation of the quality of life in Poland in a dynamic view*. Kraków: Akademia Ekonomiczna.

Annex

Table 1. Diagnostic features in studying the quality of life in voivodeships and the variation ratio in 2010 and 2015

Variables*	Variation ratio 2010	Variation ratio 2015
Material living conditions		
x1 Average housing usable area per 1 person in m ²	5.757	5.755
x2 Housing per 1,000 people	7.208	7.204
x3 Housing in cities, equipped with central heating in % of overall housing	4.113	3.988
x4 Housing in towns, equipped with central heating in % of overall housing	10.793	10.502
x5 Passenger vehicles registered per 1 thousand people	7.952	7.638
x6 Risk of poverty index - minimum subsistence level	35.212	39.082
x7 Disposable income per 1 person	13.066	11.170
x8 Average monthly expenses per 1 person in households for food and alcohol-free beverages	5.017	5.747
x9 People benefiting from social assistance services per 10 thousand people	24.207	24.673
x10 Households equipped with a computer with Internet access in %	7.844	5.049
Economic activity		
x11 Average gross monthly remuneration	11.021	10.499
x12 Employment rate in the age group of 18-59/64	3.809	4.229
x13 Registered unemployment rate	22.511	24.357
x14 Registered unemployed remaining without work for longer than one year	47.051	52.266
x15 Average gross monthly pension and annuity in the non-agricultural social insurance system in PLN	9.506	8.770
x16 Balance of internal and foreign migration, and permanent residence per 1 thousand people	-275.298	-156.347
Health		
x17 Average life expectancy of males at the age of 0	1.375	1.199
x18 Average life expectancy of females at the age of 0	0.898	0.912
x19 Deaths due to tumours and circulatory system diseases per 10 thousand residents	10.323	9.941
x20 Overweight or obese persons at the age of 15 and more in % of overall population	2.593	3.550
x21 Doctors (total working personnel) per 10 thousand people	19.109	19.792
x22 Nurses and midwives per 10 thousand people	9.509	11.567
x23 General hospital beds per 10 thousand people	10.624	7.916
Education		
x24 Children encompassed by pre-school education at the age of 3-4 in %	14.375	7.833
x25 Higher education students per 10 thousand people	23.113	32.169
x26 Percentage of people at the age of 15 and more with higher education	15.297	14.935
x27 Adults (aged 25-64) participating in education and training	21.157	34.740

Table 1. Continued

Variables*	Variation ratio 2010	Variation ratio 2015
Living environment quality		
x28 Share of legally protected areas in total area	38.645	38.927
x29 Share of parks, green spaces and neighbourhood greenery areas in total area in %	80.278	80.428
x30 Share of wastes (excluding municipal wastes) subjected to recycling in the wastes generated in a year	29.707	84.305
x31 Population using a waste treatment plant in % of the total population	14.070	10.268
x32 Dust pollutants retained or neutralised in pollution reduction devices	0.602	0.615
x33 Gas pollutants retained or neutralised in pollution reduction devices	56.516	59.571

Note: * Shaded features - features rejected due to insufficient variation and strong dependencies between one another.

Table 2. Classification of voivodeships in terms of quality of life in 2010 and 2015

Position	Voivodeship	d _i 2010	Position	Voivodeship	d _i 2015
Group I - d _i ≥ 0.318 - voivodeships with the highest quality of life			Group I - d _i ≥ 0.342 - voivodeships with the highest quality of life		
1	Silesian	0.384	1	Lower Silesian	0.391
2	Lower Silesian	0.342	2	Mazovian	0.372
3	Mazovian	0.326	3	Silesian	0.353
			4	Lesser Poland	0.342
Group II - 0.212 ≤ d _{and} < 0.318 - voivodeships with the highest quality of life			Group II - 0.228 ≤ d _{and} < 0.342 - voivodeships with the highest quality of life		
4	Lesser Poland	0.314	5	Pomeranian	0.320
5	Pomeranian	0.300	6	Opole	0.271
6	Greater Poland	0.271	7	Łódź	0.263
7	Opole	0.252	8	West Pomeranian	0.255
8	West Pomeranian	0.216			
Group III - 0.106 ≤ d _{and} < 0.212 - voivodeships with a low quality of life			Group III - 0.114 ≤ d _{and} < 0.228 - voivodeships with a low quality of life		
9	Łódź	0.208	9	Greater Poland	0.218
10	Podlasie	0.161	10	Lubusz	0.206
11	Kuyavian-Pomeranian	0.147	11	Lublin	0.168
12	Lubusz	0.135	12	Kuyavian-Pomeranian	0.162
13	Lublin	0.125	13	Podlasie	0.154
14	Świętokrzyskie	0.108			

Table 2. Continued

Position	Voivodeship	d_i 2010	Position	Voivodeship	d_i 2015
Group IV – $d_i < 0.106$ - voivodeships with the lowest quality of life			Group IV – $d_i < 0.114$ - voivodeships with the lowest quality of life		
15	Subcarpathian	0.071	14	Świętokrzyskie	0.112
16	Warmian-Masurian	0.026	15	Subcarpathian	0.055
			16	Warmian-Masurian	0.005

Figure 1. Quality of life in voivodeships in 2010 and 2015

Figure 2. Quality of life in voivodeships in 2010

Figure 3. Quality of life in voivodeships in 2015

Figure 4. Classification of voivodeships in terms of quality of life according to Ward's method for 2010

Figure 5. Classification of voivodeships in terms of quality of life according to Ward's method for 2015